1) **Proposal title:**
   Scholarship of Teaching and Learning: Integration of virtual chemical experiences into General Chemistry II via ChemCollective Labs.
2) **Applicant name:** Adrian Villalta-Cerdas, axv067@shsu.edu.
3) **Budget:** Funds requested $1,802.
4) **STEM courses involved in the proposal:** Three sections of General Chemistry II (CHEM1412), expected enrollment is 172 students.

5) **Project narrative**

   5.1) Executive summary

This project aims to improve student learning of the core ideas and scientific skills needed to understand chemical phenomena. The project proposes a thoughtful design of novel in-class activities and assessments for the General Chemistry II (CHEM1412) course to meet its goal. The work will focus on core chemistry ideas related to acid-base equilibrium and thermodynamics of inorganic salts' solubility in aqueous solutions. The project participants will create a suite of active-learning in-class simulations and virtual laboratory experiences to promote data analysis and interpretation using available ChemCollective resources (i.e., virtual labs and simulations). All activities will have an assessment component to determine the impact of student learning activities and the potential benefit to students' overall performance in the course. This project's outcomes will provide a deeper understanding of the effectiveness of virtual chemistry experiences in chemistry teaching, thus contributing to undergraduate chemistry education.

   5.2) Project Description

Project Rationale

Chemistry is an experimental science; consequently, extensive involvement with laboratory work provides an opportunity for learners to develop deeper connections between theoretical ideas and practical skills. To further stimulate students learning, the project herein comes to create and implement in-class activities using virtual experiences to enhanced students' learning in the laboratory. The main idea is to utilize freely available software from the [ChemCollective](#) (a decade long project supported by many institutions, amongst them the National Science Foundation).

The design and crafting of the in-class activities are part of the work of this project. The work will require a significant effort from the PI and the supported undergraduate student to create novel teaching approaches, implement those approaches, and assess how well they enable students to meet the expected learning outcomes.

Description of course and student population

The PI will teach three sections of CHEM1412: General Chemistry II for Spring 2021. Thus, students in the course will participate in the project. The class consists of three 50-min lectures a week and one 3-hour session of experimental chemistry in a laboratory. The student body enrolled in the course is diverse regarding majors, with many students from biology and

biomedical-science majors (33.4% of total students registered). The remaining majors include forensic chemistry (14.9%), chemistry (6.9%), Interdis-Agri-Animal-Science & Animal-Science (7.3%), geology (5.4%), physics (4.7%), kinesiology (4.5%), among others.

Materials and Methods

1. Instructional design: The instructional design's primary goal is to develop a suite of in-class activities thoughtfully linked to laboratory experiences that provide a scaffolded approach for supporting student learning. The next step will involve framing creative assessments to measure student mastery of the learning outcomes. Figure 1 presents an overview of how the virtual experiences integrate into the in-class activities for CHEM1412.

2. Implementation of virtual laboratories and simulations: the in-class activities will incorporate virtual experiences to illustrate acid-base equilibrium and salt solubility concepts and principles. The in-class activities will be drafted by the PI and further developed by an undergraduate student (supported by this grant.) The undergraduate student will test and improve the initial idea and generate creative assessments of the learning activity's

Figure 1. Overview of proposed integration of virtual experiences in CHEM1412.
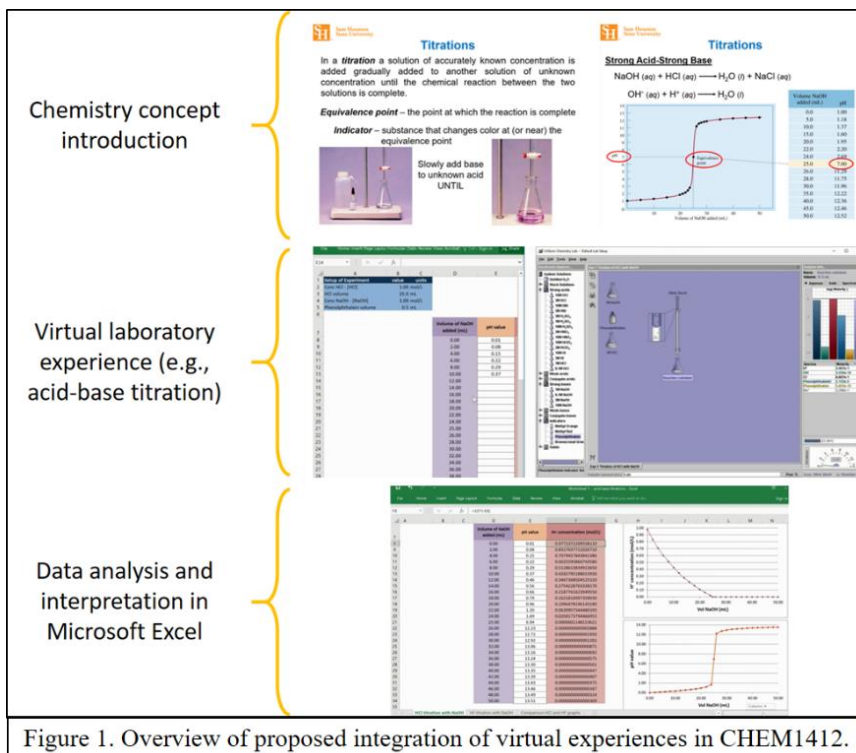
chemistry content. To this end, grant funds will purchase one laptop and one wireless mouse. The equipment will allow the undergraduate student to use the software (e.g., ChemCollective virtual lab program and simulations) and related technologies (screen capture and video editing programs) for the exclusive purpose of creating novel activities.

   The novel activities will be implemented during class time, thus allowing learners to interact with other class participants and the instructor. The activities will have an interactive nature to promote discussion and active engagement amongst all class participants. The activities are not envisioned to be asynchronous assignments to be completed individually by the students in the CHEM1412 course. As the in-class activities relate to virtual experiences, students will be instructed to work on a computer for those classes. The technology required will focus on video software and Microsoft Office programs (e.g., Excel.)

3. Assessment of student learning: The data collection will focus on maintaining the classroom environment as close as possible to a regular class session's undisturbed ecology. The project team will design questions for quizzes and exams to measure competency and achievement of the learning outcomes. The assessments will demand students to use the scientific practices embedded in the virtual experiences (e.g., use models, analyze and interpret data) to

provide a causal explanation for novel problems. The assessment approach will help determine if teaching practices and learning activities helped promote student learning of the core chemistry concepts.

Expected Results and Dissemination Plan

Phase 1: development of learning activities, January- early March 2021

The main objective of this phase is to develop and test four in-class activities. As the activities are related to equilibrium of acids and bases and salt solubility, and the content is covered later in the semester, the undergraduate student working on the project will have the first half of the semester to meet with the PI and create the activities. The PI time allocation for this phase will be three-hour-long meetings every week with the undergraduate student.

Phase 2: Implementation of virtual experiences in CHEM1412, early April 2021

This phase's main objective is to implement the novel in-class activities during the regular class time for the General Chemistry course. At this point, assessment data of student engagement and performance will be collected. The undergraduate student will work on the data analysis of the results. PI and student will keep meeting for three hours every week to discuss the project's progress and results.

Phase 3: dissemination of results, summer 2021 and fall 2021

The PI and the undergraduate research student will present the project outcomes in chemistry conferences at the American Chemical Society's regional and national meetings. Also, the learning materials will be made available to chemistry educators via peer-review journal publications (e.g., Journal of College Science Teaching, Educacion Quimica)

5.3) Budget Justification:

PI stipend: none.

Undergraduate stipend: the student will test and provide feedback on virtual laboratory experiences designed in this project; one undergraduate student for the Spring semester to be selected from the pool of chemistry and forensic chemistry majors. The undergraduate student is fundamental to the successful completion of the project.

Spring 2021: 1 UGs x $15.00/h x 3 hours/week x 12 weeks = **$540**

Other Project expenses: materials for development and testing of virtual chemistry experiences, $1,262.

Equipment	Units	Cost	Total
Laptop Computer: 2020 HP EliteBook 840 G6 14" FHD (1920x1080) IPS Business Laptop (Intel Quad Core i5-8265U, 16GB RAM, 256GB SSD) Windows 10 Pro	1	$ 1,150	$1,150
Wireless Mouse: Jelly Comb 2.4G Slim Wireless Mouse with Nano Receiver MS001 (Black and Gold)	1	$12	$12
Estimated associated costs (e.g., shipping, handling, and taxes)		$100	$100
	TOTAL		**$1,262**

Total funds requested: **$1,802**.