**Affordable Learning Georgia Textbook Transformation Grants**

**Final Report for Mini-Grants**

# General Information

Date: August 14, 2020

Grant Round: 14

Grant Number: M90

Institution Name(s): University of Georgia

Team Members: Donald Wayne Suggs

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Project Lead: Donald Wayne Suggs

Course Name(s) and Course Numbers: Quantitative Chemical Analysis (CHEM 2300L)

Final Semester of Project: Summer 2020

Average Number of Students Per Course Section: 20-25

Number of Course Sections Affected by Implementation of Revised Resources: 2

Total Number of Students Affected by Implementation of Revised Resources: ~40

# Project Narrative

The purpose of this grant was to develop inquiry-based learning modules for use in CHEM 2300 lectures with the eventual goal of creating our own textbook. These inquiries can be used by the student outside of class but work very well within the classrooms. The goal is to get students to think about the chemistry occurring in an analytical method so they can better understand how all variables affect a quantitative outcome.

The first module developed covers precipitation titrations. The chapter in the book is about titrations in general, but they start titration curve discussion with solubility equilibria applied to precipitation. This inquiry will likely become a module used in our in-house analytical curriculum. The inquiry is self-explanatory and the PI developed PowerPoint slides to go along with the question progression. Classroom response questions an be inserted into these inquires to make sure student understands the process. For instance, during the pre-equivalence region (any region of the titration curve will work!), you can ask the students about the limiting reagent, what controls the concentration of the analyte in solution or what species are significant in the solution. Questions like these usually end up on the exam in one form or another. The students are asked at the end of the inquiry to calculate a precipitation titration curve in EXCEL using percent titrated as the starting x value. They are also asked to enter all pertinent values to calculate the curve such as volumes of the starting analyte solution, its concentration and the solubility product, etc. The only thing not covered is different stoichiometries.

A similar inquiry was developed for the titration of a strong acid with a strong base. Initially, the PI included calculating ionic strength and using activities in the calculations of the pH. Thermodynamic equilibrium constants are discussed, but for the most part ionic strength and activity calculations have been removed to make the chemistry clearer to the student.

This inquiry follows in the SAME pattern as the precipitation titration inquiry. The exception comes when the reaction goes to completion there is no equilibrium to consider. Assumptions fail in this respect as the equivalence point is approached or when the volume is just past the equivalence point. The same series of questions can be asked here about limiting reagents, etc. that were asked in the precipitation titration. The student can see that the ideas behind a titration are universal, but the chemistry and equilibria used does change. The PI likes to ask the students to identify the type of solution created at each point in the curve. They can then easily remember: “Hey! I know how to calculate the pH of this type of solution!” from the word problems they see in class or on their homework.

This inquiry also introduces the idea of percent composition (or alpha values) and is based on an understanding of mass balance in a solution. These are more commonly called the percent association and percent dissociation of a monoprotic weak acid in general chemistry.

Again, at the end of the inquiry, students are asked to create an EXCEL worksheet that calculates the titration curve. They are also asked to reverse the acid and base and calculate the curve.

A final titration inquiry involves the titration of a weak monoprotic acid. Again, emphasis is placed on the solution composition during the titration as well as an understanding of mass balance relative to the acid itself. Buffers are also emphasized during the pre-equivalence region.

Again, at the end of the inquiry, students are asked to create an EXCEL worksheet that calculates the titration curve. They are also asked to reverse the situation and titrate a weak base with a strong acid.

A final inquiry for chromatography was also developed. The PI successfully used this in class to talk about how basic chromatographic parameters like retention time and peak width lead us to the thermodynamic partition coefficient AND an understanding of the variables that effect separation efficiency. These factors ultimately determine how well a set of analytes can be quantitated.

The PI was hampered in completion of this project due to the coronavirus in the Spring 2020 semester and for the Summer 2020 semester. Conversion of the entire course to online format meant that all of these resources were put into play. But, time was limited in any further developments.

# Materials Description

It made more sense to do this in the previous section.

# Materials Links

# Future Plans

The PI plans to continue to develop these resources as well as others. This would include a diprotic acid guided inquiry set as well as a set for spectroscopy. The goal is to eventually build an analytical textbook based at the University of Georgia. The hope is that the lecture portion of the course will be reduced to two day and the lab portion increased to two 3 hour laboratory sections.