Spring 2018

Linear Algebra (UNG)

Hashim Saber
University of North Georgia, hashim.saber@ung.edu

Beata Hebda
University of North Georgia, beata.hebda@ung.edu

Piotr Hebda
University of North Georgia, piotr.hebda@ung.edu

Benkam Bobga
University of North Georgia, benkam.bobga@ung.edu

Grants Collection
University of North Georgia

UNIVERSITY SYSTEM OF GEORGIA

Hashim Saber, Beata Hebda, Piotr Hebda, and Benkam Bobga

Linear Algebra

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 Details

Manage Application: Textbook Transformation Grants Round Seven

Award Cycle:	Round 7
Internal Submission Deadline:	Sunday, September 4, 2016

Application Title:	264
Application ID:	#001163
Submitter First Name:	Hashim
Submitter Last Name:	Saber
Submitter Title:	Professor
Submitter Email Address:	Hashim.saber@ung.edu
Submitter Phone Number:	678-717-3588
Submitter Campus Role:	Proposal Investigator (Primary or additional)
Applicant First Name:	Hashim
Applicant Last Name:	Saber
Applicant Email Address:	hashim.saber@ung.edu
Applicant Phone Number:	678-717-3588
Primary Appointment Title:	Professor
Institution Name(s):	University of North Georgia
Proposal Category:	No-or-Low-Cost-to-Students Learning Materials
Submission Date:	Tuesday, September 6, 2016

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

Dr. Hashim Saber, Professor of Mathematics; Hashim.Saber@ung.edu

Dr. Piotr Hebda, Professor of Mathematics; Piotr.Hebda@ung.edu

Dr. Beata Hebda, Professor of Mathematics; Beata.Hebda@ung.edu

Dr. Benkam Bobga, Associate Professor of Mathematics; Benkam.Bobga@ung.edu

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

Dr. John Cruthirds, Department Chair of Mathematics, University of North Georgia;

john.cruthirds@ung.edu

Final Semester of Instruction: Fall 2017

Proposal Title: 264

Course Names, Course Numbers and Semesters Offered:

1.	*Calculus I; Math 1450, offered every Fall, Spring and Summer semesters*
2.	*Calculus III; Math 2470, offered every Fall, Spring, and Summer semesters.*
3.	*Linear Algebra; Math 3650, offered every Fall, Spring and Summer semesters.*
4.	*Differential Equations; Math 3000, Offered every Fall and Spring semesters.*

Average Number of Students per Course Section: 30

Number of Course Sections Affected by Implementation in Academic Year: 20

Total Number of Students Affected by Implementation in Academic Year: 600

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

Requested Amount of Funding: $21,400

Original per Student Cost: Calculus I($305.00); Clculus III($305.00)Linear Algebra($207.00);Differential Equations($235.00)

Post-Proposal Projected Student Cost: $0. (100% savings)

Projected Per Student Savings:	Calculus I($305.00); Clculus III($305.00)Linear Algebra($207.00);Differential Equations($235.00)
Projected Total Annual Student Savings:	Total $167,880

Creation and Hosting Platforms (Use "n/a" if none):

WeBWork*: Online Homework Management System – Hosted by UNG server,*

Shared Class Files: *local platform made available to our faculty to store class materials,*

Desire to Learn (D2L).

Project Goals:

1.1Project Goals

There are four goals that the project intends to achieve

To Replace high-cost required textbooks by high-quality and affordable instructional materials through Open Education Resources (OER) at zero cost to students for four courses. As a result of using available zero cost resources, students will have access to their textbooks starting the first day of class, regardless of their financial situation. Some students in general 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. By using available textbooks from day one of classes, we eliminate such issues.

To incorporate a free computerized homework delivery, quiz delivery, and grading system (WeBWork) into each course. WeBWorK is a free online homework management system created by the Mathematical Association of America to manage homework assignments, quizzes, and to create problem sheets. Commercial software is usually costly and most students do not take the advantage of using the software because they cannot afford buying it. WeBWork is already hosted on the UNG server. With WeBWork complementing a free textbook, we will be matching the commercial textbook approach by having an online textbook and an online homework delivery system at no cost.

Utilize the freedom to edit, share, and make the necessary changes to open educational resources to construct and tailor class notes. This will be done utilizing an instructional framework that is more classroom-devoted, engaging students in the learning process, and

teaching students how to learn. Two of the proposed textbooks (Calculus I and Calculus III) will be chosen from OpenStax College textbooks and the other two (Differential Equations and Linear Algebra) from other OER.

Build awareness among faculty at UNG about open educational resources (OERs) and the available Open resources. This will include introducing faculty at our four campuses to the opportunities and resources offered at Affordable Learning Georgia (ALG). To achieve this goal we will organize a presentation accessible to all campuses.

This project will make all instructional materials (online textbook and online homework system) available to all students in the four proposed courses from day one of the semester at no cost. The project may serve to increase retention and progression in the course especially for low-income students and students who rely on financial-aid arrangements.

Statement of Transformation:

1.1Statement of Transformation

For the four courses, Calculus I, Calculus III, Linear Algebra, and Differential Equations, free online texts will be adopted and will be linked to D2L and Shared Class Files to make them accessible to students on-campus and out of campus. We will be using OpenStax textbooks for Calculus I and Calculus II. The Linear algebra and Differential equations textbooks will be chosen from other from other OER.

Students will access all open resources on the D2L and Shared Class Files at no cost to them. To improve teaching and learning, WeBWork, which is also free, will be used for homework and quizzes. All materials will be available to students at no cost. Students will be given the option to purchase a hard copy (which is about $35 for OpenStax textbooks). Research results indicated that 82% of students felt they would do SIGNIFICANTLY BETTER in a course if the textbook was available free online and buying a hard copy was optional. (Senack, Ethan 2014)

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.

The faculty members at UNG who teach these courses are also stakeholders, because the materials developed in this project will be available to them. Mathematics faculty will have the opportunity to use innovative open resources with the same quality as commercial texts and materials. In addition, each faculty member will be able to use 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 the four proposed courses. Significant features of this project are: the high quality of teaching materials using OpenStax and other resources, reduction in financial concerns for students, and easy access to our class websites on Shared Class Files. Also, in agreement with the goals of this project, we will organize a presentation to UNG faculty to introduce them to open resources.

This project will have an immediate impact on approximately 600 students, reducing their total cost of learning materials by approximately *$167,880* during the implementation year. The annual savings will be even higher when more faculty join the program in the future.

Transformation Action Plan:

1.1Transformation Action Plan

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

Review and development

Each team member will review all course materials and examine available free educational open resources in order to find the most appropriate open texts. We will modify existing syllabi to incorporate free open resources and computerized homework delivery system using WeBWorK.

Creation of open education rescores

Delivery process of the course material will be based on the selected open textbooks. We will also create homework assignments and quizzes for each section of each course on WeBWorK and make these assignments available to faculty who teach these courses.

Integration

We will search for appropriate videos and interactive multimedia content. We will supply students with the necessary links needed to access these short videos or interactive multimedia contents.

Implementation

The proposed project will be implemented in Calculus I, Calculus III, Linear Algebra, and Differential Equations. The proposed classes and sections covered by this project during the year of implementation is summarized in the table.

	Spring 2017	*Summer 2017*	*Fall 2017*

Dr. P. Hebda	*Calc 1;DE*		*Calc 1;DE*
Dr. H. Saber	*Calc 1; LA*	*Calc I; LA*	*Calc 1; LA;DE*
Dr. B. Bobga	*Calc I; Calc III*	*Calc III*	*Calc I; Calc III*
Dr. B. Hebda	*Calc I; Calc III*		*Calc I; Calc III*

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

Quantitative & Qualitative Measures:

1.1QUantitative and Qualitative MeasuresQuantitative MeasureThe data for the quantitative measure will be collected according to the following table:Data for the table above will be collected from Spring 2017 and Fall 2017 for all the above mentioned courses which will be analytically compared with a similar set of data from control courses (collected from old records and Banner Web) previously taught in a traditional fashion using commercial textbooks and/or an online publishers' website. The linear correlation will be examined to study the interplay between "no cost" courses and "students' success/retention". We anticipate the adoption of free material will increase retention. Existing research shows an increase in student retention and an improvement in student performance associated with the adoption of free instructional materials (Bryan and Miller, 2013).Qualitative MeasureThe data for qualitative measure will be collected through students' feedback surveys. 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. The two surveys will be conducted to determine students' progress in the following areas: how often students use online resources; how regularly students are 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. We also ask students if they encountered any difficulties using the materials accessible through the internet or their mobile devices so that the courses will be easier to access from anywhere using a wide variety of devices such as tablets and smartphones.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 will be

created to address the effect of applying open resources on the following learning outcomes:Students will be able to identify and relate to the course specific topic mastery requirements.Students will be able to relate each of the course topics with at least one real life application problem and master it.Students will be able to develop skills for reading Mathematics course materials and retain the information with ease.Students will exhibit the characteristic of self-directed learners.

Timeline:

1.1Timeline

10/17/2016	Kick-off meeting to construct learning materials for the four courses (Calculus I, Calculus III, Linear Algebra, and Differential Equations).
10/30/2016	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.
11/30/2016	Complete creation of the necessary class notes and materials needed for each of the four courses based on the selected no-cost e-textbook.
12/15/2016	Complete creation of assignments in WeBWork for each of the four courses. [WeBWork is already installed in UNG-Gainesville server]
12/20/2016	Submit a semester status report to ALG
12/20/2016	Finalize the learning materials and upload all needed electronic materials to Shared Class Files and UNG WeBWork site to make sure that all four courses are ready for delivery in the Spring 2017 semester.

January 09, 2017-May 6, 2017	1/16/2017 Pre-survey completed for the four courses
	Implementation: Piloting of course materials for 8 sections of the four courses during Spring 2017 semester.
	5/6/2017 Complete data collection and complete Post-survey (for the four courses)
May 2017	Review and modify the piloted materials
May 20, 2017	Submit a semester status report to ALG
Summer 2017	Implement possibly 3 sections for three of the four courses
August 12, 2017	Submit a semester status report to ALG
Fall 2017	Implement the process for 9 sections of the four courses;
	Give a presentation to introduce faculty to open resources and conduct discussions to see if implementation on a larger scale is an appropriate departmental endeavor.
December 2017	Work on data analysis and evaluating course effectiveness
	Prepare final project report
December 23, 2017	Submit final project report

Budget:

1.1Budget

Dr. Hashim Saber	Faculty additional time spent for preparing instructional materials	$5,000
Dr. Piotr Hebda		$5,000
Dr. Beata Hebda		$5,000
Dr. Benkam Bobga		$5,000
Travel	Kick-off meeting or Conference	$800
Supplementary material	Paper, ink cartridges, hardcopies of the textbook, and copying cost. etc	$600

Sustainability Plan:

1.1Sustainability 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 (8 sections in Spring 2017, possibly 3 sections in Summer 2017, and 9 sections in Fall 2017). Materials (OpenStax and No-Cost Resources 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 materials and will maintain and update materials as needed.

References & attachments

Goodwin Bryan, and Kirsten Miller. “Evidence On Flipped Classrooms Is Still Coming In.” Educational Leadership 70.6 (2013): 78–80. OmniFile Full Text Mega (H.W. Wilson).

Lane Fischer, John Hilton III, T. Jared Robinson, David A. Wiley “*A multi-institutional study of the impact of open textbook adoption on the learning outcomes of post-secondary students”;* Journal of Computing in Higher Education; December 2015, Volume 27, Issue 3, pp 159–172

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

Senack, Ethan. “*Fixing the Broken Textbook Market: How Students Respond to High Textbook Costs and Demand Alternatives*.” (2014). US Public Interest Research Group. retrieved from http://www.uspirg.org/sites/pirg/files/reports/NATIONAL%20Fixing%20Broken%20Textbooks%20Report1.pdf

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DEPARTMENT OF MATHEMATICS

August 30, 2016

Affordable Learning Textbook Transformation Grant
Review Committee

Dear Committee Members:

I am writing this letter in support of the proposal being submitted to you by Professors Piotr Hebda, Beata Hebda, Benkam Bobga, and Hashim Saber from my department. I am in full support of this proposal because I believe the proposal has strong merit and because these four faculty members are talented faculty members who are well qualified to accomplish the goals of the proposal.

Piotr Hebda, Beata Hebda, Benkam Bobga, and Hashim Saber all have significant experience teaching the courses that are targeted in the proposal. I am excited at the potential financial savings our students could realize, and I intend to lend full departmental support for the work of this proposal. Since we teach multiple sections of these courses every semester, including summer, the potential sustainability of the project will not be a concern. The expansion of the project to other sections of these classes on our other four campuses can be accomplished by working through our existing departmental Curriculum Committee which has representation from faculty on all University of North Georgia campuses.

I am in full support of this proposal, and I hope that you will be able to give the proposal every possible consideration. I would be happy to comment further if you so like.

Sincerely,

John Cruthirds

John Cruthirds, Head
Department of Mathematics
john.cruthirds@ung.edu
706 864-1810

Affordable Learning Georgia Textbook Transformation Grants
Rounds Six, Seven, and Eight
For Implementations beginning Spring Semester 2017
Running Through Fall Semester 2017

Submitter Name	Hashim Saber
Submitter Title	Professor
Submitter Email	Hashim.saber@ung.edu
Submitter Phone Number	678-717-3588
Submitter Campus Role	*Proposal Investigator*
Applicant Name	*Hashim Saber*
Applicant Email	Hashim.saber@ung.edu
Applicant Phone Number	678-717-3588
Primary Appointment Title	Professor
Institution Name(s)	University of North Georgia – Gainesville Campus
Team Members	1. *Dr. Hashim Saber, Professor of Mathematics; Hashim.Saber@ung.edu* 2. *Dr. Piotr Hebda, Professor of Mathematics; Piotr.Hebda@ung.edu* 3. *Dr. Beata Hebda, Professor of Mathematics; Beata.Hebda@ung.edu* 4. *Dr. Benkam Bobga, Associate Professor of Mathematics; Benkam.Bobga@ung.edu*
Sponsor, Title, Department, Institution	*Dr. John Cruthirds, Department Chair of Mathematics, University of North Georgia; john.cruthirds@ung.edu*

<table>
<tr><td>Proposal Title</td><td colspan="5">Zero-cost textbooks and online homework management system for four mathematics courses

(Calculus I, Calculus III, Differential Equations and Linear Algebra)</td></tr>
<tr><td>Course Names, Course Numbers and Semesters Offered</td><td colspan="5"><table>
<tr><td>1.</td><td>Calculus I; Math 1450, offered every Fall, Spring and Summer semesters</td></tr>
<tr><td>2.</td><td>Calculus III; Math 2470, offered every Fall, Spring, and Summer semesters.</td></tr>
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<tr><td>4.</td><td>Differential Equations; Math 3000, Offered every Fall and Spring semesters.</td></tr>
</table></td></tr>
<tr><td>Final Semester of Instruction</td><td colspan="5">Fall 2017</td></tr>
<tr><td>Average Number of Students Per Course Section</td><td>30</td><td>Number of Course Sections Affected by Implementation in Academic Year</td><td>20</td><td>Total Number of Students Affected by Implementation in Academic Year</td><td>600</td></tr>
<tr><td>Award Category (pick one)</td><td colspan="5">☒ No-or-Low-Cost-to-Students Learning Materials (No – Cost for Differential Equations and Linear Algebra)
☒ OpenStax Textbooks (for Calculus I and III)
☐ Interactive Course-Authoring Tools and Software
☐ Specific Top 100 Undergraduate Courses</td></tr>
<tr><td>List the original course materials for students (including title, whether optional or required, & cost for each item)</td><td colspan="5"><table>
<tr><td>Calculus I</td><td>Calculus. Early Transcendental Functions 6th edition by Larson & Edwards (Publisher: Brooks/Cole)</td><td>$305</td></tr>
<tr><td>Calculus III</td><td>Same as Calculus I</td><td>$ 305</td></tr>
<tr><td>Linear Algebra (LA)</td><td>Linear Algebra and its Applications (5th edition)</td><td>$207</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>David Lay, Steven Lay, Judi McDonald</td><td></td></tr>
<tr><td>Differential Equations (DE)</td><td>Zill, A First Course in Differential Equations with Modeling Applications, 10th Ed., Brooks/Cole, 2012.</td><td>$235.00</td></tr>
</table>
</td></tr>
<tr><td>Requested Amount of Funding</td><td>$21,400</td></tr>
<tr><td>Original Per Student Cost</td><td>
<table>
<tr><td>1</td><td>Calculus I</td><td>$305.00</td><td>Total 9 sections per year</td></tr>
<tr><td>2</td><td>Calculus III</td><td>$305.00</td><td>Total 5 sections per year</td></tr>
<tr><td>3</td><td>Linear Algebra</td><td>$207.00</td><td>Total 3 section per year</td></tr>
<tr><td>4</td><td>Differential Equations</td><td>$235.00</td><td>Total 3 section per year</td></tr>
</table>
</td></tr>
<tr><td>Post-Proposal Projected Per Student Cost</td><td>$0. (100% savings)</td></tr>
<tr><td>Projected Per Student Savings</td><td>
<table>
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<tr><td>4</td><td>Differential Equations</td><td>$ 235.00</td></tr>
</table>
</td></tr>
<tr><td>Projected Total Annual Student Savings</td><td>Calculus I: 9*30*$305= $82, 350
Calc III: 5*30*$305=$45,750
Linear Algebra: 3*30*207 = $18,630
Differential Equations: 3*30*$235 =$21,150
Total $167,880</td></tr>
<tr><td>Creation and Hosting Platforms Used</td><td>WeBWork: Online Homework Management System – Hosted by UNG server,

Shared Class Files: local platform made available to our faculty to store class materials,</td></tr>
</table>

	Desire to Learn (D2L).

NARRATIVE

1.1 PROJECT GOALS

There are four goals that the project intends to achieve

1. To Replace high-cost required textbooks by high-quality and affordable instructional materials through Open Education Resources (OER) at zero cost to students for four courses. As a result of using available zero cost resources, students will have access to their textbooks starting the first day of class, regardless of their financial situation. Some students in general 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. By using available textbooks from day one of classes, we eliminate such issues.

2. To incorporate a free computerized homework delivery, quiz delivery, and grading system (WeBWork) into each course. WeBWorK is a free online homework management system created by the Mathematical Association of America to manage homework assignments, quizzes, and to create problem sheets. Commercial software is usually costly and most students do not take the advantage of using the software because they cannot afford buying it. WeBWork is already hosted on the UNG server. With WeBWork complementing a free textbook, we will be matching the commercial textbook approach by having an online textbook and an online homework delivery system at no cost.

3. Utilize the freedom to edit, share, and make the necessary changes to open educational resources to construct and tailor class notes. This will be done utilizing an instructional framework that is more classroom-devoted, engaging students in the learning process, and teaching students how to learn. Two of the proposed textbooks (Calculus I and Calculus III) will be chosen from OpenStax College textbooks and the other two (Differential Equations and Linear Algebra) from other OER.

4. Build awareness among faculty at UNG about open educational resources (OERs) and the available Open resources. This will include introducing faculty at our four campuses to the opportunities and resources offered at Affordable Learning Georgia (ALG). To achieve this goal we will organize a presentation accessible to all campuses.

   This project will make all instructional materials (online textbook and online homework system) available to all students in the four proposed courses from day one of the semester at

no cost. The project may serve to increase retention and progression in the course especially for low-income students and students who rely on financial-aid arrangements.

1.2 STATEMENT OF TRANSFORMATION

For the four courses, Calculus I, Calculus III, Linear Algebra, and Differential Equations, free online texts will be adopted and will be linked to D2L and Shared Class Files to make them accessible to students on-campus and out of campus. We will be using OpenStax textbooks for Calculus I and Calculus II. The Linear algebra and Differential equations textbooks will be chosen from other from other OER.

Students will access all open resources on the D2L and Shared Class Files at no cost to them. To improve teaching and learning, WeBWork, which is also free, will be used for homework and quizzes. All materials will be available to students at no cost. Students will be given the option to purchase a hard copy (which is about $35 for OpenStax textbooks). Research results indicated that 82% of students felt they would do SIGNIFICANTLY BETTER in a course if the textbook was available free online and buying a hard copy was optional. (Senack, Ethan 2014)

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.

The faculty members at UNG who teach these courses are also stakeholders, because the materials developed in this project will be available to them. Mathematics faculty will have the opportunity to use innovative open resources with the same quality as commercial texts and materials. In addition, each faculty member will be able to use 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 the four proposed courses. Significant features of this project are: the high quality of teaching materials using OpenStax and other resources, reduction in financial concerns for students, and easy access to our class websites on Shared Class Files. Also, in agreement with the goals of this project, we will organize a presentation to UNG faculty to introduce them to open resources.

This project will have an immediate impact on approximately 600 students, reducing their total cost of learning materials by approximately *$167,880* during the implementation year. The annual savings will be even higher when more faculty join the program in the future.

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 examine available free educational open resources in order to find the most appropriate open texts. We will modify existing syllabi to incorporate free open resources and computerized homework delivery system using WeBWorK.

2. *Creation of open education rescores*

Delivery process of the course material will be based on the selected open textbooks. We will also create homework assignments and quizzes for each section of each course on WeBWorK and make these assignments available to faculty who teach these courses.

3. Integration

We will search for appropriate videos and interactive multimedia content. We will supply students with the necessary links needed to access these short videos or interactive multimedia contents.

4. Implementation

The proposed project will be implemented in Calculus I, Calculus III, Linear Algebra, and Differential Equations. The proposed classes and sections covered by this project during the year of implementation is summarized in the table.

	Spring 2017	*Summer 2017*	*Fall 2017*
Dr. P. Hebda	*Calc 1;DE*		*Calc 1;DE*
Dr. H. Saber	*Calc 1; LA*	*Calc I; LA*	*Calc 1; LA;DE*
Dr. B. Bobga	*Calc I; Calc III*	*Calc III*	*Calc I; Calc III*
Dr. B. Hebda	*Calc I; Calc III*		*Calc I; Calc III*

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

1.4 QUANTITATIVE AND QUALITATIVE MEASURES

Quantitative Measure

The data for the quantitative measure will be collected according to the following table:

Course	Total no. of stud. Registered	Preliminary assessment [First formative assessment] (median)	Withdraw %	Cumulative Final exam [Summative assessment] (median)	Pass %	Fail % Individual Scores are less than 60%
Calculus I (Math 1450)						
Calculus III (Math 2470)						

Linear Algebra (Math 3650)						
Differential Equations (Math 3000)						

Data for the table above will be collected from Spring 2017 and Fall 2017 for all the above mentioned courses which will be analytically compared with a similar set of data from control courses (collected from old records and Banner Web) previously taught in a traditional fashion using commercial textbooks and/or an online publishers' website. The linear correlation will be examined to study the interplay between "no cost" courses and "students' success/retention". We anticipate the adoption of free material will increase retention. Existing research shows an increase in student retention and an improvement in student performance associated with the adoption of free instructional materials (Bryan and Miller, 2013).

Qualitative Measure

The data for qualitative measure will be collected through students' feedback surveys. 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. The two surveys will be conducted to determine students' progress in the following areas: how often students use online resources; how regularly students are 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. We also ask students if they encountered any difficulties using the materials accessible through the internet or their mobile devices so that the courses will be easier to access from anywhere using a wide variety of devices such as tablets and smartphones.

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 will be created to address the effect of applying open resources on the following learning outcomes:

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.

1.5 TIMELINE

10/17/2016	Kick-off meeting to construct learning materials for the four courses (Calculus I, Calculus III, Linear Algebra, and Differential Equations).
10/30/2016	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.
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12/20/2016	Submit a semester status report to ALG
12/20/2016	Finalize the learning materials and upload all needed electronic materials to Shared Class Files and UNG WeBWork site to make sure that all four courses are ready for delivery in the Spring 2017 semester.
January 09, 2017-May 6, 2017	1/16/2017 Pre-survey completed for the four courses Implementation: Piloting of course materials for 8 sections of the four courses during Spring 2017 semester. 5/6/2017 Complete data collection and complete Post-survey (for the four courses)
May 2017	Review and modify the piloted materials
May 20, 2017	Submit a semester status report to ALG
Summer 2017	Implement possibly 3 sections for three of the four courses
August 12, 2017	Submit a semester status report to ALG
Fall 2017	Implement the process for 9 sections of the four courses; Give a presentation to introduce faculty to open resources and conduct discussions to see if implementation on a larger scale is an appropriate departmental endeavor.
December 2017	Work on data analysis and evaluating course effectiveness Prepare final project report
December 23, 2017	Submit final project report

1.6 BUDGET

Dr. Hashim Saber	Faculty additional time spent for preparing instructional materials	$5,000
Dr. Piotr Hebda		$5,000
Dr. Beata Hebda		$5,000
Dr. Benkam Bobga		$5,000
Travel	Kick-off meeting or Conference	$800
Supplementary material	Paper, ink cartridges, hardcopies of the textbook, and copying cost. etc	$600

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 (8 sections in Spring 2017, possibly 3 sections in Summer 2017, and 9 sections in Fall 2017). Materials (OpenStax and No-Cost Resources 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 materials and will maintain and update materials as needed.

References & attachments

Goodwin Bryan, and Kirsten Miller. "Evidence On Flipped Classrooms Is Still Coming In." Educational Leadership 70.6 (2013): 78–80. OmniFile Full Text Mega (H.W. Wilson).

Lane Fischer, John Hilton III, T. Jared Robinson, David A. Wiley "*A multi-institutional study of the impact of open textbook adoption on the learning outcomes of post-secondary students";* Journal of Computing in Higher Education; December 2015, Volume 27, Issue 3, pp 159–172

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

Senack, Ethan. "*Fixing the Broken Textbook Market: How Students Respond to High Textbook Costs and Demand Alternatives*." (2014). US Public Interest Research Group. retrieved from http://www.uspirg.org/sites/pirg/files/reports/NATIONAL%20Fixing%20Broken%20Textbooks%20Report1.pdf

Syllabus

University of North Georgia
College of Science and Mathematics
Mathematics Department

Mathematics 3650, Introduction to Linear Algebra

Semester: Fall 2017, 3:30 pm

Instructor: Dr. Beata Hebda

Office: Gainesville Campus, Watkins Building, Room 143

Office Phone: 678 717 3809
If I am not in my office, please leave a message. In general, if I am not in my office, it is easier to contact me via email, since I check my email more often than I listen to the voice mail.

E-Mail: beata.hebda@ung.edu

Fax number: 678 717 3778

Office Hours:

M, W	9:00 am - 10:00 am
F	8:00 am - 10:00 am
Tu, Th	9:00 am - 9:30 am 10:45 am - 11:15 am 3:00 pm - 3:30 pm

Important dates:

1. Drop Add: August 21-25, 2017

2. Mid-Semester Drop Date: Friday, October 13, 2017.

Dropping the course after this date means an automatic "WF", unless the Dean gives specific approval. Prior to this date, a "W" will be awarded.

3. Final Exam: 8:00 am-10:00 am, Thursday, Dec. 14, 2017

Text and Other Materials:

1. Required Text: Linear Algebra, Jim Hefferon, 3rd edition (available at http://joshua.smcvt.edu/linearalgebra/)

2. Supplemental Text: None.
3. Library Resources:

- Dunham, *The Mathematical Universe: An Alphabetical Journey Through the Great Proofs, Problems, and Personalities*, Wiley & Sons, New York, 1994.

- Halmos, Paul R., *Linear Algebra Problem Book*, Dolciani Mathematical Expositions Number 16, The Mathematical Association of America, Washington, D.C., 1995.
- Halmos, *Problems for Mathematicians, Young and Old*, MAA, Washington, D.C., 1991.
- Leon, S. J. Linear Algebra with Applications (5th edition), Prentice Hall, Inc., Upper Saddle River, N.J., 1998.
- Sterrett, *101 careers in mathematics*, MAA, second edition, 2003.
- *Women, Minorities and Persons with Disabilities in Science and Engineering,* National Science Foundation, 1999 (NS 1.49).
- Yount, *A to Z of women in science and math*, Facts on File, 1999.

4. World Wide Web resources:

- Association for Women in Mathematics - http://www.awm-math.org
- Math Archives - http://archives.math.utk.edu
- The Math Forum - http://mathforum.org/
- Texas Instruments - http://education.ti.com/educationportal/
- Eric Weisstein's World of Mathematics (Encyclopedia of Mathematics) - http://mathworld.wolfram.com
- SOS Mathematics – www.sosmath.com
- The Geometry Center - http://www.geom.uiuc.edu
- Careers in mathematics - http://www.ams.org/careers/

5. Technology Resources:

- A graphing calculator such as a TI-84 Plus
- Software: Maple or Matlab

Course Description: This course is an introduction to the study of linear algebra. The topics included in this course are linear systems, matrices, vector spaces, determinants, linear transformations, inner products, eigenvalues and eigenvectors. **Credit:** 3 hours. **Prerequisite**: Grade of C or above in Math 2460 or approval of the department head.

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

- Use row operations and echelon forms to solve a system of linear equations.
- Use systems of equations to determine linear independence and span of a set of vectors.
- Prove basic theorems of linear algebra.
- Find the inverse of an invertible matrix and use it to solve systems of equations.
- Find the determinant of a square matrix and apply determinant methods for solving systems of linear equations.
- Determine if a given set with a defined addition and scalar multiplication is a vector space.
- Determine if a subset of a vector space is or is not a subspace of that vector space.
- For a set of vectors in a vector space, determine the span, whether the set is linear independent and whether the set is a basis for the vector space.
- Find a basis for the row space, column space and nullspace of a given matrix.
- Find the rank of a given matrix.
- Find the transition matrix from one basis to another.
- Determine if a function from a vector space to a vector space is or is not a linear transformation. Represent a given linear transformation as a matrix with respect to any given bases.
- Determine if a set of vectors is or is not orthogonal with respect to a given inner product.

- Determine the eigenvalues of a given matrix.
- Find bases for the eigenspaces of a given matrix.
- Give definitions of inner product and inner product space. Describe the fundamental properties of inner product spaces..
- Explain the concept of orthogonality of vectors and subspaces. Explain the concept of orthogonality of vectors. Explain the orthogonality relations among the four fundamental subspaces of a matrix.
- Diagonalize a given nxn matrix and state necessary and sufficient conditions for a matrix to be diagonalizable.
- Derive the normal equations and solve a least-squares problem.
- Model an applied problem using matrices and/or concepts of linear algebra.
- Interpret the solution of an applied problem in the context of the situation.

Methods of Instruction: The methods of instruction are determined by the instructor; however, the instructor is encouraged to use a variety of methods. These methods 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: Formative assessment will be in the form of 4 written tests and weekly online homework. Summative assessment will be in the form of a final examination.

Final grades will be determined as follows:

4 tests	60%
WebWork homework	15%
Comprehensive Final Exam	25%

Grade Distribution:

90 - 100	A
80 - 89	B
70 - 79	C
60 - 69	D
Below 60	F

Test dates:

Test 1	**Thursday, September 14, 2017**
Test 2	**Tuesday, October 10, 2017**
Test 3	**Thursday, November 2, 2017**
Test 4	**Thursday, November 30, 2017**

Weekly WebWork Homework will be due at 11:59 pm each Wednesday (except November 22, 2017) starting on August 30, 2017.

Course Calendar: (Number of 50 minute lessons is approximate)
1. Systems of equations, row operations and echelon forms – 6 days
2. Matrices, vectors, span and linear independence – 6 days

3. Determinants – 3 days
4. Vector spaces, bases, dimension and rank – 9 days
5. Linear transformations – 3 days
6. Eigenvalues and eigenvectors – 4 days
7. Inner products and orthogonality – 4 days.

Class notes can be accessed in Shared Class Files under Instructors, H, hebda.b, and the class folder. If you miss a class, it is your responsibility to check the class notes and complete any work assigned on that day.

Make-up Information:

Make-up tests will be given only in cases of serious, documented emergencies. Difficulties with transportation to campus will not, in general, count as such emergencies.

No makeup of WebWork homework will be offered, but there will be an unlimited number of tries for each assignment. Two lowest homework scores will be dropped.

The lowest test score will be replaced by the score of the final exam, if that score is higher.

Attendance Policy:

The attendance at all classes is mandatory. All tests must be taken when scheduled.

Coming to a class late or leaving a class earlier will count as ½ of an absence. If you come to class late, it is your responsibility to make sure that I mark you as present.

Any student with 5 or more unexcused absences *may* be dropped from class without warning. The grade will be a W or WF, depending on time of dropping (not the time of absence) and student performance.

Academic Honesty:

Academic honesty is highly valued at UNG. A student caught using any unauthorized materials while taking a test will receive a zero on the test and will be reported to the University Administration.

Students are expected to refer to the Supplemental Syllabus (http://ung.edu/academic-affairs/policies-and-guidelines/supplemental-syllabus.php**) for the following information:**

1. **Academic Exchange**
2. **Academic Integrity Policy**
3. **Academic Success Plan Program**
4. **Class Evaluations**
5. **Course Grades and Withdrawal Process**
6. **Disruptive Behavior Policy**
7. **Inclement Weather**
8. **Smoking Policy**
9. **Students with Disabilities**

SPECIFIC DETAILS OF THIS SYLLABUS MAY BE SUBJECT TO CHANGE.

Final Report

Affordable Learning Georgia Textbook Transformation Grants

Final Report

Date: 12/20/2017

Grant Number: 264

Institution Name(s): University of North Georgia

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

1. Beata Hebda, Professor of Mathematics; Beata.Hebda@ung.edu

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

3. Piotr Hebda, Professor of Mathematics; Piotr.Hebda@ung.edu

4. Benkam Bobga, Associate Professor of Mathematics; Benkam.Bobga@ung.edu

Project Lead: Hashim Saber

Course Name(s) and Course Numbers:

1. *Calculus I; Math 1450*
2. *Calculus III; Math 2470*
3. *Linear Algebra: Math 3650*
4. *Differential Equations; Math 3000*

Semester Project Began: Spring 2017

Semester(s) of Implementation: Spring 2017, Summer 2017, Fall 2017

Average Number of Students Per Course Section: 26

Number of Course Sections Affected by Implementation: 15 [6 in Spring2017; 3 in Summer2017; and 6 in Fall2017]

Total Number of Students Affected by Implementation: 397

1. Narrative

	Cost of textbook	2015/2016 data	Students affected by Implementation of this project during 2017			
		Number of Students enrolled	Number of Students enrolled	Number of sections	No. of students responded to survey (Before)	No. of students responded to survey (After)
Calculus I	$305	220	229	7	129	92
Calculus III	$305	131	64	3	33	42
Differential Equations	$235	30	56	2	52	50
Linear Algebra	$207	31	48	3	55	40
Total		412	397	15	269	224

This project had a direct impact on 397 students and saved them a significant amount of money [$112,461] in four mathematics courses (Calculus I, Calculus II, Differential Equations, and Linear Algebra). We felt that we accomplished our main goal of this project in replacing high-cost required textbooks by high-quality and affordable instructional materials at zero cost to 397 students. We have incorporated chosen open textbooks, a free computerized homework, and quiz delivery and grading system (WeBWork). Depending whether students in a typical course buy an e-version (usually at half price of the hardcopy book), or purchase a hardcover copy, the savings were $56,230 to $112,461. 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. 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. For calculus I, Calculus III and Differential Equations, students were generally pleased with the content and examples of the selected textbooks. The selected linear algebra textbook was more theoretical and students found it hard to follow. Many students commented though that using the textbook allowed them to become more mature mathematically. Also, some students appreciated learning the theory behind linear algebra matrix manipulations.

Transformative impacts on students involved in this project include relevance, zero cost of the material and presentation of the resources. The chosen open resources and constructed materials (class notes, open textbooks materials) 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. Local shared class files were used to post course materials.

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 from day one eliminates the inconvenience of unnecessary delay making course material available to students at the beginning of the semester. It also raised their awareness regarding resources that available to them at zero cost.

Having ALG and other venders 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. 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. On the other hand, WeBWorK is based on a remarkable computational power system that is capable of verifying a wide variety of students' answers, wider than typical commercial systems.

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 with a different approach of assessment (specifications grading) that encourage students to do the homework with ease and without their worry about grades.

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.

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. Another approach which we can explore in the future is to have students purchase a commercial homework delivery system like WebAssign with an extra cost and keep the free textbook. In this case we will be moving from zero cost to students to partial cost for the software and students still can save a lot of money.

Quotes from students

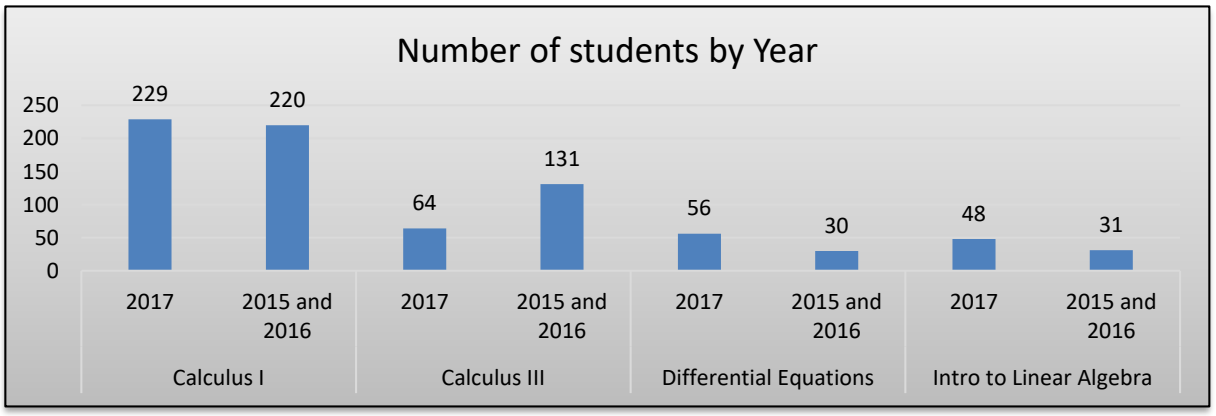
- **Textbook:** I would also like to say that yes, the free text was definitely helpful since textbooks normally cost a good deal of money. I also found the smart board notes to be helpful.

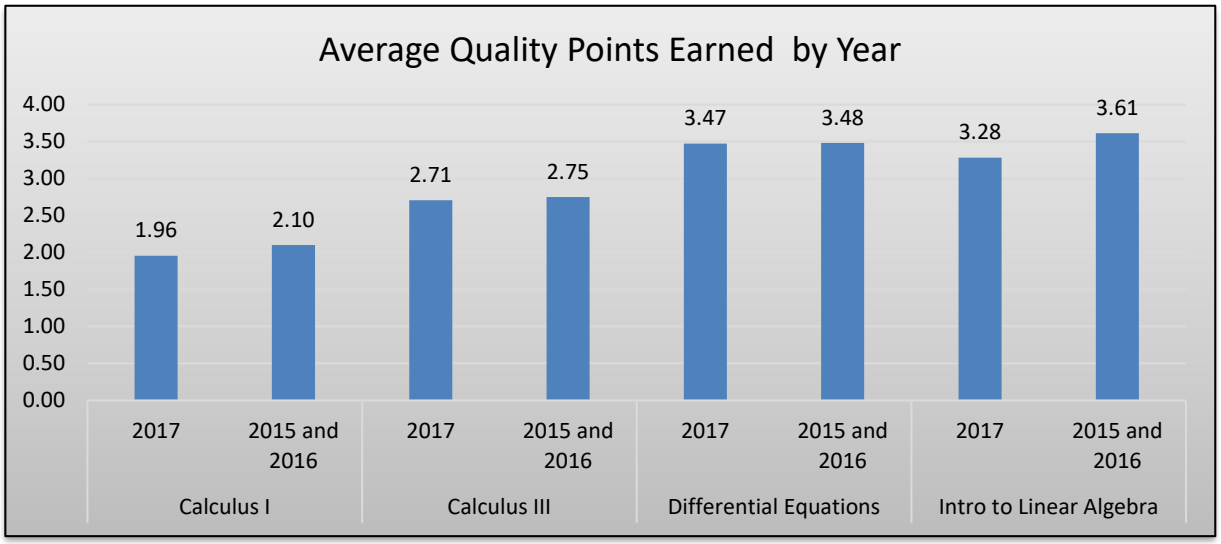
- **Online Delivery System WeBWorK:** The webwork was helpful in some cases, but it mostly just felt like busy work that I was constantly forgetting about due to the fact that it did not really have a set due date and there were so many problems essentially covering the same exact concepts with just some slight number changes here and there.

- **Linear Algebra Student:** The book for this class is horrible. I understand the need for affordable books and support materials but the book and the webwork were totally different. I ended up purchasing another Linear Algebra book off of Amazon that explained things in a clearer manner but by that time I was already so lost. Each book teaches things in different orders so even if I knew how to do something correct, if we had not learned it I could not use the method. I feel like with a better book I would have understood more. Also, the webwork homework was nothing like the book problems. I am usually great at math but this course was so difficult for some reason.
  [Our team would like to emphasize that the textbook problems and the WeBworK problems were supposed to be different. The textbook problems were more theoretical and often required proving some theorems. The WeBworK problems mainly concentrated on computational part of Linear Algebra. We believed that both parts were important in learning linear algebra concepts.]

2. Quantitative and Qualitative Measures

In the following chart and all charts in this report, the label 2017 refers to data collected from students affected by implementation of our open resources project in the academic year 2017. The label 2015 and 2016 refers to data collected from students taught by the same instructors involved in this project during 2015 &2016 without using open resources and using commercial textbooks.





The quality points are calculated according to:

$$\left\{\begin{matrix}\text{Quality}\\ \text{Points}\end{matrix}\right\} = \left[\left\{\begin{matrix}\text{No. of}\\ \text{students}\\ \text{earned A}\end{matrix}\right\} * 4 + \left\{\begin{matrix}\text{No. of}\\ \text{students}\\ \text{earned B}\end{matrix}\right\} * 3 + \left\{\begin{matrix}\text{No. of}\\ \text{students}\\ \text{earned C}\end{matrix}\right\} * 2 + \left\{\begin{matrix}\text{No. of}\\ \text{students}\\ \text{earned D}\end{matrix}\right\} * 1 + \left\{\begin{matrix}\text{No. of}\\ \text{students}\\ \text{earned F}\end{matrix}\right\} * 0\right] \div \left[\begin{matrix}\text{Total Number of}\\ \text{student in the course}\end{matrix}\right]$$

This chart gives an assurance that using a zero cost textbook and homework delivery system maintained the same level of students' performance where costly textbooks are used.

2a. Overall Measurements

Student Opinion of Materials

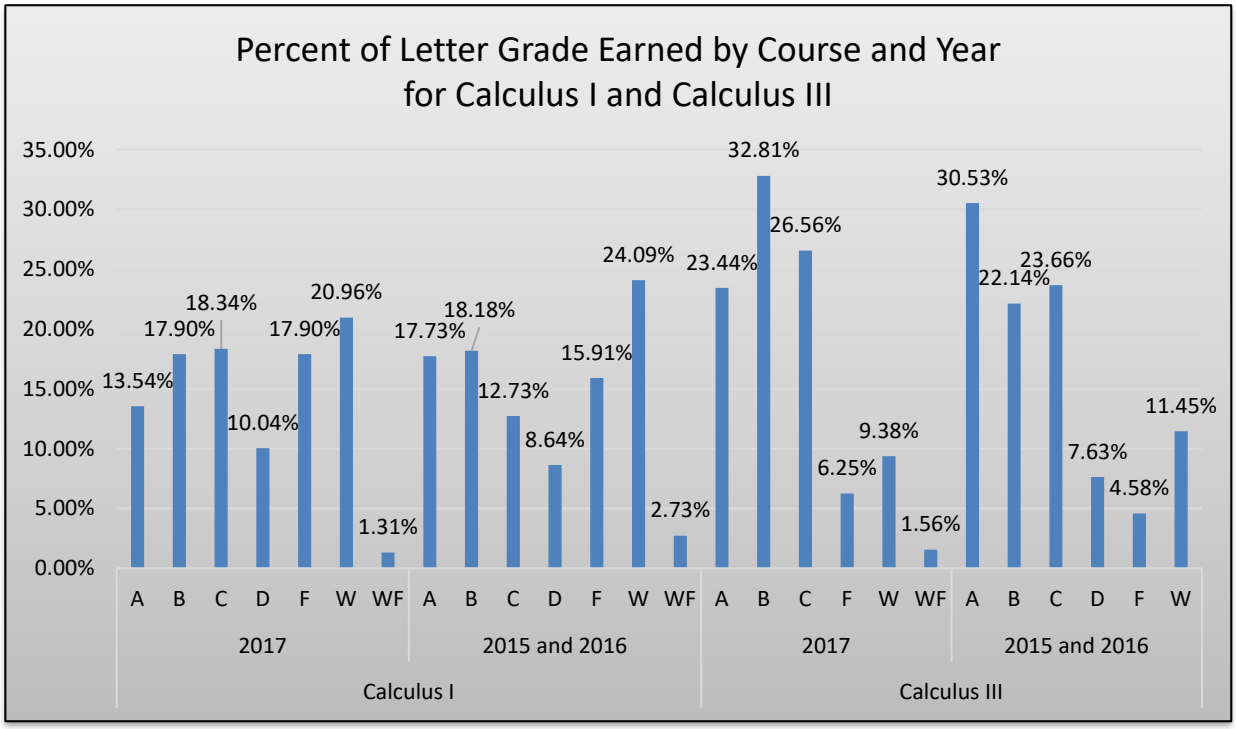
Was the overall student opinion about the materials used in the course positive, neutral, or negative?

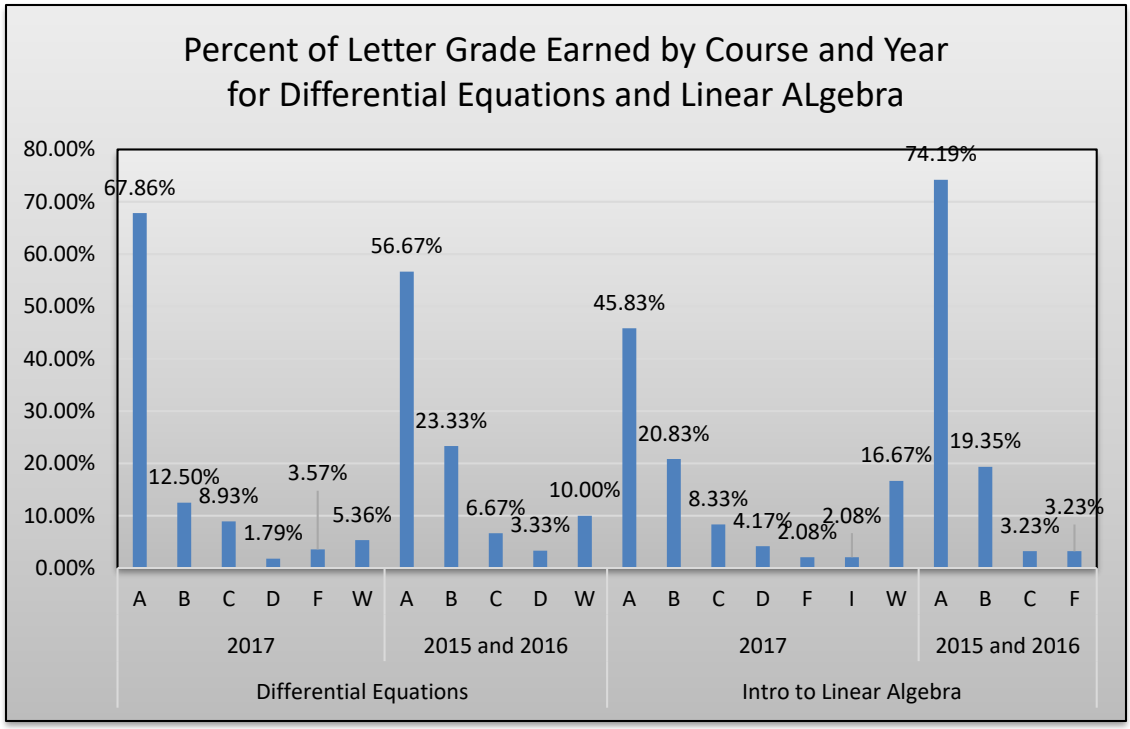
Total number of students affected in this project: **397**

- Positive: **62.9 %** of respondents
- Neutral: **25.8 %** of respondents
- Negative: **11.3 %** 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?





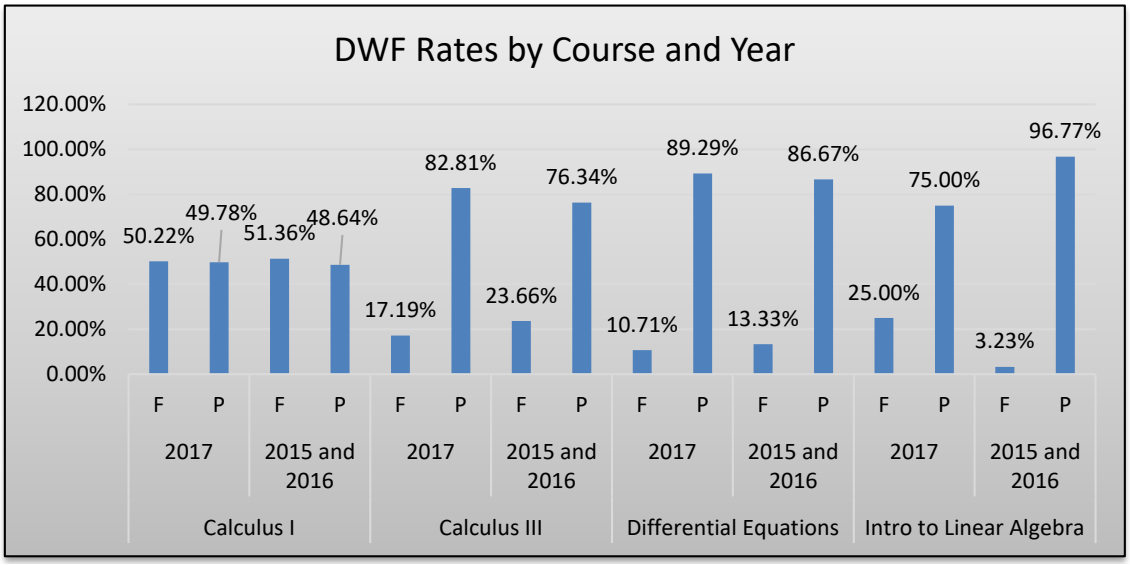
The overall outcomes and grades in the semester(s) of implementation over previous semesters positive.

Choose One:

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



	Total	Number of D/W/F students	% of D/W/F students
Students Registered (Project implementation) During Academic Year 2017	397	144	36.3%
Students Registered (Previous semesters) During Academic Year 2015/ & 2016	412	149	36.2%

Choose One:

- _____Positive: This is a lower percentage of students with D/F/W than previous semester(s)
- _X_ Neutral: This is the same percentage of students with D/F/W than previous semester(s)
- ____ Negative: This is a higher percentage of students with D/F/W than previous semester(s)

3b. Narrative

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.

Course	*Total no. of stud. Registered*		*Withdraw %*	
	2017 Project	**2015 /2016**	**2017 Project**	**2015 /2016**
Calculus I (Math 1450)	229	220	***20.96 %***	***24.09 %***
Calculus III (Math 2470)	64	131	***9.35 %***	***11.45 %***
Differential Equations Math 3000)	56	30	***5.36 %***	***10 %***
Linear Algebra (Math 3650)	48	31	***16.63 %***	***0%***

Course	*Total no. of stud. Registered*		*A/B/C/D Percentage*		*Pass % [A,B,C or D]*		*Fail % Individual Scores are less than 60%*	
	2017 Project	**2015 /2016**	**2017 Project**	**2015 /2016**	**2017 Project**	**2015 /2016**	**2017 Project**	**2015 /2016**
Calculus I (Math 1450)	229	220	*A/B/C/D 13.54/17.90/ 18.34/10.04*	*A/B/C/D 17.73/18.18/ 12.73/8.64*	*49.78*	*48.64*	*50.22*	*51.36*
Calculus III (Math 2470)	64	131	*A/B/C/D 23.44/32.81/ 26.56/0*	*A/B/C/D 30.53/22.14/ 23.66/7.63*	*82.81*	*76.34*	*17.19*	*23.66*
Differential Equations Math 3000)	56	30	*A/B/C/D 67.86/12.5/ 8.93/1.79*	*A/B/C/D 56.67/23.33/ 6.67/3.33*	*89.29*	*86.67*	*10.71*	*13.33*
Linear Algebra (Math 3650)	48	31	*A/B/C/D 45.83/20.83/ 8.33/4.17*	*A/B/C/D 74.19/19.35/ 3.23/3.23*	*75*	*96.74*	*25*	*3.23*

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 three. 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%.

i) **Technological Competency:** The students' Internet skills, retrieving and managing information via technology was evaluated twice during the semester via assessments through D2L or using a similar hardcopy form. Data like how often and how long a student is logged in to the online learning system WeBWorK or accessing Open resources text books and how that corresponds to their successful completion of the course agree with our expectations.

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.

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

	Mean beginning of the semester	Mean end of the semester
Calculus 1	3.94	3.64
Calculus 3	4.12	4.12
Differential Equations	3.9	3.82
Linear Algebra	3.95	4.18

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

	Mean beginning of the semester	Mean end of the semester
Calculus 1	4.18	4.18
Calculus 3	4.27	3.68
Differential Equations	4.10	4.30
Linear Algebra	4.32	4.4

3. How helpful is your online homework for learning?

	Mean beginning of the semester	Mean end of the semester
Calculus I	3.60	3.64
Calculus III	3.88	3.86
Diff. Equations	3.81	3.82
Linear Algebra	3.96	3.51

4. How helpful is your textbook for learning?

	Mean beginning of the semester	Mean end of the semester
Calculus I	3.43	3.55
Calculus	3.88	3.7
Diff. Equations	3.02	3.86
Linear Algebra	3.57	3.2

5. 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
Calculus 1	3.74	3.69
Calculus 3	3.85	3.98
Diff. Equations	3.54	3.78
Linear Algebra	3.85	3.54

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

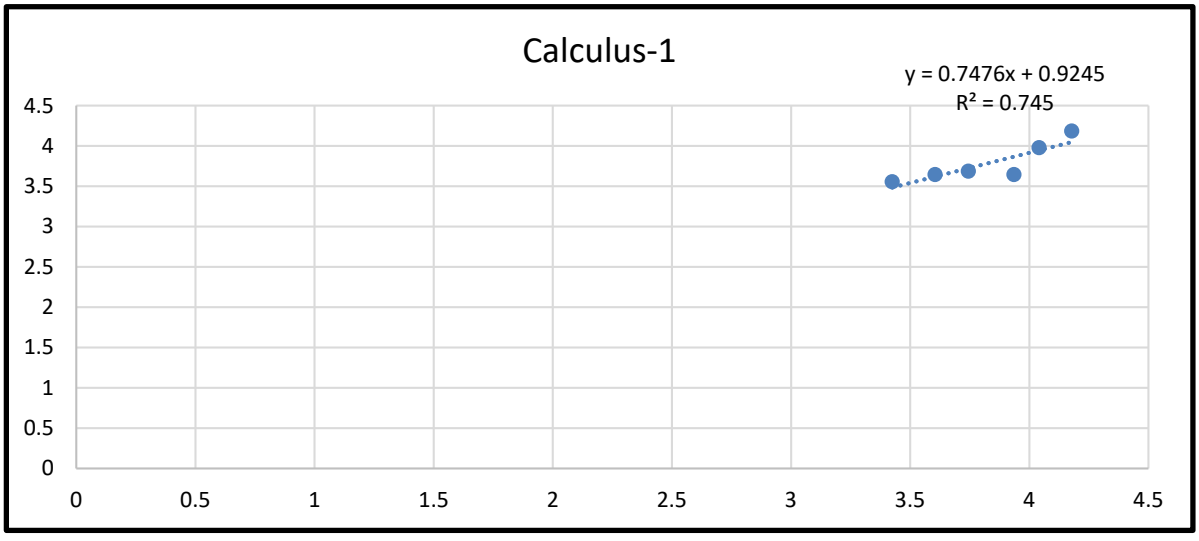
	Mean beginning of the semester	Mean end of the semester
Calculus I	4.04	3.98
Calculus	4.19	3.85
Differential Equations	4.13	4.38
Linear Algebra	4.25	3.58

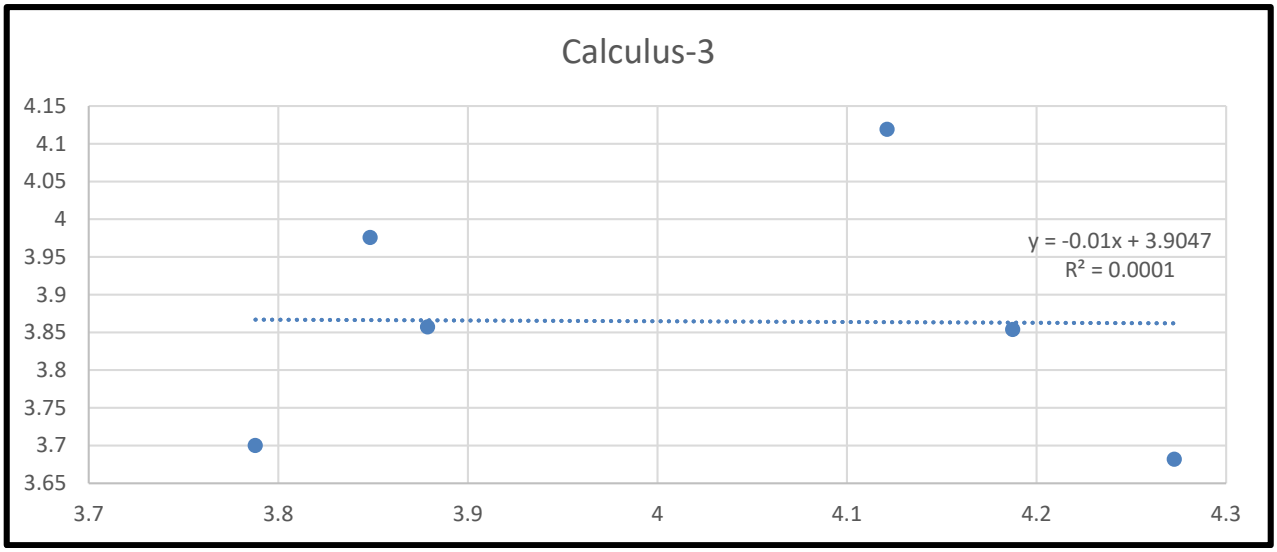
Statistical Analysis:

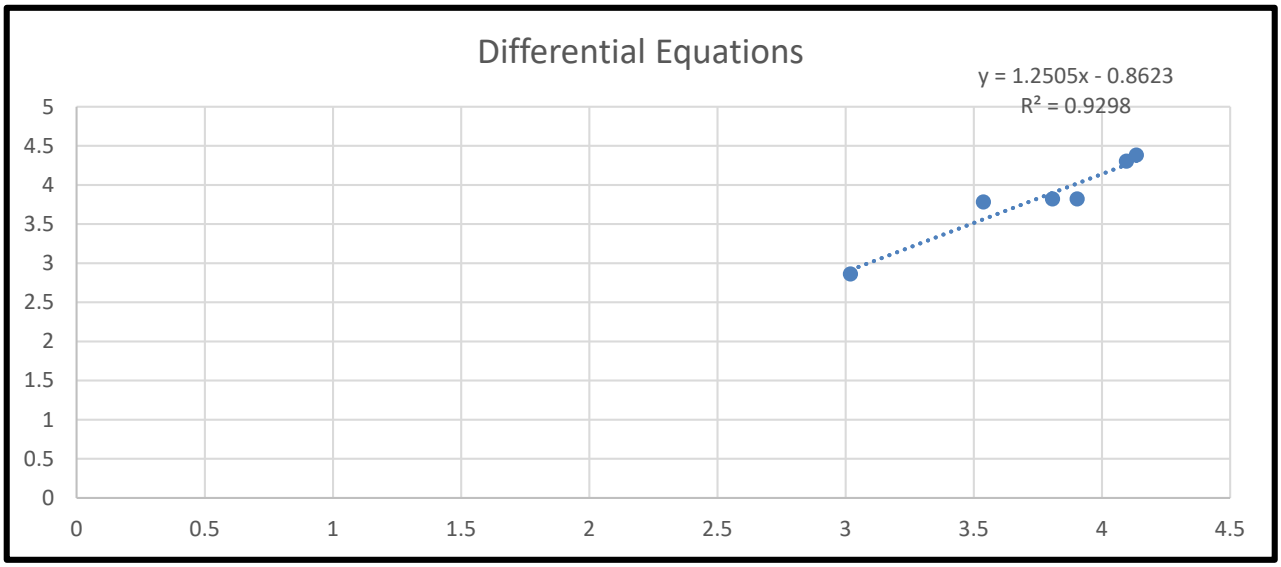
We performed regression analysis with these data to see whether the ALG project has any positive impact on the outcomes over the aforesaid qualitative traits of the subjected students. We examined selected questions (questions 1-6 in the table below) from the two surveys, the first done early in the semester and the second done in the weeks preceding final exams. In comparing the two surveys, we have seen moderate increase in the quality of the responses for Calculus I, Calculus III and Differential Equations courses.

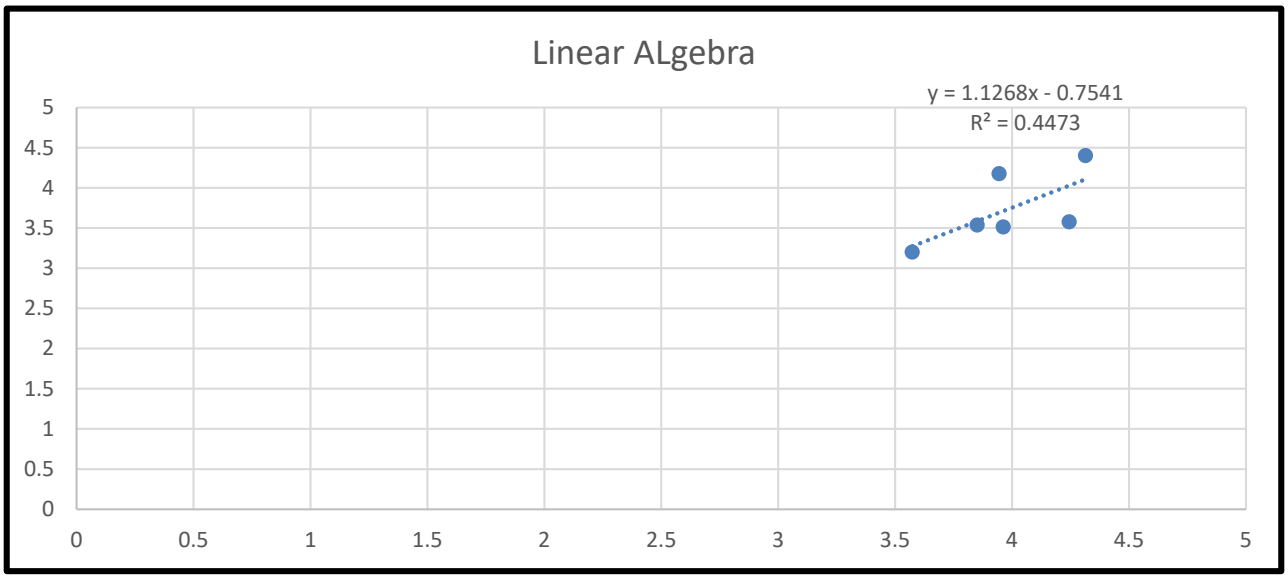
	x = Mean beginning of the semester; y= Mean end of the semester	Points on each graph
1	How often do you use material posted on D2L or shared class files?	(x_1,y_1)
2	How often do you use the online homework system?	(x_2,y_2)
3	How helpful is your online homework for learning?	(x_3,y_3)
4	How helpful is your textbook for learning?	(x_4,y_4)
5	Overall, are you satisfied with the educational materials, for example, a text book, WeBWorK or worksheets?	(x_5,y_5)
6	Overall, are you satisfied with your learning experience in this class?	(x_6,y_6)

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. We focused on the last six questions from the survey, listed below. For the following charts:




Calculus-3
y = -0.01x + 3.9047
R² = 0.0001
4.15
4.1
4.05
4
3.95
3.9
3.85
3.8
3.75
3.7
3.65
3.7
3.8
3.9
4
4.1
4.2
4.3


Differential Equations
y = 1.2505x - 0.8623
R² = 0.9298
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5


Linear ALgebra
y = 1.1268x - 0.7541
R² = 0.4473
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

As shown in the above graphs, Calculus I, Linear Algebra and Differential equations 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.

Calculus III regression analysis does not show the same trend like other courses. The fact that students in calculus III were already used to a commercial text in calculus I and calculus II and were not planning on purchasing any new text in calculus III may contribute to the results. Multiple regression where other factors can be included could be a better choice for the analysis.

We also performed hypothesis testing on the data where ***P1*** =proportion of student's withdraw-2017 project and ***P2*** = proportion of students' withdraw-2015/2016. The results of the tests are listed in the table below:

Course	*Total no. of stud. Registered*		*Withdraw %*		*Withdraw Data for hypotheses testing*		***Test the hypothesis H0:P1=P2 Ha:P1<P2***
	2017 Project	**2015 /2016**	**2017 Project**	**2015 /2016**	**2017 Project**	**2015 /2016**	**P-value**
Calculus I (Math 1450)	229	220	***20.96 %***	***24.09 %***	***n1=229; x1=48***	***n2=220; x2=53***	***.21356***
Calculus III (Math 2470)	64	131	***9.35 %***	***11.45 %***	***n1=64; x1=6***	***n2=131; x2=15***	***.33***
Differential Equations Math 3000)	56	30	***5.36%***	***10%***	***n1=56; x1=3***	***n2=30; x2=3***	***.22***
Linear Algebra (Math 3650)	48	31	***16.63 %***	***0 %***	***Statistical analysis for this course were not done due to lack of enough data to compare our project with previous years.***		
Total	397	412	***16.37 %***	***18.2 %***	***n1=397; x1=65***	***n2=412; x2=75***	***.246***

The resulted p-values of the hypotheses test indicate that there is no significant evidence that the withdraw proportion for our 2017 implementation of the project is less than the withdraw proportion from previous years. With this result, we feel that we achieved our main goal by having students to access zero-cost material without affecting students' performance and their retention level.

7. Sustainability Plan

We will share materials (open textbooks, class notes, WeBWorK assignments) for the four courses, Calculus I, Calculus III, Differential Equations, Linear Algebra, with math instructors who are interested in OER. The project team members will keep the original copy of the learning materials and will maintain and update materials as needed.

8. Future Plans

Our team members 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.

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 modify our materials and encourage faculty to adopt OERs. This is in line with one of the main advantages of using OERs where it can be improved quickly through direct editing by users or through solicitation and incorporation of user feedback. Faculty who choose to take advantage of our project can take our existing OER, adapt it for a class, and make the necessary modification to use them in their classroom. We anticipate to present our results at a conference.

9. Description of Photograph

(left to right) Dr. Hashim Saber instructor and proposal investigator; Dr. Piotr Hebda, instructor; Dr. Beata Hebda, instructor; Dr. Benkam Bobga, instructor.