Project Name

A Virtual Instrumental Analysis Laboratory (VIAL) for Buffalo State and Open SUNY

Principal Investigator Jinseok Heo

Campus Buffalo State College

Year of Project 2013

Tier Tier One

Project Team

- Dr. Alexander Nazarenko, Buffalo State College
- Dr. M. Scott Goodman, Buffalo State College
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Overview Summary

Creation of online modules to support student not yet exposed to advanced analytical instruments for use in advanced chemical analysis, forensic investigation, and materials characterization.

Outcomes Summary

The project outcomes share demonstration modules on a range of analytical instruments.

Project Abstract

The availability of modern analytical instruments has resulted in a change of methodology in analytical chemistry and related sciences—these have almost completely replaced traditional “wet” analysis methods. Furthermore, advances in engineering and computer technology are continuing to improve the capabilities of analytical instruments and the speed of acquiring and processing data. Industry, government labs, and academia have been steadily adopting the new generation of fast and reliable instruments. Accordingly, this necessitates that educators equip students with new skill sets and knowledge to meet the demands of their potential employers.

In this project, we propose to begin development of a Virtual Instrumental Analysis Laboratory (VIAL). In the VIAL project, we aspire to achieve the following goals:
1. to effectively educate students to use modern analytical instruments by combining virtual and hands-on lab experiences
2. to provide learning opportunities with advanced analytical instruments to students, faculty, and staff at other SUNY institutions
3. to provide professional training on data acquisition and processing to the local scientific community
4. to investigate the feasibility of remote control of advanced analytical instruments

Thanks to a newly built science building, the Department of Chemistry at Buffalo State is now equipped with major contemporary analytical instruments for use in advanced chemical analysis, forensic investigation, and materials characterization. The acquisition of these new instruments will not only enable us to provide excellent on-site education to our students, but it also offers the potential to serve as a center for online education in the Western New York area and beyond. We propose to examine how we might help students and others learn to successfully collect and analyze data obtainable on our analytical instruments. These instruments include an X-ray diffractometer (Bruker D8 Venture with a PHOTON 100 CMOS detector), a Nuclear Magnetic Resonance spectrometer (Bruker Avance III 400 MHz), a dispersive Raman microscope (Thermo DX-R), a Fourier Transform-Infrared spectrophotometer (Thermo iS-50), a Gas Chromatography-Mass Spectrometer (Agilent) equipped with an automated sample injector (CTC PAL), and a Liquid Chromatography-Mass Spectrometer (Thermo Orbitrap). All of these instruments are widely used in chemical and biomedical research laboratories and industries.

Over the next year, we will incorporate these instruments into various undergraduate and graduate courses offered in the Department of Chemistry at Buffalo State. These analytical instruments require significant amounts of training before students can routinely use them with confidence. Since only 1-3 students can use an instrument at the same time, one major difficulty with this undertaking is that a faculty member cannot effectively train and supervise all the students in a class, since students are simultaneously using different instruments. Unfortunately, a simple mistake by an improperly trained student can be very expensive—repairs are rarely less than $1000 and usually much more. The VIAL platform will initially be used to provide online-based experiences for those who need training before they actually use an advanced instrument (goal 1). We expect that the VIAL approach will resolve these practical issues and reduce a student's learning curve once they are in front of the instrument and attempting to it. Specifically, we will make a variety of tutorials available in the VIAL so that students can understand all aspects of the instruments prior to their actual use. The tutorials will include descriptions of the underlying principles of the analysis, sample preparation steps, instructions on the software for acquiring and processing data, demonstrations of running the instruments, and simple maintenance procedures. Animation, video clips, webinar and text formats will be used for the tutorials, which will be made available through Blackboard. Although initially these tutorials will be only available to students registered in appropriate courses, it should be a simple matter to make them available to Open SUNY on the fullness of time (goal 2).

Faculty experts in the Department of Chemistry at Buffalo State will develop the tutorials with the aid of student workers. Drs. Alexander Nazarenko, Scott Goodman, Jaime Kim, and Jinseok Heo will participate in this project as faculty experts. Each will develop the tutorials and evaluate how they help students gain skills and knowledge of the new analytical instruments. Success can be evaluated based on student performance on lab experiments using the instruments in advanced chemistry, biochemistry, and forensic science courses.

Another VIAL approach is live streaming to students seated in classrooms. As previously mentioned, it is not possible to simultaneously show analytical instrumentation in a lab to more than 3 students at a time, but classes that use this equipment often have 12-15 students enrolled. Thus, live demonstrations of the equipment with audio, video, screen sharing and student questions will enable students to receive enhanced instruction (goal 1). This will require webinar software (e.g. OpenMeetings, GoToWebinar, Adobe Connect for Webinars). Instrument vendors, as part of their sales and training processes, commonly run these demos to

customers, so we will simply adapt and implement their existing methods. Furthermore, these software packages allow recording for later viewing, so that the webinars can be posted for asynchronous viewing by students (goals 1, 2). Finally, with this technology up and running, it should be possible to conduct live demonstrations for others in the scientific community (goal 3), although this will likely be beyond the scope of VIAL in its initial stages.

Finally, we will also try to demonstrate that the analytical instruments can be remotely controlled, so that off-campus users can directly benefit from our advanced facilities (goal 4). Other schools in SUNY may not possess all of the instruments that we own, and vice versa. We will explore how the VIAL can be used to remotely acquire and process data. Sharing access to expensive instruments between SUNY campuses will benefit everyone involved. We envision that eventually users anywhere will be trained using resources on Open SUNY and/or live webinars, then analytical samples can be sent to the campus that owns the instrument and analyzed remotely by the sender. We will initially test this idea using our campus intranet and report the results.

Reports and Resources

- Project outcomes report
- CIT 2014 presentation
- 2014 IUCr Conference presentation
- Mid-project report
- Tutorial videos on how to use analytical instruments were created and used in several undergraduate classes:
- Raman tutorial 01, Thermo DXR Raman basics
- Raman tutorial 02, How to use OMNIC1
- Raman tutorial 03, How to use OMNIC2
- Raman tutorial 04, How to use Atlus
- Raman tutorial 05, How to use MCR
- How to use Brucker Avance III 400 MHZ NMR
- How to use Agilent GC 7890A
- How to use Agilent GC-MS
- How to use Shimadzu GC2014

Faculty Development

- Organizational Models of Faculty Support

Instructional Design

- Online Education

Instructional Technologies

- Open Educational Resources (OER)