

Affordable Learning Georgia Affordable Materials Grants Continuous Improvement Grants Final Report

(or Mini-Grants, for R17 and earlier)

General Information

Date: **Jun. 2, 2021**

Grant Round: **R17**

Grant Number: **M122**

Institution Name(s): **Georgia State University**

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

1. **Julie La Corte** (sole team member)
Assistant Professor
Perimeter College
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Project Lead: **Julie La Corte**

Course Name(s) and Course Numbers: **MATH 2211, Calculus of One Variable 1**

Final Semester of Project: **Spring 2021**

If applicable to your project:

Average Number of Students Per Course Section: **5** (one section)

Number of Course Sections Affected by Implementation of Revised Resources: **1**

Total Number of Students Affected by Implementation of Revised Resources: **5**

1. Project Narrative

Describe the course of your revision or ancillary creation project, including

- *A summary of your project's purpose, plan, and timeline.*
- *The original works which were revised or added to, with links. For example, if you revised an open textbook, give the title, author, and link.*
- *A narrative description of how the project's plan was carried out.*
- *Lessons learned, including anything you would do differently next time.*

Source textbook: OpenStax (Rice University), *Calculus, Volume 1*
(<https://openstax.org/details/books/calculus-volume-1>).

Goals

- Improve student performance on targeted portions of the MATH 2211 curriculum, including:
 - Finding one-sided limits of a function from its graph,
 - Computing the slope of a tangent line to the graph of a function at a given point,
 - Optimization problems (e.g., maximizing rectangular area),
 - Finding intervals of increase and decrease, and
 - Related rates
- Empower students by facilitating visual, kinesthetic, and interactive experiences of conceptually difficult material, including:
 - The formal definition of a limit,
 - The linear approximation of a differentiable function in the neighborhood of a point on its graph, and
 - Related rates.
- Release applets under a Creative Commons license (CC BY-NC-SA 4.0) so that they are freely accessible to all USG faculty and students.

Plan

- Align existing Department curriculum for MATH 2211 with OpenStax textbook sections and specific homework exercises (Summer 2020)
- Develop applets (Summer 2020, Fall 2020, Spring 2021)
- Create BrightSpace/D2L/iCollege course module (Summer and Fall 2020)
- Write “Workbook” in which all lecture material is comprehensively presented (Summer and Fall 2020)
- Prepare for the possibility of campus closure by making the “Workbook” self-contained, e.g. by providing narrative and exposition to accompany worked solutions to exercises (Summer and Fall 2020)
- Pilot materials and assess pedagogical effectiveness (Spring 2021)

Narrative: Summer and Fall 2020

My initial intent, as expressed in my grant proposal, was simply to author a handful of Mathematica applets for Calculus 1 that would provide students with an interactive, kinesthetic

experience of concepts that were identified as being challenging for students in a formal assessment conducted at Georgia State University's satellite campuses in 2018 and 2019.

But once it became clear that the Coronavirus pandemic would not be resolved in the U.S. before Spring 2021, all my assumptions about how I'd teach my grant-funded pilot class went out the window. By Fall 2020, my modest original goals for the project no longer seemed appropriate for the circumstances that were nearly at hand.

I got more ambitious. Instead of planning to teach face-to-face, I prepared as if for an online-only course, keeping in mind that the University might decide at a later date to switch the class to a hybrid or traditional modality. I typeset and extensively revised my existing personal lecture notes for Calculus 1, aligning them with the OpenStax textbook section by section. I copied homework problems from each OpenStax section into the resulting PDFs ("Lessons"), choosing problems similar to those recommended in the University's Calculus 1 teaching guide.

The role of the applets became more central in my revised conception of the class. I couldn't count on there being any real-time discussion of what students would be seeing onscreen, nor could I assume I'd be present to guide the students through the shared experiences I'd hoped the applets would provide. I couldn't assume the applets were going to be peripheral to in-class discussions—they might be replacing them.

Instead of writing four or five applets as planned, I wrote 15 (and counting), and integrated them into the PDF "Lessons." Since I wanted the applets to facilitate experimentation and discovery, in most cases, I didn't prescribe step-by-step instructions for their use, but rather prefaced references to applets with expositions that pose questions which are intentionally left open and which can be answered after students experimented with the applet. I tried to make the applets' interfaces as self-explanatory as possible, and reused display elements in the hopes of providing a degree of visual consistency throughout.

The final product consists of a suite of over 25 open-source Mathematica and GeoGebra applets (over 15 of which were authored by me for the current grant), a BrightSpace/D2L/iCollege online course, and a 340+ page PDF—called the "Workbook"—which aggregates the PDF "Lessons."

Each module in the online course begins with a link to a section in the OpenStax Calculus textbook, followed by a PDF "Lesson" which includes fully worked solutions to many of the exercises, and leaves blank spaces for exercises that have not been worked out. Most of the online modules provide at least one applet. The applets are intended to provide the student with experiences of calculus concepts in which they can actively participate, not by mechanically filling in blanks left in partial solutions, but by physically manipulating multiple parameters, setting animations into motion or freezing them in place, and hiding or revealing visual overlays.

Narrative: Spring 2021

Health and safety restrictions imposed by the pandemic prevented the project from proceeding as initially conceived.

The original idea had been to put individual students at a computer running an applet during class. This could have been implemented in at least two different ways, for two different purposes: (1) to facilitate class discussion, with a single student controlling the applet, taking guidance from other students and myself, and (2) to facilitate individual exploration and peer-to-peer discussion during in-class group work. In either case, individual experience was to be fused with collaborative learning.

However, social distancing requirements made this initial conception impossible to carry out safely. Instead, I incorporated the applets into my lectures, operating the controls for the students while promoting class discussion.

The implementation was thus completely at odds with the central goal of the project, which was to provide students with the opportunity to directly experience concepts through hands-on interaction in the context of cooperative learning.

I considered requiring students to engage with the applets on their own time, as a substitute for in-class hands-on experience—e.g., by giving assignments that relied on the use of the applets—but I opted not to do this. I felt that to add extra work on top of required online assignments would be unfair, perhaps even callous, given students' universally elevated stress level during the Spring 2021 semester due to the Coronavirus pandemic.

Two other significant challenges for the project were enrollment and student attendance. Only 5 students enrolled in the single section in which I piloted my materials. Of those 5, only 2 attended class more than 50% of the time. Since the class was listed as having the "hybrid model" as its modality, I could not require attendance, even if I'd wanted to. My sample size for any statistical analysis I might subsequently perform was therefore inadequate.

For these three reasons—the infeasibility of hands-on interaction during class and/or group discussion, low enrollment, and low attendance rates—I concluded that a quantitative report on the effectiveness of project materials during Spring 2021 would be meaningless, and deferred any such statistical study to a future semester in which students can safely use the applets during class and/or group discussion.

Lessons Learned

First lesson learned: Be flexible.

One lasting lesson I learned during the pandemic was that the benefit of designing course materials that allow for deployment in a variety of modalities.

In Summer and Fall 2020, it was anyone's guess what Spring 2021 would look like. This uncertainty forced me to prepare for multiple contingencies, e.g. face-to-face vs. distance learning. In doing so, I came to more greatly appreciate that course materials which can be deployed in a diversity of ways, have the ability to connect with a greater diversity of learning styles.

Second lesson learned: Be responsive.

No academic year has more dramatically demonstrated to me the importance of student feedback in real time. Without being able to carry out a meaningful quantitative analysis of the applets' impact on student performance, I relied heavily on person-to-person interaction in order to assess teaching effectiveness.

The very small size of our class enabled me to build a personal relationship with each student. I gauged the pedagogical value of my course materials qualitatively on the basis of our in-class interactions. When something I'd planned didn't work, or wasn't feasible, I took my direction from the students, and did my best to pivot in their direction.

The activities I'd planned for class often looked quite different in practice than I'd imagined them. The attendance policy was not what I would have preferred. But I believe the project was pedagogically successful, regardless of how little the implementation resembled the original vision.

Distribution of Final Grades (5 students enrolled):

1 A, 2 B's, 2 C's, 0 D's, 0 F's, 0 I's.

2. Materials Description

Describe all the materials you have created or revised as part of this project. These descriptions may be used in the [OpenALG](#) repository description field.

(Submitted in file "**OpenStax Calculus 1 Applets**" and "**Workbook May 2021**")

3. Materials Links

If you are hosting your materials in places other than OpenALG, please provide these links in this section. Otherwise, leave blank. Note: we cannot access D2L or Canvas links.

(Submitted in file “**Workbook May 2021**”)

The “Workbook”—which was not part of the original proposal, but grew out of it—cannot be freely distributed at this time, as it may contain copyrighted material. It is based on my lecture notes over the years, which incorporated materials from a variety of textbooks. A serious effort has been made to remove direct quotations of expository material and exercises I suspect I may have originated in copyrighted textbooks, and to provide citations where the sources are known, but more work needs to be done before the “Workbook” can be released under an open-source license.

The applets will be hosted on OpenALG.

4. Future Plans

- *Describe any planned or actual papers, presentations, publications, or other professional activities that you expect to produce that reflect your work on this project.*
- *Describe any plans to revise or add to these materials in the future.*

I plan to present the materials produced for this project at local and/or national conferences, e.g. AMATYC and Perimeter College Faculty Development Day. If the response is positive, I intend to formally write up the project for publication in a math education journal.

I will continue to revise and refine the materials (applets, Workbook, and iCollege portal) produced in association with this project. In particular, I plan to scrub all copyrighted material from the “Workbook” and release it under a Creative Commons license.