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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:	Robin Lewis
Application ID:	3382
Application Title:	449
Date Submitted:	04/09/2019 at 8:23 AM

Personal Details

Institution Name(s):	Georgia College & State University
Applicant First Name:	Rachel
Applicant Last Name:	Epstein
Applicant Email Address:	rachel.epstein@gcsu.edu
Applicant Phone Number:	478-445-5000
Primary Appointment Title:	Assistant Professor
Submitter First Name:	Robin
Submitter Last Name:	Lewis
Submitter Email Address:	grants@gcsu.edu
Submitter Phone Number:	478-445-2754
Submitter Title:	Director, Office of Grants & Sponsored Projects

Application Details

Proposal Title

449

Final Semester of Project

Summer 2020

Requested Amount of Funding

10,800

Type of Grant

Gateways to Completion

Course Title(s)

Precalculus

Course Number(s)

Math 1113

Team Member 1 Name

Rachel Epstein

Team Member 1 Email

rachel.epstein@gcsu.edu

Team Member 2 Name

Marcela Chiorescu

Team Member 2 Email

marcela.chiorescu@gcsu.edu

Team Member 3 Name

Team Member 3 Email

Team Member 4 Name

Team Member 4 Email

Additional Team Members (Name and email address for each)

Sponsor Name

Kelli Brown

Sponsor Title

Provost and Senior Vice President for Academic Affairs

Sponsor Department

Office of the Provost

Original Required Commercial Materials (title, author, price)

MyMathLab access code for College Algebra and Trigonometry, Fifth Edition, by Lial, Hornsby, Schneider, and Daniels

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

30

Average Number of Sections Affected by Project in One Academic Year

11

Total Number of Students Affected by Project in One Academic Year

330

Average Number of Students Affected per Summer Semester

0

Average Number of Students Affected per Fall Semester

90

Average Number of Students Affected per Spring Semester

240

Original Total Cost per Student

\$126

Post-Project Cost per Student

at most \$22

Post-Project Savings per Student

at least \$104

Projected Total Annual Student Savings per Academic Year

\$34,320

Using OpenStax Textbook?

Yes

Project Goals

Precalculus is an Area A core course taken by hundreds of students at Georgia College each year. It has one of the highest rates of students who receive D's, F's, or W's (i.e., DFW rates) at around 25%. In the 2017 academic year, 196 students were unsuccessful in their attempts to pass the course. The high DFW rate led Precalculus to be selected as part of the Gateways to Completion (G2C) program. We are applying for this grant as faculty who frequently teach Precalculus and also as the Co-Chairs of the G2C Precalculus Course Committee. We are finishing the first year of the G2C process and plan to implement a variety of changes in the upcoming "Act and Monitor" phase. Improving equity by giving each student in our courses access to the resources they need to learn and thrive is the overarching goal of our project.

According to data from the 2018 academic year, Georgia College students who are Pell-eligible have a 30% higher chance to receive a D, F, or W in Math 1113 than those who are not Pell-eligible. In a recent study (2019), Delgado, H., Delgado, M. and Hilton found that Open Educational Resources (OER) have a significantly positive impact on Pell Grant eligible students. In a 2017 article reprinted in the G2C Guidebook, Gardner Institute President Andrew Koch says, "If inequity in the United States concerns you, and inequitable outcomes exist in the courses you and your colleagues teach, then it is important to remember that you have agency to address this" (Koch, 2017). Our first objective in support of our goal consists of using pedagogical practices known to promote equity in order to achieve similar rates of success among all demographic groups. We will create materials and design activities with the aim of "Enhancing Meaning," "Engendering Competence," "Establishing Inclusion," and "Developing Positive Attitude," which are Wlodkowski and Ginsberg's necessary conditions for culturally responsive teaching (Wlodkowski and Ginsberg, 1995).

"Today nine out of ten Pell recipients graduate with debt. Of the Pell recipients who attend public colleges and universities – fully two-thirds of all Pell recipients – just 48 percent who start college full time complete a degree or certificate of any kind within six years. Of the remaining 52 percent, one in three leaves with a double burden: no credential and an average of \$9,000 in student loan debt" (Goldrick-Rab, 2016). The price of textbooks is one barrier that can prevent students from achieving success in the course. Our second objective is to reduce the course costs for the students. By switching to a no-cost textbook and a low-cost online homework system, we will save the students over \$100 per person compared with the MyMathLab access code that is the current department standard for the course.

Our third objective for the project is for our students to demonstrate knowledge retention of the fundamental concepts of Precalculus. We will create assessment instruments to give at the beginning and end of the course to measure their learning.

These three objectives are intertwined. Our efforts to achieve these objectives will significantly overlap. With these objectives in mind, we will create learning materials such as in-class discovery activities and writing assignments, including some that help students to learn about the contributions of various world cultures to the subject.

Statement of Transformation

Math 1113, Precalculus, is taken by around 600-700 students at Georgia College each year. The Math department consists of 18 full-time faculty, 14 of whom have taught Math 1113 in the past five years. The department uses a common textbook, Precalculus by Lial, Hornsby, Schneider, and Daniels. This is bundled with MyMathLab and costs the students \$126. Department policy allows for instructors to deviate from the common textbook in order to use Open Educational Resources (OER).

In Spring 2015, Dr. Chiorescu explored using OER in her College Algebra course, which has been offered using a hybrid learning model. All of the assignments for this course were regularly done online using online instructional software, namely MyMathLab. Since at that time there were few reliable low-cost online math software available, she tried WebAssign to replace MyMathLab. Although the e-textbook adopted and the LibGuide created were adequate for the course, the online software was not, as students complained about various technical problems and its lack of tutorials (Chiorescu, 2017).

She returned the next semester to the traditional resources used before Spring 2015. However, despite difficulties with the software, one of the key findings of her study based on this OER adoption was that there were statistically significantly fewer students who dropped the course after OER were implemented. (Chiorescu, 2017). Also, the grades were higher when the OER course was used, comparing Spring 2015 and Spring 2014. Since OER have potential to save money for our students without negatively affecting learning outcomes, for Spring 2019, Dr. Chiorescu decided to explore OER in her Precalculus course as well. Currently, she is exploring the textbook Precalculus by OpenStax.

In our project, the two team members will adopt the OpenStax Precalculus textbook in our sections of Precalculus. We will also review and select an online homework system at a low cost, such as Rover by OpenStax or Edfinity, in order to provide students with practice as well as frequent feedback.

In “A Framework for Culturally Responsive Teaching” by Wlodkowski and Ginsberg (1995), they provide four conditions necessary for culturally responsive teaching. One condition is “Enhancing Meaning,” which includes providing “challenging learning experiences involving higher order thinking and critical inquiry.” We plan to create assignments and in-class activities that fit this description. Dr. Epstein has previously created homework assignments for Precalculus that combine the history of the subject with challenging problems that require critical thinking and complex problem-solving. In her classes, Dr. Chiorescu has previously incorporated inquiry-based learning (IBL) activities that expose students to “mathematics-in-the-making” as opposed to “mathematics-as-an-end-product” that they found in their textbook. Knowledge and ability stick better and are more readily available than when imposed by others. Discovery of concepts can be enjoyable and learning by reinvention may be motivating. It also fosters the attitude of experiencing mathematics as a human activity (Freudenthal, 2002). We are planning to adapt and expand on these to promote motivation and belonging, and to align them with Precalculus by OpenStax.

Another of Wlodkowski and Ginsberg’s four conditions is “Engendering Competence,” which includes self-assessment. As many students have never been taught how to effectively learn, we will use metacognitive techniques as in Saundra McGuire’s Teach Students How to Learn (2015) to help students understand the process of learning and become more efficient learners. We plan to provide the students with metacognitive prompts on assignments and in-class activities so that they can assess how they are thinking about problems and become more aware of their process of learning. Kimberly Tanner’s article “Promoting Student Metacognition” (2012) includes a large list of metacognitive prompts that will help us design our questions. We also plan to give exam wrappers with questions about their methods of studying before and after exams to help the students assess and refine their study skills. Another way to help engender competence is to teach the value of a growth mindset, as discussed in Carol Dweck’s book Mindset (2006). Since a fixed mindset can be a barrier to success, we will discuss mindset with students throughout the course and help to foster a growth mindset. A growth mindset can help students from groups underrepresented in mathematics feel a greater sense of belonging and be more resistant to the effects of negative stereotypes (Dweck 2006). We will review existing materials to promote a growth mindset and design an activity for the beginning of the semester to help students be aware of their mindset and to foster a growth mindset.

The other two of Wlodkowski and Ginsberg’s conditions are “Establishing Inclusion” and “Developing Positive Attitude.” To establish inclusion, we will use cooperative learning techniques, such as having students work in small groups and establishing ground rules for equitable collaboration. To develop positive attitude, we will use examples and applications that are relevant to the students’ lives. We will also be transparent about what is expected of them and what the learning goals of the assignments and activities are to help the students recognize the value of the work.

References

Brown, P. C., Roediger, H. L. III, & McDaniel, M. A. (2014). Make it stick: The science of successful learning. Cambridge, MA, US: Belknap Press of Harvard University Press.

Chiorescu, M. (2017). Exploring Open Educational Resources for College Algebra. *The International Review of Research in Open and Distributed Learning*, 18(4). <https://doi.org/10.19173/irrodl.v18i4.3003>

De Castella, K., & Byrne, D. (2015). My intelligence may be more malleable than yours: The Revised Implicit Theories of Intelligence (Self-Theory) Scale is a better predictor of achievement, motivation, and student disengagement. *European Journal of Psychology of Education*, 30, 245–267. <http://dx.doi.org/10.1007/s10212-015-0244-y>

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Freudenthal, H. *Revisiting Mathematics Education China Lectures* (2002)

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McGuire, S. Y. (2015). *Teach Students How to Learn: Strategies You Can Incorporate into Any Course to Improve Student Metacognition, Study Skills, and Motivation*. Sterling, VA: Stylus Publishing.

Tanner, K. D. (2017). Promoting Students' Metacognition. *CBE—Life Sciences Education*, 11(2), 113-199. <https://doi.org/10.1187/cbe.12-03-0033>

Wlodkowski, R. J. and Ginsberg, M. B. (1995). A Framework for Culturally Responsive Teaching. *Educational Leadership*, 53(1), 17-21. Retrieved from <http://www.ascd.org/publications/educational-leadership/sept95/vol53/num01/A-Framework-for-Culturally-Responsive-Teaching.aspx>

Transformation Action Plan

In Fall 2019, Dr. Epstein is scheduled to teach one section of Precalculus, and Dr. Chiorescu is scheduled for 2 sections. We will each teach 3-4 sections of the course in the Spring 2020 semester. Dr. Chiorescu is experimenting this semester (Spring 2019) with the textbook Precalculus by OpenStax. Before choosing this one, she looked at Precalculus, 3rd edition by Carl Stitz and Jeff Zeager (listed under the American Institute of Mathematics Approved Open Textbooks) but found that the OpenStax textbook has a greater variety of examples, is more accessible, and the presentation of the topics promotes a deeper understanding of the concepts. We both decided to adopt Precalculus by OpenStax for Fall 2019 and Spring 2020. This textbook is available in a variety of formats and it is accessible. "The text in our books, including the headers, features and exercises, is designed to be as reader-friendly as possible on-screen. Math content is rendered in MathML, which is an accessible format that can be read with screen readers and styled with CSS. Though we render some complex mathematical graphics as images, all images are developed with detailed explanatory text." (Accessibility Statement, OpenStax <https://openstax.org/accessibility-statement>)

The online version is also interactive. For many of the exercises in the e-book, the answers are hidden to give students an opportunity to assess their knowledge. When students are ready to see the answers, they just need to click one button to see them.

One of the first steps of this project is to identify the list of key topics to emphasize in the course. The goal is to ensure that students who are taking the course are prepared and that upon completion of the course, they will be well prepared for Calculus I and other future math and science courses. For this, we will collect information from the faculty of our department who teach Calculus I and from other departments on campus that use topics from Precalculus. Our next step will be to map these concepts to the corresponding ones in the newly adopted textbook and decide in which order we will cover the topics.

Together we will review two online homework systems: Rover created by OpenStax and Edfinity, a recipient of multiple National Science Foundation awards. We chose these two systems after looking into others, such as WebWork and TopHat. Rover costs \$22 per student per course and provides full access until the students pass the course. Edfinity costs between \$6 and \$12 for 3 months, depending on the number of students enrolled per semester. Our evaluation of the online homework systems will be based on the following in no particular order: accessibility and easy access on multiple platforms, immediate technical support, variety of questions (conceptual questions and open-ended questions) with meaningful instant feedback, and the format of the response that needs to be entered (some systems are very particular about this).

Based on our teaching experiences, we have noticed that students often lack long-term retention. We will discuss and implement teaching strategies that improve long-term retention. Retrieval practice is one method that has been shown to improve retention (Brown, Roediger, and McDaniel, 2014). Giving frequent low-stakes quizzes can help with retention through retrieval practice and can also help provide valuable early feedback, even during the first few weeks.

We plan to create teaching instruments to assess where students have gaps in the background knowledge needed for the course. We also plan to help our students review the content of the prerequisite course, College Algebra, and create (online) assignments covering the prerequisite material to be assigned shortly before the material will be needed in the course.

Dr. Chiorescu will be the team leader for the in-class material preparation, and Dr. Epstein will be the team leader for the out-of-class material preparation. We will meet often to discuss both types of materials. These materials will also include activities that make use of interactive presentation software, such as menti.com, for formative assessment. We will also anonymously collect questions from our students in class or out of class with software, such as slido.com.

For Fall 2019 we plan to upload all of our developed materials to D2L, which all our math faculty can access. At the end of the project (summer 2020) we plan to make all our newly created and revised materials available through GALILEO Open Learning Materials repository and GC Library Libguide (Library-Specific Springshare Product) that will serve as an easily accessible resource for anybody (student or instructor) interested in these.

Quantitative & Qualitative Measures

We will design an assessment instrument to be given both at the beginning of the course as a pre-test and at the end of the course to measure student improvement. It will contain questions about the fundamental topics of the course, such as knowing what a function is and how to model real-world situations with exponential or trigonometric functions. This instrument will help us to assess the success of the course with regards to the learning outcomes by comparing the results of the pre-test with the post-test.

We will also collect student grade data, including final grades as well as scores on assignments, quizzes, and exams throughout the course. We will compare grades and DFW rates with those from previous semesters, which we have been analyzing as part of the G2C process. We will also compare the rates in which our students continue to Calculus I with the rates from previous semesters. In addition, we will compare DFW rates of various demographic groups with those from previous semesters, to see if the success rates have become more equitable.

We are also interested to know if students' mindsets change over time and if their mindsets affect their performance in the course. To this end, we will use the National Mentoring Resource Center's "Growth Mindset for Intelligence" scale (Castella & Byrne, 2015), which we can administer online at both the beginning and end of the semester. We will compare the students' mindsets over time and will also see if there is a correlation between their tendency toward a growth mindset and their scores on the assessment of learning outcomes.

In addition to the quantitative data, we will collect qualitative data through surveys and metacognitive prompts. We will ask them to think about their own learning throughout the course as well as how the various aspects of the course affect their learning.

We will apply for IRB approval before teaching the course. The project will be classified as exempt, and we both have experience with the IRB, so we are confident the project will be approved.

Timeline

- May 20, 2019 Kickoff meeting would be attended by Marcela Chiorescu and Rachel Epstein
- May 21 - August 1, 2019 Develop a variety of materials to be implemented by both team members in Fall 2019. Share these with math faculty from our department on D2L. Apply for IRB approval.
- August 19-December 13, 2019 Implement the developed materials in our MATH 1113 sections. We will meet to reflect on our teaching experiences and make necessary adjustments weekly.
- December 16-20, 2019 Go over all the revisions, make final adjustments to the developed materials to be implemented in Spring 2020.
- January 6-May 1, 2020 Implementation of the revised materials in the 6-8 section of the Math 1113 sections that will be taught by both team members.
- May, 2020 Analyzing of both qualitative and quantitative instruments and reflecting on the results. Share our revised materials available through GALILEO Open Learning Materials repository and GC Library Libguide. Project report submitted to ALG.
- August 2020 and beyond Share our results locally to our GC faculty, regionally at the USG SoTL and at the math conference MAA-SE. We are also planning on discussing our results in the context of G2C project. Update and revise our materials every year as needed.

Budget

- Summer compensation for preparation time – \$10,000 Dr. Marcela Chiorescu - \$5,000 (salary and benefits) Dr. Rachel Epstein – \$5,000 (salary and benefits)
- Kick-off meeting and conference travel for both team members – \$800

Sustainability Plan

Sustainability for GC

We will share our materials with our math faculty through Desire 2 Learn (D2L) in Fall 2019 and also after revisions in Fall 2020. We will encourage other faculty who teach the course to make the switch to OER and will offer our materials and guidance to support them. Every semester, after our possible revisions and expansions of our materials, we will make necessary updates to these in D2L.

Sustainability outside GC

At the end of our project, in May 2020, we will make our materials publicly available through GALILEO Open Learning Materials repository and GC Library Libguide. Every semester, after our possible revisions, will update our materials on these websites as well.

Every two years we will check the accessibility of our materials.

Dissemination

We will disseminate our results locally to our GC faculty, regionally at the USG SoTL conference and at the MAA-SE math conference. We are also planning on sharing our results, in the context of G2C project, with our G2C team, and possibly presenting them at one of the G2C conferences.

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.



Provost and Senior Vice President
for Academic Affairs
Campus Box 24
Milledgeville, GA 31061-0490
Phone 478.445.4715
Fax 478.445.5151

April 08, 2019

Dear Review Board,

On behalf of Georgia College, I am pleased to offer this letter of support for our institution's **Gateways to Completion** Textbook Transformation grant application. Georgia College is requesting funding for the creation of "Low-Cost-to-Students" Learning Materials for the Precalculus (Math 1113) course, the development of which will be undertaken by Assistant Professor of Mathematics, Dr. Rachel Epstein, and Associate Professor of Mathematics, Dr. Marcela Chiorescu. Each year, Georgia College provides 6,000 undergraduate students with an exceptional learning environment that extends beyond the classroom, with hands-on involvement with faculty research, community service, residential learning communities, study abroad, and internships. Georgia College was ranked #5 in Best Undergraduate Teaching Programs – South and fourth among Georgia's public universities of value by Money Magazine.

As Georgia's designated Public Liberal Arts University, our institution seeks to combine the education experience of private liberal arts colleges with the *affordability* of public higher education. In recent years, affordability has become more and more of a challenge for Georgia's students, especially with regard to the cost of textbooks. Though the College Board estimates that the average student attending a four-year public college spent \$1,240 on books and supplies in 2018-19, Georgia College students will spend an average of \$1,500 on textbooks during the 2019-2020 academic year. As a growing body of literature suggests, no-cost learning materials are crucial to ensuring student retention and completion of courses. If Georgia College is to contribute to the additional 250,000 graduates needed to enter our state's growing workforce by 2020, it is imperative that we lower the cost of college for students through initiatives such as the ALG Textbook Transformation program.

The project of Dr. Epstein and Dr. Chiorescu will support the creation of online learning materials for Precalculus, which is an Area A2 core course and is required for many majors. The objective of working toward equity through pedagogy and textbook transformation is directly in line with Georgia College's Diversity Action Plan and our path to preeminence. Creating a classroom culture where all students have their best chance at success will not only help increase student achievement, it will also empower students to feel confident in their other coursework as well. Approximately 330 students in 11 course sections will benefit from replacing the textbook in the coming academic year. Dr. Epstein and Dr. Chiorescu will ensure the sustainability of their work by sharing their course materials with the other faculty in their department and making them publicly available through GALILEO Open Learning Materials repository and GC Library Libguide. They also plan to present their work at regional conferences. The Office of the Provost, along with the Office of Grants and Sponsored Projects, will ensure compliance with all State, Board of Regents, and institutional policies and procedures, should we receive funding.

Thank you for your favorable consideration of Georgia College's application. Please contact me should you have any questions regarding this project.

Best Regards,

Dr. Kelli Brown
Provost and Senior Vice President of Academic Affairs

Georgia College, the state's designated public liberal arts university, combines the educational experience expected at esteemed private liberal arts colleges with the affordability of public higher education.



Textbook Transformation Grants, Round Fourteen (Summer 2019 – Summer 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)	Georgia College & State University
Applicant Name	Rachel Epstein
Applicant Email	rachel.epstein@gcsu.edu
Applicant Phone #	478-445-5000
Applicant Position/Title	Assistant Professor, Department of Mathematics
Submitter Name	Robin Lewis
Submitter Email	robin.lewis@gcsu.edu
Submitter Phone #	478-445-2754
Submitter Position	Director, Office of Grants & Sponsored Projects

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	Rachel Epstein	rachel.epstein@gcsu.edu
Team Member 2	Marcela Chiorescu	marcela.chiorescu@gcsu.edu

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

Kelli Brown, Provost and Senior Vice President for Academic Affairs, Office of the Provost, Georgia College & State University

Project Information and Impact Data

Title of Grant Project	Improving Equity in Precalculus
Type of Grant	<i>"Gateways to Completion."</i>
Requested Amount of Funding	10,800
Course Names and Course Numbers	Precalculus, Math 1113
Final Semester of Project	<i>Summer 2020</i>
Average Number of Students Per Course Section Affected by Project	30
Average Number of Sections Affected by Project in One Academic Year	11
Total Number of Students Affected by Project in One Academic Year	330
Average Number of Students Affected per Summer Semester	0
Average Number of Students Affected per Fall Semester	90
Average Number of Students Affected per Spring Semester	240
Title/Author of Original Required Materials	MyMathLab access code for <i>College Algebra and Trigonometry, Fifth Edition</i> , by Lial, Hornsby, Schneider, and Daniels
Original Total Cost Per Student	\$126
Post-Project Cost Per Student	At most \$22
Post-Project Savings Per Student	At least \$104
Projected Total Annual Student Savings Per Academic Year	\$34,320
Using OpenStax Textbook?	Yes

Narrative Section

1. Project Goals

Precalculus is an Area A core course taken by hundreds of students at Georgia College each year. It has one of the highest rates of students who receive D's, F's, or W's (i.e., DFW rates) at around 25%. In the 2017 academic year, 196 students were unsuccessful in their attempts to pass the course. The high DFW rate led Precalculus to be selected as part of the Gateways to Completion (G2C) program. We are applying for this grant as faculty who frequently teach Precalculus and also as the Co-Chairs of the G2C Precalculus Course Committee. We are finishing the first year of the G2C process and plan to implement a variety of changes in the upcoming "Act and Monitor"

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She returned the next semester to the traditional resources used before Spring 2015. However, despite difficulties with the software, one of the key findings of her study based on this OER adoption was that there were statistically significantly fewer students who dropped the course after OER were implemented. (Chiorescu, 2017). Also, the grades were higher when the OER course was used, comparing Spring 2015 and Spring 2014. Since OER have potential to save money for our students without negatively affecting learning outcomes, for Spring 2019, Dr. Chiorescu decided to explore OER in her Precalculus course as well. Currently, she is exploring the textbook Precalculus by OpenStax.

In our project, the two team members will adopt the OpenStax *Precalculus* textbook in our sections of Precalculus. We will also review and select an online homework system at a low cost, such as Rover by OpenStax or Edfinity, in order to provide students with practice as well as frequent feedback.

In “A Framework for Culturally Responsive Teaching” by Wlodkowski and Ginsberg (1995), they provide four conditions necessary for culturally responsive teaching. One condition is “Enhancing Meaning,” which includes providing “challenging learning experiences involving higher order thinking and critical inquiry.” We plan to create assignments and in-class activities that fit this description. Dr. Epstein has previously created homework assignments for Precalculus that combine the history of the subject with challenging problems that require critical thinking and complex problem-solving. In her classes, Dr. Chiorescu has previously incorporated inquiry-based learning (IBL) activities that expose students to “mathematics-in-the-making” as opposed to “mathematics-as-an-end-product” that they found in their textbook. Knowledge and ability stick better and are more readily available than when imposed by others. Discovery of concepts can be enjoyable and learning by reinvention may be motivating. It also fosters the attitude of experiencing mathematics as a human activity (Freudenthal, 2002). We are planning to adapt and expand on these to promote motivation and belonging, and to align them with *Precalculus* by OpenStax.

Another of Wlodkowski and Ginsberg’s four conditions is “Engendering Competence,” which includes self-assessment. As many students have never been taught how to effectively learn, we will use metacognitive techniques as in Sandra McGuire’s *Teach Students How to Learn* (2015) to help students understand the process of learning and become more efficient learners. We plan to provide the students with metacognitive prompts on assignments and in-class activities so that they can assess how they are thinking about problems and become more aware of their process of learning. Kimberly Tanner’s article “Promoting Student Metacognition” (2012) includes a large list of metacognitive prompts that will help us design our questions. We also

plan to give exam wrappers with questions about their methods of studying before and after exams to help the students assess and refine their study skills. Another way to help engender competence is to teach the value of a growth mindset, as discussed in Carol Dweck's book *Mindset* (2006). Since a fixed mindset can be a barrier to success, we will discuss mindset with students throughout the course and help to foster a growth mindset. A growth mindset can help students from groups underrepresented in mathematics feel a greater sense of belonging and be more resistant to the effects of negative stereotypes (Dweck 2006). We will review existing materials to promote a growth mindset and design an activity for the beginning of the semester to help students be aware of their mindset and to foster a growth mindset.

The other two of Wlodkowski and Ginsberg's conditions are "Establishing Inclusion" and "Developing Positive Attitude." To establish inclusion, we will use cooperative learning techniques, such as having students work in small groups and establishing ground rules for equitable collaboration. To develop positive attitude, we will use examples and applications that are relevant to the students' lives. We will also be transparent about what is expected of them and what the learning goals of the assignments and activities are to help the students recognize the value of the work.

3. Transformation Action Plan

In Fall 2019, Dr. Epstein is scheduled to teach one section of Precalculus, and Dr. Chiorescu is scheduled for 2 sections. We will each teach 3-4 sections of the course in the Spring 2020 semester. Dr. Chiorescu is experimenting this semester (Spring 2019) with the textbook *Precalculus* by OpenStax. Before choosing this one, she looked at *Precalculus*, 3rd edition by Carl Stitz and Jeff Zeager (listed under the American Institute of Mathematics Approved Open Textbooks) but found that the OpenStax textbook has a greater variety of examples, is more accessible, and the presentation of the topics promotes a deeper understanding of the concepts. We both decided to adopt *Precalculus* by OpenStax for Fall 2019 and Spring 2020. This textbook is available in a variety of formats and it is accessible. "The text in our books, including the headers, features and exercises, is designed to be as reader-friendly as possible on-screen. Math content is rendered in MathML, which is an accessible format that can be read with screen readers and styled with CSS. Though we render some complex mathematical graphics as images, all images are developed with detailed explanatory text." (Accessibility Statement, OpenStax <https://openstax.org/accessibility-statement>)

The online version is also interactive. For many of the exercises in the e-book, the answers are hidden to give students an opportunity to assess their knowledge. When students are ready to see the answers, they just need to click one button to see them.

One of the first steps of this project is to identify the list of key topics to emphasize in the course. The goal is to ensure that students who are taking the course are prepared and that upon completion of the course, they will be well prepared for Calculus I and other future math and science courses. For this, we will collect information from the faculty of our department who teach Calculus I and from other departments on campus that use topics from Precalculus.

Our next step will be to map these concepts to the corresponding ones in the newly adopted textbook and decide in which order we will cover the topics.

Together we will review two online homework systems: Rover created by OpenStax and Edfinity, a recipient of multiple National Science Foundation awards. We chose these two systems after looking into others, such as WebWork and TopHat. Rover costs \$22 per student per course and provides full access until the students pass the course. Edfinity costs between \$6 and \$12 for 3 months, depending on the number of students enrolled per semester. Our evaluation of the online homework systems will be based on the following in no particular order: accessibility and easy access on multiple platforms, immediate technical support, variety of questions (conceptual questions and open-ended questions) with meaningful instant feedback, and the format of the response that needs to be entered (some systems are very particular about this).

Based on our teaching experiences, we have noticed that students often lack long-term retention. We will discuss and implement teaching strategies that improve long-term retention. Retrieval practice is one method that has been shown to improve retention (Brown, Roediger, and McDaniel, 2014). Giving frequent low-stakes quizzes can help with retention through retrieval practice and can also help provide valuable early feedback, even during the first few weeks.

We plan to create teaching instruments to assess where students have gaps in the background knowledge needed for the course. We also plan to help our students review the content of the prerequisite course, College Algebra, and create (online) assignments covering the prerequisite material to be assigned shortly before the material will be needed in the course.

Dr. Chiorescu will be the team leader for the in-class material preparation, and Dr. Epstein will be the team leader for the out-of-class material preparation. We will meet often to discuss both types of materials. These materials will also include activities that make use of interactive presentation software, such as menti.com, for formative assessment. We will also anonymously collect questions from our students in class or out of class with software, such as slido.com.

For Fall 2019 we plan to upload all of our developed materials to D2L, which all our math faculty can access. At the end of the project (summer 2020) we plan to make all our newly created and revised materials available through GALILEO Open Learning Materials repository and GC Library Libguide (Library-Specific Springshare Product) that will serve as an easily accessible resource for anybody (student or instructor) interested in these.

4. Quantitative and Qualitative Measures

We will design an assessment instrument to be given both at the beginning of the course as a pre-test and at the end of the course to measure student improvement. It will contain questions about the fundamental topics of the course, such as knowing what a function is and how to model real-world situations with exponential or trigonometric functions. This instrument will help us to assess the success of the course with regards to the learning outcomes by comparing the results of the pre-test with the post-test.

We will also collect student grade data, including final grades as well as scores on assignments, quizzes, and exams throughout the course. We will compare grades and DFW rates with those from previous semesters, which we have been analyzing as part of the G2C process. We will also compare the rates in which our students continue to Calculus I with the rates from previous semesters. In addition, we will compare DFW rates of various demographic groups with those from previous semesters, to see if the success rates have become more equitable.

We are also interested to know if students' mindsets change over time and if their mindsets affect their performance in the course. To this end, we will use the National Mentoring Resource Center's "Growth Mindset for Intelligence" scale (Castella & Byrne, 2015), which we can administer online at both the beginning and end of the semester. We will compare the students' mindsets over time and will also see if there is a correlation between their tendency toward a growth mindset and their scores on the assessment of learning outcomes.

In addition to the quantitative data, we will collect qualitative data through surveys and metacognitive prompts. We will ask them to think about their own learning throughout the course as well as how the various aspects of the course affect their learning.

We will apply for IRB approval before teaching the course. The project will be classified as exempt, and we both have experience with the IRB, so we are confident the project will be approved.

5. Timeline

- May 20, 2019
 - Kickoff meeting would be attended by Marcela Chiorescu and Rachel Epstein
- May 21 - August 1, 2019
 - Develop a variety of materials to be implemented by both team members in Fall 2019.
 - Share these with math faculty from our department on D2L.
 - Apply for IRB approval.
- August 19-December 13, 2019
 - Implement the developed materials in our MATH 1113 sections. We will meet to reflect on our teaching experiences and make necessary adjustments weekly.
- December 16-20, 2019
 - Go over all the revisions, make final adjustments to the developed materials to be implemented in Spring 2020.
- January 6-May 1, 2020
 - Implementation of the revised materials in the 6-8 section of the Math 1113 sections that will be taught by both team members.
- May, 2020
 - Analyzing of both qualitative and quantitative instruments and reflecting on the results.

- o Share our revised materials available through GALILEO Open Learning Materials repository and GC Library Libguide.
- o Project report submitted to ALG.
- August 2020 and beyond
 - o Share our results locally to our GC faculty, regionally at the USG SoTL and at the math conference MAA-SE. We are also planning on discussing our results in the context of G2C project.
 - o Update and revise our materials every year as needed.

6. Budget

- Summer compensation for preparation time – \$10,000
 - o Dr. Marcela Chiorescu – \$5,000 (salary and benefits)
 - o Dr. Rachel Epstein – \$5,000 (salary and benefits)
- Kick-off meeting and conference travel for both team members – \$800

7. Sustainability Plan

Sustainability for GC

We will share our materials with our math faculty through Desire 2 Learn (D2L) in Fall 2019 and also after revisions in Fall 2020. We will encourage other faculty who teach the course to make the switch to OER and will offer our materials and guidance to support them. Every semester, after our possible revisions and expansions of our materials, we will make necessary updates to these in D2L.

Sustainability outside GC

At the end of our project, in May 2020, we will make our materials publicly available through GALILEO Open Learning Materials repository and GC Library Libguide. Every semester, after our possible revisions, will update our materials on these websites as well.

Every two years we will check the accessibility of our materials.

Dissemination

We will disseminate our results locally to our GC faculty, regionally at the USG SoTL conference and at the MAA-SE math conference. We are also planning on sharing our results, in the context of G2C project, with our G2C team, and possibly presenting them at one of the G2C conferences.

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