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Application Summary

Competition Details

Competition Title:	Textbook Transformation Grants, Round Fourteen (2019-2020)
Category:	University System of Georgia
Award Cycle:	Round 14
Submission Deadline:	04/09/2019 at 11:59 PM

Application Information

Submitted By:	Beulah Narendrapurapu
Appplication ID:	3390
Application Title:	468
Date Submitted:	04/09/2019 at 8:26 AM

Personal Details

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Applicant Phone Number:	7062961321
Primary Appointment Title:	Lecturer of Chemistry
Submitter First Name:	Beulah
Submitter Last Name:	Narendrapurapu
Submitter Email Address:	bnarendrapurapu@georgiasouthern.edu
Submitter Phone Number:	7062961321
Submitter Title:	Lecturer of Chemistry

Application Details

Proposal Title
468

Final Semester of Project
Spring 2020

Requested Amount of Funding
18500 $

Type of Grant

No-or-Low-Cost-to-Students Learning Materials

Course Title(s)
Comprehensive General Chemistry

Course Number(s)
CHEM 1310

Team Member 1 Name
Beulah Narendrapurapu

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Sponsor Name
Will Lynch

Sponsor Title
Chair of the Department

Sponsor Department
Chemistry and Biochemistry

Original Required Commercial Materials (title, author, price)
1) Homework and e-Text: Chemistry, The Central Science 14th ed.by Brown/Lemay/Bursten/Murphy/Woodward/Stoltzfus with Modified Mastering Chemistry

2) iClicker2

Average Number of Students per Course Section Affected by Project in One Academic Year
125

Average Number of Sections Affected by Project in One Academic Year
5

Total Number of Students Affected by Project in One Academic Year
624

Average Number of Students Affected per Summer Semester
48

Average Number of Students Affected per Fall Semester
384

Average Number of Students Affected per Spring Semester
192

Original Total Cost per Student
180

Post-Project Cost per Student
35

Post-Project Savings per Student
145

Projected Total Annual Student Savings per Academic Year
90480

Using OpenStax Textbook?
Yes

Project Goals

Georgia Southern University has a total enrollment of over 20,000 undergraduate students and we take pride in the fact that it is ranked #2 in Affordable Colleges in Georgia in 2018 and is in the top 25 producers of ACS certified BS degrees in Chemistry. However, for an average undergraduate student enrolled into the Freshman Year, the cost of textbooks and supplies can be shocking. **The goal of our project is to create affordable and robust major-oriented textbook materials for the lecture portion of the Comprehensive General Chemistry course (CHEM 1310) for engineering majors**. The College Board1 estimates that an average undergraduate student expenditure is approximately $1,200 on textbooks and supplies and the costs for engineering majors are even higher. Financial aid statistics in US News2 reports that 47.8% of the students at Georgia Southern university rely on self-help aid and there are still 31% of students who have unmet financial needs. Therefore, providing a low-cost or free-of-cost textbook option to students will not only decrease financial stress but also improve student learning by ensuring that students have access to course materials starting from the beginning of the semester.

While student savings is one of our goals for this project, our motivation for creating transformed textbook materials come from the need for material that focusses on engineering chemistry in the “Comprehensive General Chemistry” course (CHEM 1310), a required one-semester general chemistry course for Engineering majors. A majority of the general chemistry textbooks are not written from the perspective of teaching Engineering Majors and there is no open educational resource (OER) on general chemistry for Engineering Majors. Many students lack motivation to excel when the course objectives do not appear applicable to their academic major3. Also, the layout of traditional general chemistry textbooks designed for a two-semester schedule is not compatible with a condensed one-semester course. Also, Students with financial constraints delay buying the textbook which is critical for them to stay on course. This calls for a dire need for collection and reorganization of material suited to the students enrolled in the course.

The main goals of this project are to:

1. Provide no-cost curriculum-based resources and supplemental materials in the form of online libguides hosted on the University’s library website.
2. Create homework problems and quizzes compatible with the reformed textbook on the low-cost Sapling digital homework system.

References:

1. https://trends.collegeboard.org/college-pricing/figures-tables/average-estimated-undergraduate-budgets-2018-19#Key%20Points
2. https://www.usnews.com/best-colleges/georgia-southern-university-1572
3. https://www.cmu.edu/teaching/solveproblem/strat-lackmotivation/lackmotivation-01.html

Statement of Transformation

This proposal emphasizes a renovation and complete organization of course material for general chemistry curriculum for engineering majors (CHEM 1310) at Georgia Southern University's Statesboro campus ; this is a one-semester required science course for engineering majors. Every year, a total of approximately 576 students enroll for the Fall and Spring semesters, and with an additional enrollment of 48 students during the Summer term.

It is no secret that these days majority of students prefer to shuffle internet to get all the required understanding or information in order to prepare for the tests and/or assignments. They hardly consider printed text-book to look for answers. It is largely because of the convenience of searching an answer on a digital platform as compared to printed textbook. Over the years, we have observed that e-text book cannot be considered as an effective alternative since students are reluctant to look for any specific information since the existing e-textbook also does not provide interactive tool for learning and metacognition. **In a survey conducted in Fall 2017, less than 40% of the students reported buying the e-text for the course.** Choosing an alternative textbook written solely for Engineering majors ("Chemistry for Engineering Majors" by Tom Holme) in one summer semester did not help either and students reported preferring online no-cost interactive tutorials. Also, we have often observed that at the beginning of the semester, students have difficulties arranging all the study materials due to their financial constraints and they largely rely on lecture materials to get through the process. In most occasions, for the mid-tier or struggling students, only PowerPoint lecture materials are not sufficient which is sadly reflected in the retention and DF rates (30-45% DWF rates). Studies also corroborate that not purchasing textbook increase the chance of failure or withdrawal from the course4. We would like to propose a complete organization of our study materials through a very cost effective alternative as compared to the current curriculum.

The proposal aims to replace the text book with guided and structured online supplemental materials hosted under the university library resources. These materials are designed in such a way that students will be encouraged to look into the materials for relevant information and guidance rather than incoherent probing of the internet. The foundational course materials will be developed based on learning objectives for each chapter and the material will be curated from Open Educational Resources (OER) (https://www.oercommons.org/ including OpenStax). Additional inquiry-based learning resources with problem sets keeping engineering majors in mind will be provided by project team members. The greatness of OER materials with creative common open licenses, lies in the facts that we can reuse, recreate, reorganize and reapply as it fits to our required curriculum. **Also a point to be noted is that all the examples so far published online, are largely focused on science majors and/or nursing majors. In our proposal, we would like to create several examples suitable for engineering majors and we eventually like to publish our materials for better good and for larger audience.** These free supplemental materials will emphasize guided inquiry and provide all the relevant information to various forms of problem solving including videos & interactive simulations for key learning objectives of the course material. Transformation of the current, traditional general chemistry text-book for engineering majors to a no-cost course material will provide students online access to the aforementioned course materials from day-1 of the course with the aim of improving student learning and engagement.

In the Fall and Spring semesters, the course is taught in two large lecture classes (~192 students per class in Fall and 96 students per class in Spring). Currently, the courses uses an e-text (Chemistry, The Central Science 14th ed. by Brown/ Lemay/ Bursten/ Murphy/ Woodward/ Stoltzfus) integrated with the Modified Mastering Chemistry homework platform. The cost of the homework with e-text access code is $124. The large lecture classes also make it necessary for instructors to add effective formative assessment tools such as iClicker2 which add significantly to student costs for the lecture course to $180 ($56 being the cost of the iClicker2). With the reformed no-cost textbook

and low cost homework system (Sapling), the cost reduces to $35 per student including a similar formative assessment tool, iClicker Reef (the tool costs only $5 when bought along with Sapling homework platform). The Sapling homework system is integrated with OpenStax which is where most of the material for our transformation will be curated from. This would mean a significant savings of $145 per student for the lecture portion of the course. Switching to reformed text book materials integrated with less expensive digital homework platform and custom-made supplemental learning materials will surely provide a low-cost, wholesome learning experience to all our engineering majors enrolled in CHEM 1310.

Students will be able download all our created course materials. There is an ongoing dichotomy of opinion regarding the preference of printed text vs digital text.5 One study has shown that capabilities such as annotation, bookmarking, hypertexts and highlighting available for digital text emphasize aspects of learning such as recall, comprehension and retention of information6. In order to account for useful digital capabilities as well as to give students a printed option, we will make the online materials print-friendly as well as have “download as pdf” functions.

Undoubtedly, stakeholders affected by such transformation will be largely students enrolled in CHEM 1310 and faculty teaching the course. As mentioned above, the transformation shall provide financial savings to students. Use of formatted and structured no-cost (or low cost) study materials shall provide a uniform learning and teaching experience to all our 624 students taught by any number of faculties. The outcome of this proposal will encourage faculties to use such study materials for other general chemistry curriculum for science and nursing majors at GSU’s Statesboro campus, since, currently, general chemistry curriculum is heavily focused on using high-cost, traditional text-book with digital homework system. We truly believe, that this ALG grant will provide a new pathway to our department of Chemistry and Biochemistry’s Statesboro campus to reconsider a cost effective and uniform learning experience to all our students enrolled into general chemistry curriculum. Finally, the benefit of using library subscription and OER in creating low-cost model lies in the proper utilization of university’s library resources which no doubt adds values to institutional investments along with the availability of most up-to-date content for our new proposed curriculum.

References:

1. Florida Distance Learning Consortium. (2011, September). Florida Student Textbook Survey. Tallahassee, FL. http://www.openaccesstextbooks.org/projectInfo.html
2. Daniel, D. B. and Woody, W. D. E-textbooks: At what cost? Performance and use of electronic v. print texts. Computers and Education. **2013**, 62, 18-23.
3. “Print versus digital texts: understanding the experimental research and challenging the dichotomies”, Research in Learning Technology. **2017**, 25. https://journal.alt.ac.uk/index.php/rlt/article/view/1976/html#CIT0068_1976

Transformation Action Plan

Currently, there is no open access material dedicated only to the engineering students studying general chemistry. However, there are some open resources available for introductory chemistry course. We, as a team, strive towards that goal to compile necessary contents of Chemistry for Engineers that will replace the textbook for CHEM 1310 course. The contents will be curated from OpenStax and other Open Access Resources designed for General Chemistry. Our focus will be to select and modify material in a way that is relevant to Engineering majors in terms of both approach and examples. The curated material will be presented as libguides and students will be able to access the contents through Georgia Southern University's GALILEO library facility. Additional supplemental materials such as guided problem sets and lecture guides will also be provided. Homework assignments that match with the reformed textbook materials will be created on the Sapling platform.

OpenStax provides two open access books for Principles of Chemistry. The book, "Chemistry" is the most suited one for CHEM 1310 course and we intend to use that book as our primary resource (https://openstax.org/details/books/chemistry). Most of the contents of the book are adequate to deliver information on the related topics. However, some modifications will be made to meet the requirements of the course suitable for engineering students. For some topics, other open access resources that have a better presentation of content will be used.

Typically, in general chemistry, "Equilibrium", "acids-base equilibrium" and "additional aspects of equilibrium" are taught as three separate chapters. However, in our transformed syllabus content, the three chapters will be consolidated into one chapter. The latter two chapters are applications of equilibrium concepts and a similar consolidation is used in the textbook "Chemistry for Engineering Majors" by Tom Holme. This modification will help the engineering majors to identify the primary concept and apply it for solving problems related to several practical applications such as preparation of buffer solutions for dyeing fabrics and treating industrial waste.

For the CHEM 1310, following chapters will be included from OpenStax:

1. New Chapter 1: Matter and Measurements

Contents will be selected and edited from OpenStax Chapter 1: Essential Ideas.

1. New Chapter 2: Atoms, Molecules and Ions

Will be used with minor editions to OpenStax Chapter 2

1. New Chapter 3: Chemical Reactions, Mole Concept and Stoichiometry

Contents will be selected and edited from Chapter 3 and 4 from OpenStax.

1. New Chapter 4: Thermochemistry

Contents will be selected and edited from OpenStax Chapter 5: Thermochemistry

1. New Chapter 5: Gases

Selected and edited from Chapter 9: Gases from OpenStax

1. New Chapter 6: Intermolecular Forces, Solution and Colligative properties.

Selected and edited from Chapters 10 and 11 from OpenStax.

1. New Chapter 7: Chemical Kinetics

Will be used with minor editions to Chapter: 12 from OpenStax.

1. New Chapter 8: Chemical Equilibrium and its Applications

Contents will be selected and edited from Chapter: 13, 14, 15 of OpenStax.

1. New Chapter 9: Thermodynamics

Use as it is from Chapter: 16 from OpenStax.

1. New Chapter 10: Electrochemistry

Contents will be selected and edited from Chapter: 17 from OpenStax.

The team comprises of four faculty members, Dr. Beulah Narendrapurapu (BN), Dr. Debanjana Ghosh (DG), Dr. Arpita Saha (AS), Dr. Leah Williams (LW) and a library liaison, Ms. Dawn Cannon-Rech (DC). The faculties, BN, DG have taught CHEM 1310 (as well as other Principles of Chemistry courses) and BN is the coordinator for the CHEM 1310 course. AS and LW have taught Principles of Chemistry I and II (CHEM 1211K and 1212K) and Survey of Chemistry I (CHEM 1151) courses multiple times at Georgia Southern University.

Under the leadership of BN, the team will share responsibilities as follows:

- BN, DG and LW will be primarily involved in curating, creating and organizing reformed textbook and supplemental materials for the course. The faculty will be involved in creating bridges between any curated materials collected from two different resources and establishing continuity. They will be responsible for designing qualitative and quantitative evaluations of the transformation, gathering data and dissemination of the resources to faculty at Georgia Southern University and at professional conferences.
- LW will be involved in assisting with Institutional Review Board (IRB) applications for data collection, editing the transformed materials and providing assessment advice.
- DC will be involved in compiling the materials into libguides and for creating open-access to CHEM 1310 students.

The transformation will involve the following steps:

Organize:

1. Identify chapter learning goals and group concepts within chapters to create a skeleton for the lib-guides (responsible personnel: BN, DG).

Reformed textbook chapters (as libguides):

1. Curate the course chapters by extracting information from OpenStax and other Open Educational Resources. Curate and create examples that are relevant to the needs of engineering students (responsible personnel: BN, DG, AS).
2. Edit the created content (responsible personnel: LW).
3. Arrange these reformed materials as libguides for easy student access (responsible personnel: DC).

Supplementary materials:

- v. Create guided numerical problems with solutions and also self-assessment questions with hints for each chapter as part of supplementary material (responsible personnel: BN, DG, AS).

1. Create PowerPoint slides that align with the redesigned content for use by instructors teaching CHEM 1310 (responsible personnel: BN, DG).

2. Create lecture guides for chapters (responsible personnel: BN).
3. Edit and provide all the supplemental material also as libguides (responsible personnel: LW, DC).

Homework:

1. Explore Sapling digital platform and create relevant homework problems that align with the newly designed course material (responsible personnel: BN, DG, AS).

IRB and Data Collection:

- x. Apply for IRB for collecting pre- and post- transformation data. Administer student surveys in CHEM 1310 course (responsible personnel: LW, BN).

Quantitative & Qualitative Measures

The satisfaction of the students will be measured by asking students to fill out surveys with questions related to how helpful the open access materials were in the learning of material and preparation for exams. In order to properly compare the current satisfaction of students using a textbook with satisfaction of students who would use libguides in the future, the PI will ask students to answer the following questions at the end of semesters before transformation (Fall 2019) and semesters after transformation (Spring 2020, Fall 2020).

Example of questions that will be asked before transformation (as multiple choice)

1. Did you buy the textbook for the course? Yes/No

If Yes, when was the textbook bought?

Week-1 week-2 week-3 week-4 later in the semester

Questions 2-8 will be answered on a Likert scale:

Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree.

2. I read the textbook to understand the course material ("textbook" will be replaced by "libguides" for post transformation survey).

3. I refer to the textbook worked out examples to understand how to solve problems.

4. I study from the PowerPoints uploaded for the chapters.

5. I use information available on the internet (eg. you-tube videos) to study for the course.

6. I learn from the homework questions.

7. I feel the available resources are adequate to prepare for an exam.

8. I feel the course concepts relate to engineering applications.

9. What suggestions do you have for improving the libguides (post transformation question only)?

In addition to satisfaction surveys mentioned above, retention and success rates before and after transformation will be compared. The withdrawal and failure (DWF) rates for the course, mid-term grades, final exam grades, correlation between homework scores and exam scores will be compared between semesters before and after transformation to measure the effect of the transformation on student success. In the class that the PI teaches, same final exam will be administered in semesters before and after transformation to compare student performance on course concepts before and after access to the transformed low-cost reading and learning materials. It is expected open-access materials will provide early access to reading materials and the formatted content will enhance students' performance in the course.

Timeline

June 2019: Identify chapter learning goals and group the concepts in each chapter to create a skeleton for the lib-guides in the first half of June. An IRB approval will be submitted for conducting research with students for measuring effectiveness of transformation.

June 2019 – August 2019: In the second half of June, the chapters (learning objectives) will be divided between BN, DG and AS and they will select materials from OpenStax and other Open Educational Resources. In the month of July and August, several examples and applications that are suitable to engineering students will be designed (some will be curated, but most will be designed as there are no open access resources for engineering chemistry). This information will be gathered on google documents and any information that needs to be added to the curated material will be designed. This will also include securing copy right permissions for any materials that need exclusive permissions. Effective digital homework platform will be chosen and the homework will be aligned with the reformed textbook material.

September 2019: The curated materials will be will be given to LW for editing. At the end of the editing, this information will be given to our library liaison for creating library guides.

October – December 2019: Supplemental materials such as guided problem sets, PowerPoint slides for lectures and lecture guides will be designed by BN, DG, AS, edited by LW and given to out library liaison for creating library guides.

Students will be given a survey at the end of the semester in December 2019 (this will be the pre-transformation survey).

January 2020 – May 2020: CHEM 1310 will be taught using library guides. Students will be given a survey at the end of the semester (post transformation survey for Spring 2020). Results will be shared at STEM conferences and at other professional meetings.

For completeness, we will continue collecting post-transformation survey data in Fall 2020 as well and compare it with pre-transformation data from Fall 2019.

Budget

Dr. Beulah Narendrapurapu (5000$)

The PI will need the money as a compensation for time spent on designing and curating transformed textbook materials and supplemental materials for engineering chemistry. The PI will be involved in gathering data, submitting IRB, planning data collection and dissemination of the project results in STEM conferences. The PI will maintain and update the created course materials.

Dr. Debanjana Ghosh (5000$)

The co-PI will need the money as a compensation for time spent on designing and curating transformed textbook materials and supplemental materials for engineering chemistry. The co-PI in data collection and dissemination of project results STEM conferences.

Dr. Arpita Saha (5000$)

The co-PI will need the money as a compensation for time spent on designing and curating transformed textbook materials and supplemental materials for engineering chemistry. The co-PI will also be data collection and disseminating it in STEM conferences.

Leah Williams (2500$)

The personnel will assist with editing the reformed textbook and supplementary materials created by the PI and co-PIs. The faculty will also assist with submitting IRB applications and providing assessment advice.

Travel (800$)

The money will be spent on travel and registration expenses for sharing the results at STEM conferences.

Supplies (200$)

The money will be used for printing and office supplies for the team members.

Sustainability Plan

The transformation project will have a long lasting influence on how the CHEM 1310 course will be taught in future. All instructors for CHEM 1310 will use the transformed materials in conjunction with Sapling homework to teach the course. Based on future requirements and survey data gathered from students, the libguides repository will be continuously kept up-to-date. Since the PI is also the coordinator for the course, she will be responsible for gathering feedback from instructors teaching the course and for the maintaining and updating the course website with the help of the library liaison.

The project has a vast possibility for expansion as well. The curriculum based digital platform will allow us to explore the possibility of blended learning. In the future, the scope of self-assessment tests will be expanded by adding tutorial like feedback and adaptive learning questions.

The work will be shared with other campuses of Georgia Southern University. The results from our survey data will be presented at STEM conferences. The provision of materials online also allows the instructors of the course to gather data for tuning their pedagogy and conducting related scholarly activity.

Acknowledgment

Grant Acceptance

[Acknowledged] I understand and acknowledge that acceptance of Affordable Learning Georgia grant funding constitutes a commitment to comply with the required activities listed in the RFP and that my submitted proposal will serve as the statement of work that must be completed by my project team. I further understand and acknowledge that failure to complete the deliverables in the statement of work may result in termination of the agreement and funding.

Date: April 05, 2019

From: Will Lynch, Department Chair
Department of Chemistry and Biochemistry

To:

On behalf of the Department of Chemistry and Biochemistry at Georgia Southern University, I am very pleased to be writing this letter of support for the Affordable Learning Georgia Textbook Transformation grant proposal authored by Drs. Beulah Narendrapurapu, Debanjana Gosh, Arpita Saha and Leah Williams of our department and Dawn Cannon-Rech from the Library. Their proposal, entitled, "Complete organization of textbook and study materials through a cost-effective alternative for Comprehensive General Chemistry Course (CHEM 1310) for Engineering Majors" intends to adopt a no-cost textbook to lower the cost of the book and ancillary materials by more than 75%, reducing the cost to approximately $30. This project will have a broad impact on our campus and beyond due to the large enrollments in CHEM 1310, a support course for the Allen E. Paulson College of Engineering and Computing. With over 600 students taking this course during a normal academic year, this adoption will have a significant impact on our students. Moreover, this team of faculty is well positioned to implement the project they have proposed and are the point faculty for instruction of this course.

It is important to point out that commercially available comprehensive texts are generally quite expensive and due to this barrier it may be an impediment to students purchasing the text and impacting their success. Thus developing lower cost alternatives to these traditional course materials will have a significant impact on our students and their performance in the course.

One important piece to every proposal is the sustainability of the project after the term of the grant. Our intent is that this group of faculty will remain intact as a working group to ensure regular updates of the materials that are the deliverables in the grant. The department requires is faculty to maintain professional development in their courses and continuation of the project and its outcomes will be supported by faculty workload within their normal assignments.

Georgia Southern recognizes the importance of engaging our students in STEM and the proposed project will further this objective. This will be accomplished by utilizing technology, course supplements and multimedia presentations outlined in this proposal to assist student success as well as providing a no-cost text for our students. I am very pleased to have the opportunity to support this project

Sincerely,

Will E. Lynch,
Professor of Chemistry, Department Chair

DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY
11935 ABERCORN STREET • SAVANNAH, GA 31419 • 912-233-3219 • wlynch@georgiasouthern.edu

Affordable Learning Georgia

Textbook Transformation Grants, Round Fourteen
(Spring 2019 –Spring 2020)
Proposal Form and Narrative

Notes

- The proposal form and narrative .docx file is for offline drafting and review. Submitters must use the InfoReady Review online form for proposal submission.
- The only way to submit the official proposal is through the online form in Georgia Tech's InfoReady Review. The link to the online application is on the Round 14 RFP Page.
- The italic text we provide is meant for clarifications and can be deleted.

Applicant, Team, and Sponsor Information

The **applicant** is the proposed Project Lead for the grant project. The **submitter** is the person submitting the application (which may be a Grants Officer or Administrator). The submitter will often be the applicant – if so, leave the submitter fields blank.

Institution(s)	GSURSF on behalf of Georgia Southern University
Applicant Name	Dr. Beulah Narendrapurapu
Applicant Email	bnarendrapurapu@georgiasouthern.edu
Applicant Phone #	(912) 478-5876
Applicant Position/Title	Lecturer of Chemistry, Coordinator for Comprehensive General Chemistry
Submitter Name	
Submitter Email	
Submitter Phone #	
Submitter Position	

Please provide the first/last names and email addresses of all team members within the proposed project. Include the applicant (Project Lead) in this list. Do not include prefixes or suffixes such as Ms., Dr., Ph.D., etc.

	Name	Email Address
Team Member 1	Beulah Narendrapurapu	bnarendrapurapu@georgiasouthern.edu
Team Member 2	Debanjana Ghosh	dghosh@georgiasouthern.edu

	Name	Email Address
Team Member 3	Arpita Saha	asaha@georgiasouthern.edu
Team Member 4	Leah Williams	lcwilliams@georgiasouthern.edu
Team Member 5	Dawn Cannon-Rech	dcannonrech@georgiasouthen.edu
Team Member 6		
Team Member 7		
Team Member 8		

If you have any more team members to add, please enter their names and email addresses in the text box below.

Please provide the sponsor's name, title, department, and institution. The sponsor is the provider of your Letter of Support.

Dr Will Lynch, Chair of the Department of Chemistry and Biochemistry at Georgia Southern University

Project Information and Impact Data

Title of Grant Project	***Complete Organization of Textbook and Study Materials Through a Cost-effective Alternative for Comprehensive General Chemistry Course (CHEM 1310) for Engineering Majors.***
Type of Grant	*"No-or-Low-Cost-to-Students Learning Materials,"*
Requested Amount of Funding	$ 18500
Course Names and Course Numbers	Comprehensive General Chemistry (CHEM 1310)

Final Semester of Project	*Fall 2019 or Spring 2020*
Average Number of Students Per Course Section Affected by Project	125 (averaged for Fall, Spring and Summer semesters)
Average Number of Sections Affected by Project in One Academic Year	5
Total Number of Students Affected by Project in One Academic Year	624
Average Number of Students Affected per Summer Semester	*48*
Average Number of Students Affected per Fall Semester	384
Average Number of Students Affected per Spring Semester	192
Title/Author of Original Required Materials	*Homework and e-Text: Chemistry, The Central Science 14th ed.by Brown/Lemay/Bursten/Murphy/Woodward/Stoltzfus with Modified Mastering Chemistry* *iClicker2*
Original Total Cost Per Student	*$180 ($124 for Mastering Chemistry e-text and homework; $56 for iClicker2)*
Post-Project Cost Per Student	*$35 (Sapling Homework platform including iClicker Reef)*
Post-Project Savings Per Student	*$145*
Projected Total Annual Student Savings Per Academic Year	*$90,480*
Using OpenStax Textbook?	*Yes*

Narrative Section

1. Project Goals

Georgia Southern University has a total enrollment of over 20,000 undergraduate students and we take pride in the fact that it is ranked #2 in Affordable Colleges in Georgia in 2018 and is in the top 25 producers of ACS certified BS degrees in Chemistry. However, for an average undergraduate student enrolled into the Freshman Year, the cost of textbooks and supplies can be shocking. **The goal of our project is to create affordable and robust major-oriented textbook materials for the lecture portion of the Comprehensive General Chemistry course (CHEM 1310) for engineering majors**. The College Board[1] estimates that an average undergraduate student expenditure is approximately $1,200 on textbooks and supplies and the costs for engineering majors are even higher. Financial aid statistics in *US News*[2] reports that 47.8% of the students at Georgia Southern university rely on self-help aid and there are still 31% of students who have unmet financial needs. Therefore, providing a low-cost or free-of-cost textbook option to students will not only decrease financial stress but also improve student learning by ensuring that students have access to course materials starting from the beginning of the semester.

While student savings is one of our goals for this project, our motivation for creating transformed textbook materials come from the need for material that focusses on engineering chemistry in the "Comprehensive General Chemistry" course (CHEM 1310), a required one-semester general chemistry course for Engineering majors. A majority of the general chemistry textbooks are not written from the perspective of teaching Engineering Majors and there is no open educational resource (OER) on general chemistry for Engineering Majors. Many students lack motivation to excel when the course objectives do not appear applicable to their academic major[3]. Also, the layout of traditional general chemistry textbooks designed for a two-semester schedule is not compatible with a condensed one-semester course. Also, Students with financial constraints delay buying the textbook which is critical for them to stay on course. This calls for a

dire need for collection and reorganization of material suited to the students enrolled in the course.

The main goals of this project are to:

1) Provide no-cost curriculum-based resources and supplemental materials in the form of online *libguides* hosted on the University's library website.
2) Create homework problems and quizzes compatible with the reformed textbook on the low-cost *Sapling* digital homework system.

References:

1 https://trends.collegeboard.org/college-pricing/figures-tables/average-estimated-undergraduate-budgets-2018-19#Key%20Points
2 https://www.usnews.com/best-colleges/georgia-southern-university-1572
3 https://www.cmu.edu/teaching/solveproblem/strat-lackmotivation/lackmotivation-01.html

2. Statement of Transformation

This proposal emphasizes a renovation and complete organization of course material for general chemistry curriculum for engineering majors (CHEM 1310) at Georgia Southern University's Statesboro campus ; this is a one-semester required science course for engineering majors. Every year, a total of approximately 576 students enroll for the Fall and Spring semesters, and with an additional enrollment of 48 students during the Summer term.

It is no secret that these days majority of students prefer to shuffle internet to get all the required understanding or information in order to prepare for the tests and/or assignments. They hardly consider printed text-book to look for answers. It is largely because of the convenience of searching an answer on a digital platform as compared to printed textbook. Over the years, we have observed that e-text book cannot be considered as an effective alternative since students are reluctant to look for any specific information since the existing e-textbook also does not provide interactive tool for learning and metacognition. **In a survey conducted in Fall 2017, less**

than 40% of the students reported buying the e-text for the course. Choosing an alternative textbook written solely for Engineering majors ("Chemistry for Engineering Majors" by Tom Holme) in one summer semester did not help either and students reported preferring online no-cost interactive tutorials. Also, we have often observed that at the beginning of the semester, students have difficulties arranging all the study materials due to their financial constraints and they largely rely on lecture materials to get through the process. In most occasions, for the mid-tier or struggling students, only PowerPoint lecture materials are not sufficient which is sadly reflected in the retention and DF rates (30-45% DWF rates). Studies also corroborate that not purchasing textbook increase the chance of failure or withdrawal from the course[4]. We would like to propose a complete organization of our study materials through a very cost effective alternative as compared to the current curriculum.

The proposal aims to replace the text book with guided and structured online supplemental materials hosted under the university library resources. These materials are designed in such a way that students will be encouraged to look into the materials for relevant information and guidance rather than incoherent probing of the internet. The foundational course materials will be developed based on learning objectives for each chapter and the material will be curated from Open Educational Resources (OER) (https://www.oercommons.org/ including OpenStax). Additional inquiry-based learning resources with problem sets keeping engineering majors in mind will be provided by project team members. The greatness of OER materials with creative common open licenses, lies in the facts that we can reuse, recreate, reorganize and reapply as it fits to our required curriculum. **Also a point to be noted is that all the examples so far published online, are largely focused on science majors and/or nursing majors. In our proposal, we would like to create several examples suitable for engineering majors and we eventually like to publish our materials for better good and for larger audience.** These free supplemental materials will emphasize guided inquiry and provide all the relevant information to various forms of problem solving including videos & interactive simulations for key learning objectives of the course material. Transformation of the current, traditional general chemistry text-book for engineering majors to a no-cost course material will provide students

online access to the aforementioned course materials from day-1 of the course with the aim of improving student learning and engagement.

In the Fall and Spring semesters, the course is taught in two large lecture classes (~192 students per class in Fall and 96 students per class in Spring). Currently, the courses uses an e-text (*Chemistry, The Central Science 14th ed. by Brown/ Lemay/ Bursten/ Murphy/ Woodward/ Stoltzfus)* integrated with the *Modified Mastering Chemistry* homework platform. The cost of the homework with e-text access code is $124. The large lecture classes also make it necessary for instructors to add effective formative assessment tools such as *iClicker2* which add significantly to student costs for the lecture course to $180 ($56 being the cost of the *iClicker2*). With the reformed no-cost textbook and low cost homework system (Sapling), the cost reduces to $35 per student including a similar formative assessment tool, *iClicker Reef* (the tool costs only $5 when bought along with Sapling homework platform). The Sapling homework system is integrated with OpenStax which is where most of the material for our transformation will be curated from. This would mean a significant savings of $145 per student for the lecture portion of the course. Switching to reformed text book materials integrated with less expensive digital homework platform and custom-made supplemental learning materials will surely provide a low-cost, wholesome learning experience to all our engineering majors enrolled in CHEM 1310.

Students will be able download all our created course materials. There is an ongoing dichotomy of opinion regarding the preference of printed text vs digital text.[5] One study has shown that capabilities such as annotation, bookmarking, hypertexts and highlighting available for digital text emphasize aspects of learning such as recall, comprehension and retention of information[6]. In order to account for useful digital capabilities as well as to give students a printed option, we will make the online materials print-friendly as well as have “download as pdf” functions.

Undoubtedly, stakeholders affected by such transformation will be largely students enrolled in CHEM 1310 and faculty teaching the course. As mentioned above, the transformation shall provide financial savings to students. Use of formatted and structured no-cost (or low cost) study materials shall provide a uniform learning and teaching experience to all our 624 students

taught by any number of faculties. The outcome of this proposal will encourage faculties to use such study materials for other general chemistry curriculum for science and nursing majors at GSU's Statesboro campus, since, currently, general chemistry curriculum is heavily focused on using high-cost, traditional text-book with digital homework system. We truly believe, that this ALG grant will provide a new pathway to our department of Chemistry and Biochemistry's Statesboro campus to reconsider a cost effective and uniform learning experience to all our students enrolled into general chemistry curriculum. Finally, the benefit of using library subscription and OER in creating low-cost model lies in the proper utilization of university's library resources which no doubt adds values to institutional investments along with the availability of most up-to-date content for our new proposed curriculum.

References:

[4] Florida Distance Learning Consortium. (2011, September). Florida Student Textbook Survey. Tallahassee, FL. http://www.openaccesstextbooks.org/projectInfo.html

[5] Daniel, D. B. and Woody, W. D. E-textbooks: At what cost? Performance and use of electronic v. print texts. *Computers and Education*. **2013**, *62,* 18-23.

[6] "Print versus digital texts: understanding the experimental research and challenging the dichotomies", *Research in Learning Technology.* **2017**, 25. https://journal.alt.ac.uk/index.php/rlt/article/view/1976/html#CIT0068_1976

3. Transformation Action Plan

Currently, there is no open access material dedicated only to the engineering students studying general chemistry. However, there are some open resources available for introductory chemistry course. We, as a team, strive towards that goal to compile necessary contents of Chemistry for Engineers that will replace the textbook for CHEM 1310 course. The contents will be curated from OpenStax and other Open Access Resources designed for General Chemistry. Our focus will be to select and modify material in a way that is relevant to Engineering majors in terms of both approach and examples. The curated material will be presented as *libguides* and students will be able to access the contents through Georgia Southern University's GALILEO library facility. Additional supplemental materials such as guided problem sets and lecture guides

will also be provided. Homework assignments that match with the reformed textbook materials will be created on the *Sapling* platform.

OpenStax provides two open access books for Principles of Chemistry. The book, "Chemistry" is the most suited one for CHEM 1310 course and we intend to use that book as our primary resource (https://openstax.org/details/books/chemistry). Most of the contents of the book are adequate to deliver information on the related topics. However, some modifications will be made to meet the requirements of the course suitable for engineering students. For some topics, other open access resources that have a better presentation of content will be used.

Typically, in general chemistry, "Equilibrium", "acids-base equilibrium" and "additional aspects of equilibrium" are taught as three separate chapters. However, in our transformed syllabus content, the three chapters will be consolidated into one chapter. The latter two chapters are applications of equilibrium concepts and a similar consolidation is used in the textbook "Chemistry for Engineering Majors" by Tom Holme. This modification will help the engineering majors to identify the primary concept and apply it for solving problems related to several practical applications such as preparation of buffer solutions for dyeing fabrics and treating industrial waste.

For the CHEM 1310, following chapters will be included from OpenStax:

1. New Chapter 1: Matter and Measurements
   Contents will be selected and edited from OpenStax Chapter 1: Essential Ideas.
2. New Chapter 2: Atoms, Molecules and Ions
   Will be used with minor editions to OpenStax Chapter 2
3. New Chapter 3: Chemical Reactions, Mole Concept and Stoichiometry
   Contents will be selected and edited from Chapter 3 and 4 from OpenStax.
4. New Chapter 4: Thermochemistry
   Contents will be selected and edited from OpenStax Chapter 5: Thermochemistry
5. New Chapter 5: Gases
   Selected and edited from Chapter 9: Gases from OpenStax
6. New Chapter 6: Intermolecular Forces, Solution and Colligative properties.

Selected and edited from Chapters 10 and 11 from OpenStax.

7. New Chapter 7: Chemical Kinetics

   Will be used with minor editions to Chapter: 12 from OpenStax.

8. New Chapter 8: Chemical Equilibrium and its Applications

   Contents will be selected and edited from Chapter: 13, 14, 15 of OpenStax.

9. New Chapter 9: Thermodynamics

   Use as it is from Chapter: 16 from OpenStax.

10. New Chapter 10: Electrochemistry

    Contents will be selected and edited from Chapter: 17 from OpenStax.

The team comprises of four faculty members, Dr. Beulah Narendrapurapu (BN), Dr. Debanjana Ghosh (DG), Dr. Arpita Saha (AS), Dr. Leah Williams (LW) and a library liaison, Ms. Dawn Cannon-Rech (DC). The faculties, BN, DG have taught CHEM 1310 (as well as other Principles of Chemistry courses) and BN is the coordinator for the CHEM 1310 course. AS and LW have taught Principles of Chemistry I and II (CHEM 1211K and 1212K) and Survey of Chemistry I (CHEM 1151) courses multiple times at Georgia Southern University.

Under the leadership of BN, the team will share responsibilities as follows:

- BN, DG and LW will be primarily involved in curating, creating and organizing reformed textbook and supplemental materials for the course. The faculty will be involved in creating bridges between any curated materials collected from two different resources and establishing continuity. They will be responsible for designing qualitative and quantitative evaluations of the transformation, gathering data and dissemination of the resources to faculty at Georgia Southern University and at professional conferences.
- LW will be involved in assisting with Institutional Review Board (IRB) applications for data collection, editing the transformed materials and providing assessment advice.
- DC will be involved in compiling the materials into libguides and for creating open-access to CHEM 1310 students.

The transformation will involve the following steps:

Organize:

i. Identify chapter learning goals and group concepts within chapters to create a skeleton for the lib-guides (responsible personnel: BN, DG).

Reformed textbook chapters (as libguides):

ii. Curate the course chapters by extracting information from OpenStax and other Open Educational Resources. Curate and create examples that are relevant to the needs of engineering students (responsible personnel: BN, DG, AS).
iii. Edit the created content (responsible personnel: LW).
iv. Arrange these reformed materials as libguides for easy student access (responsible personnel: DC).

Supplementary materials:

v. Create guided numerical problems with solutions and also self-assessment questions with hints for each chapter as part of supplementary material (responsible personnel: BN, DG, AS).
vi. Create PowerPoint slides that align with the redesigned content for use by instructors teaching CHEM 1310 (responsible personnel: BN, DG).
vii. Create lecture guides for chapters (responsible personnel: BN).
viii. Edit and provide all the supplemental material also as libguides (responsible personnel: LW, DC).

Homework:

ix. Explore Sapling digital platform and create relevant homework problems that align with the newly designed course material (responsible personnel: BN, DG, AS).

IRB and Data Collection:

x. Apply for IRB for collecting pre- and post- transformation data. Administer student surveys in CHEM 1310 course (responsible personnel: LW, BN).

4. Quantitative and Qualitative Measures

The satisfaction of the students will be measured by asking students to fill out surveys with questions related to how helpful the open access materials were in the learning of material and preparation for exams. In order to properly compare the current satisfaction of students using a textbook with satisfaction of students who would use libguides in the future, the PI will ask students to answer the following questions at the end of semesters before transformation (Fall 2019) and semesters after transformation (Spring 2020, Fall 2020).

Example of questions that will be asked before transformation (as multiple choice)

1) Did you buy the textbook for the course? Yes/No

   If Yes, when was the textbook bought?

   Week-1 week-2 week-3 week-4 later in the semester

   Questions 2-8 will be answered on a Likert scale:
   Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree.

2) I read the textbook to understand the course material ("textbook" will be replaced by "libguides" for post transformation survey).
3) I refer to the textbook worked out examples to understand how to solve problems.
4) I study from the PowerPoints uploaded for the chapters.
5) I use information available on the internet (eg. you-tube videos) to study for the course.
6) I learn from the homework questions.
7) I feel the available resources are adequate to prepare for an exam.
8) I feel the course concepts relate to engineering applications.

9) What suggestions do you have for improving the libguides (post transformation question only)?

In addition to satisfaction surveys mentioned above, retention and success rates before and after transformation will be compared. The withdrawal and failure (DWF) rates for the course, mid-term grades, final exam grades, correlation between homework scores and exam scores will be compared between semesters before and after transformation to measure the effect of the transformation on student success. In the class that the PI teaches, same final exam will be administered in semesters before and after transformation to compare student performance on course concepts before and after access to the transformed low-cost reading and learning materials. It is expected open-access materials will provide early access to reading materials and the formatted content will enhance students' performance in the course.

5. Timeline

June 2019: Identify chapter learning goals and group the concepts in each chapter to create a skeleton for the lib-guides in the first half of June. An IRB approval will be submitted for conducting research with students for measuring effectiveness of transformation.

June 2019 – August 2019: In the second half of June, the chapters (learning objectives) will be divided between BN, DG and AS and they will select materials from OpenStax and other Open Educational Resources. In the month of July and August, several examples and applications that are suitable to engineering students will be designed (some will be curated, but most will be designed as there are no open access resources for engineering chemistry). This information will be gathered on google documents and any information that needs to be added to the curated material will be designed. This will also include securing copy right permissions for any materials that need exclusive permissions. Effective digital homework platform will be chosen and the homework will be aligned with the reformed textbook material.

September 2019: The curated materials will be will be given to LW for editing. At the end of the editing, this information will be given to our library liaison for creating library guides.

October – December 2019: Supplemental materials such as guided problem sets, PowerPoint slides for lectures and lecture guides will be designed by BN, DG, AS, edited by LW and given to out library liaison for creating library guides.

Students will be given a survey at the end of the semester in December 2019 (this will be the pre-transformation survey).

January 2020 – May 2020: CHEM 1310 will be taught using library guides. Students will be given a survey at the end of the semester (post transformation survey for Spring 2020). Results will be shared at STEM conferences and at other professional meetings.

For completeness, we will continue collecting post-transformation survey data in Fall 2020 as well and compare it with pre-transformation data from Fall 2019.

6. Budget

Dr. Beulah Narendrapurapu (5000$)

The PI will need the money as a compensation for time spent on designing and curating transformed textbook materials and supplemental materials for engineering chemistry. The PI will be involved in gathering data, submitting IRB, planning data collection and dissemination of the project results in STEM conferences. The PI will maintain and update the created course materials.

Dr. Debanjana Ghosh (5000$)

The co-PI will need the money as a compensation for time spent on designing and curating transformed textbook materials and supplemental materials for engineering chemistry. The co-PI in data collection and dissemination of project results STEM conferences.

Dr. Arpita Saha (5000$)

The co-PI will need the money as a compensation for time spent on designing and curating transformed textbook materials and supplemental materials for engineering chemistry. The co-PI will also be data collection and disseminating it in STEM conferences.

Leah Williams (2500$)

The personnel will assist with editing the reformed textbook and supplementary materials created by the PI and co-PIs. The faculty will also assist with submitting IRB applications and providing assessment advice.

Travel (800$)

The money will be spent on travel and registration expenses for sharing the results at STEM conferences.

Supplies (200$)

The money will be used for printing and office supplies for the team members.

7. Sustainability Plan

The transformation project will have a long lasting influence on how the CHEM 1310 course will be taught in future. All instructors for CHEM 1310 will use the transformed materials in conjunction with Sapling homework to teach the course. Based on future requirements and survey data gathered from students, the libguides repository will be continuously kept up-to-date. Since the PI is also the coordinator for the course, she will be responsible for gathering feedback from instructors teaching the course and for the maintaining and updating the course website with the help of the library liaison.

The project has a vast possibility for expansion as well. The curriculum based digital platform will allow us to explore the possibility of blended learning. In the future, the scope of self-assessment tests will be expanded by adding tutorial like feedback and adaptive learning questions.

The work will be shared with other campuses of Georgia Southern University. The results from our survey data will be presented at STEM conferences. The provision of materials online also allows the instructors of the course to gather data for tuning their pedagogy and conducting related scholarly activity.

Note: Letter of Support

A letter of support must be provided from the sponsoring area (unit, office, department, school, library, campus office of the Vice President for Academic Affairs, etc.) that will be responsible for receipt and distribution of funding. Letters must reference sustainability. In the case of multi-institutional affiliations, all participants' institutions/departments must provide a letter of support.