

Inquiry Oriented Learning in Science

Charles Sturt University Chemistry – Progress at August 2012?
Project Summary and a Reflection on the AFFA initiative
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Project Summary August, 2012

Our involvement in the project has been the introduction of inquiry based laboratory experiences for students in our third year analytical chemistry subjects. Historically this has been a single one year subject; however, 2012 is the first year the subject is being offered in a new sequence of two single semester subjects – CHM323 and CHM324. Given the changes and rewrites of the subject topics for this new two subject format it has proved a perfect opportunity to make substantive changes in the format for the laboratory experience. Students in these subjects study by distance, and complete their practical experiences at intensive four day residential schools.

The progress of your AFFA supported activity

In our application we indicated we would first introduce trial inquiry experiences into our second semester instrumental analysis subject (CHM324). In fact we moved such changes forward into CHM323 this Autumn semester as a trial experience for both the students and the instructors.

The CHM323 students had a 'traditional' prac experience as we have done in the past for about ¼ of the four day residential school. The instructors for the subject, Dr. Howitt and Dr. Doran, have, through conversations with Drs. Ryan, Prenzler, and me, have changed the remainder of the labs. There is an experiment analysing caffeine in beverages that compares liquid chromatography techniques with derivative UV-Vis techniques. In the past students have been told what to do and asked to compare results. This year students were referred to a scientific paper and asked to make decisions about which analysis technique to use for their samples, and then based upon the results compare and contrast the outcomes; the students need to do the legwork to decide what and how to conduct their experiments.

There is a fluorescence experiment measuring quinine concentrations in tonic waters. This year rather than being told concentrations of standards and sample preparation students were expected to work out for themselves what a reasonable concentration of quinine standards is appropriate for use in the indirect measurement technique.

In CHM324 Dr. Prenzler, in consultation with me, has revised the chromatography experiment to put the onus on students to think carefully about what instrument conditions and parameters are appropriate for reasonable results (please see attached information provided to students *before* residential school as an advance organiser.)

Who you have trialed your activity on and any assessment you have made of the outcomes

We have trialed the activities on CHM323 and CHM324 students only. The expectation is that as we instructors become more experienced and comfortable with such laboratory methods we will expand such inquiry methods into the laboratory experiences for our other chemistry subjects. Assessment methods we are using at this point involved student questionnaires/evaluations, and instructor personal reflections. Student responses to evaluations accompany this report. Some reflections from instructors are:

For CHM323 Autumn 2012:

"The students were much more comfortable with the practical written in the usual style- clear set of instructions to follow. The newer practical required them to do some reading and make some decisions before they began- how much sample? How many replicates? How do I tell if I've contaminated the samples (i.e. do they need blanks). The students were asked to draw on the material they had been assigned to read over the previous few weeks and to make some decisions about handling the reagents, based on the materials safety data sheets. Having taught this practical for the first time, it was apparent to me that it would not be possible to conduct this particular exercise with a larger class. It was necessary to have a conversation with the students after they had thought about their approach to the activity, but before they commenced (due to OH&S issues). The students required a series of leading questions to make them consider replications and the role of solvent blanks, acid washed glassware etc and also what safety equipment they may require beyond the minimum standards. The practical took considerably longer than expected (mostly due to slow soil digests, but also due to the amount of time the students required to decide what they needed to do). In future a much more contrived sample will need to be provided to reduce the sample preparation time. The students were asked to analyse their samples using two techniques. On the whole, the reports for this exercise were not as well done as for the other practical where their instructions were more clearly laid out. The comparative part of the activity was not well done and no student commented on changes they might have made to the sample preparation method. I suspect that if the students were more familiar with this style of activity from classes in earlier years they would have handled the reports better, but the level of complexity in the analysis combined with being unfamiliar with inquiry style practicals resulted in them taking a superficial or incomplete approach to reporting their experiments."

The other instructor commented:

"Can work ok in small groups with 1 staff member, but you would need more staff to run larger groups. Students need prepping at the beginning of the lab class, and there is a fine line between guiding and directing. I gave them guidance, but I am not sure that they were as switched on as I had anticipated as even when I provided a few specific directions to get them rolling, they may have still be sitting there 15-30 minutes later messing around with calculations. I think (and Julia [the other instructor] mentioned the same to me) that they need more practice on how to do this sort of calculation work, and quickly. Perhaps we need to include it in the curriculum."

"The students seemed to like them, but I think they wanted a little more spoon feeding. Generally speaking, I would say the students were a bit like children and the ocean; never turn your back on them for too long. I didn't leave them alone for more than 30 minutes because sometimes they got off track. One instance involved reading a peak area for a standard which was 661000, but they read it as 66100, and they kept saying their sample was too conc at a PA of 240,000. Obviously it wasn't. They messed around with dilutions for about 15-20 minutes with strange results when I checked on them. I pointed out the glaringly obvious and got them back on track. It's nice to let them free range, but it needs to be done within some constraints or I expect it will always go badly when you are dealing with people who are just learning how to think this type of problem through themselves."

Who you have involved during the development of the activity

Only the several chemistry instructors. I [Bedgood] have a few years experience with inquiry format labs from teaching in the U.S. and have supported my colleagues in developing and trialing the new laboratory experiences.

Any dissemination plans you have - What you are going to do next?

At this point we are focusing on our subjects and practical experiences. We are happy to work with the Sub Dean L&T to help promote such methods among other disciplines at CSU, and serve as guides or collaborators with other academics in other areas. We have no formal plans at this point.

- The extent to which you are being supported internally to carry on your development work
No formal support.
- Anything else you regard as relevant

One issue we have had with the project here is that Dr. Ryan, who was the first name on the application, is on maternity leave this year. This has not been a real problem because Dr. Prenzler and I had lengthy discussions with Dr. Ryan the end of last year to work out the plans for this year.

The value of the AFFA initiative

There are so many distractions and pressures on us as academics that it is far too easy to come up with new ideas and plans and then have them pushed aside by the load of everything else. Frankly, it is of value to have a project to make us focus on one aspect of our teaching and galvanise us into action.

Optimisation of a Chromatographic Method for the Analysis of Phenolic Antioxidants in Red Wine:

an inquiry-based lab for CHM324 – Chromatography

The scenario

You have been asked to develop a method to quantify gallic acid, catechin, quercetin and oenin chloride in red wine. These are phenolic compounds with potential health benefits in the human diet. A wine company has asked that these be quantified to use in marketing their new line of phenolic-enriched wines.

Material provided

- solid gallic acid, catechin, quercetin and oenin chloride
- a solution of all 4 standards in 12% aqueous ethanol
- mobile phases: acidified aqueous methanol and acidified aqueous methanol/acetonitrile
- HPLC with reverse phase column and UV-Vis detector
- UV-Vis spectrophotometer and cuvettes
- wine sample
- filters
- a chromatogram of the mixture under initial conditions

Starting point

The initial conditions will be an isocratic elution using acidified H₂O/MeOH/acetonitrile with the detector set at 540 nm. You will need to optimise the conditions to achieve separation of the compounds and optimum sensitivity.

To think about

- what are the steps to optimise separation?
- what do you need to know in order to optimise sensitivity?
- what sample preparation will be required?

Pre-lab exercise

- Write out a plan for how you will go about the optimisation process.
- Read any relevant literature that you think might help.
- Post on the forum what other information may need to be provided and the reason(s) why it is needed.

Pre-lab activities (20 points)

- forum participation (8 points)
 - at least 3 postings prior to the residential school
 - could be asking a question, answering a question, posting some helpful information (along with a short explanation of why it might be helpful)
 - marks awarded on the basis of intelligent participation, not getting answers right or wrong
- written plan (12 points)