

Taking Laboratory Chemistry to China: A Personal View

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Abstract

The opportunity to prepare and deliver a three-year practical university Chemistry course in China was a very exciting and challenging prospect. I have written an account of my experiences in the hope that it will inspire colleagues to consider delivering practical chemistry laboratory courses in other countries.

Keywords: China, laboratory, courses

Introduction

My role for a number of years has been the delivery of practical chemistry in the Sheffield University undergraduate laboratories, but in 2011 I had the opportunity to develop and deliver a laboratory course for undergraduate students at Nanjing University of Technology in China as part of a 3 +1 BSc Chemistry degree course. For the theoretical part of the course, the chemistry lecturers at Sheffield deliver their modules from the first two years of our undergraduate degree, in English, to the Chinese students in NJUT over three years. But we have also to deliver the practical component of our degree in Nanjing.

The start and the laboratory challenge

The laboratory challenge is that the Chinese students will study only 17 different practicals during their first three years. At the end of their third year the students should have gained the practical skills, knowledge and experience to be able to join the Sheffield Level 3 cohort for the final year of their BSc degree. The progression must be seamless.

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The first year of the course needed to be an introduction to basic practical skills and therefore not our current Level 1 work, which we deliver to the students during their first year in Sheffield. The Chinese students were from various backgrounds: some of the students had the opportunity to do a considerable amount of practical work at school whereas other students had little or even no practical experience. Nevertheless, I planned that after the first year's delivery the students should be above Level 0, so that I could introduce the more challenging Level 1 Sheffield practicals in their Year 2 in China. The Year 3 in China would then be exactly the same as the Sheffield Level 2 practicals, this time with very little alterations to the language to give them a good preparation for joining the Sheffield students at Level 3.

What would the facilities be like?

I had no personal experience of teaching chemistry abroad when I embarked on the project and only some sketchy ideas about the facilities in the laboratories in NJUT. Colleagues who had visited showed me some photographs of the laboratory and some of the equipment and informed me that NJUT has the basic equipment. The initial six practicals for Year 1 were selected so that they could be delivered with limited resources if necessary. During my first visit I would investigate the laboratories to see what could be delivered in future years. The aim was to try, as far as possible, to deliver over three years as many of the key practical skills that the students would need via a range of organic, inorganic and physical practicals covering the chemistry curriculum.

What are the practicals?

Below are the lists of practicals that have been, or will be delivered at NJUT.

Practicals delivered to Year 1 students in Nanjing April/May 2013

- Practical 1 - Determination of the ethanoic acid content present in vinegar
- Practical 2 - Determination of the percentage of copper in a copper salt
- Practical 3 - Preparation of acetoxime from acetone
- Practical 4 - Extraction of limonene from oranges or lemons
- Practical 5 - Determination of the RMM of an unknown organic acid using a potentiometric titration

- Practical 6 - Analysis of Congo red by visible spectroscopy

Practicals delivered to students during their Year 2 (taken from and adapted from our Level 1) in Nanjing April/May 2013

- Practical 7 - Air-sensitive compounds of transition metals
- Practical 8 - Colour in TM chemistry
- Practical 9 - Oxidation of fluorenone & recrystallization
- Practical 10 - The Aldol reaction.
- Practical 11- Equilibrium constant, iron III thiocyanate complex
- Practical 12 - Kinetics, crystal violet and NaOH

Practicals to be delivered to students during their Year 3 in Nanjing April/May 2014 (from our Level 2)

Inorganic

- Practical 13 - Optically active compounds
- Practical 14 - Acetylation of ferrocene

Organic

- Practical 15 - Wittig reaction
- Practical 16 - Grignard reaction

Physical

- Practical 17 - Hydrolysis of t-butyl chloride

Year 1 preparation for China

Once the practicals were selected, although I knew them well, being able to deliver them and achieve good, reliable results were important, so some trials before going to China would be necessary. I run a Level 3 school project and the cohort of 2012 was set a problem-based research task. The students were set a scenario involving the preparation of practicals for delivery in 6th form chemistry and the presentation of their results to the Head of Chemistry. The students had no previous experience of these practicals. The remit was to trial the practicals, consider the cost for the school, prepare pre-labs, methods, post-labs and technician lists for the Head of Science and discuss the feasibility of delivering them to A-level groups. The project groups were also to carry out the practicals to gain a set of results with a view to preparing a teachers' pack for each practical. They worked in two groups and presented their findings at the end of the project. Their feedback was positive in respect of

gaining an insight into what a teacher needs to think about, and several group members have continued into teacher training. But at this stage the practicals were ready for roll out only in the UK, not in China.

Armed with my project students' results, and the knowledge that the practicals would be successful, I set to work on a package for the six practicals. For each practical the language was adapted, the style was changed to make it user-friendly and careful guidance was prepared. A pre-laboratory work sheet and answer sheet, the method, results sheet together with an answer sheet were all adapted and altered so they were fit for purpose. A detailed technician list was prepared. At this stage, I sent the technician list to a professor in China with whom I would be working. I was assured that all the equipment and chemicals would be available to enable me to deliver the six practicals. With just two weeks to go until my visit, I loaded the practicals onto Moodle and released the pre-labs and methods in time for my visit. Students were to prepare the pre-labs for practical 1 and practical 2 and hand them to me at our first meeting. I had just two weeks to deliver, mark and provide feedback to the students for the six practicals.

The first visit and delivery of Year 1 practicals to students in China

Upon arrival in China I checked that everything was ready for delivery of the practicals. On the first day, I met the students and discussed the format of the delivery. I gave a safety lecture then demonstrated how to do a titration. This was a surprise to the students as they told me later that it was not usual for a demonstration to be given and they appreciated the clarity of my instructions. During my presentations to the students, I adapted my delivery to ensure understanding. Where we had language problems, my Chinese colleague explained to the group in Chinese. I wrote the new words on the board with explanations for the students. All the techniques were demonstrated as we worked through the six practicals, a style I have used for many years. I am keen that students have a good understanding of procedures before they carry them out for themselves.

Students were to document their results in their laboratory notebooks and I carried out "in-lab" marking, discussing techniques, theory and any issues with students on a one-to-one basis. During these sessions there were no demonstrators as we have in the UK (but the group was smaller); only I, my professor and the technician were always on hand. Although the professor spoke English the technician did not. Between us, we managed so that the language did not present any major

problems and the sessions were very successful. I marked all the pre-labs and gave feedback, all the post-labs and gave feedback. The students were very grateful for the help and support with the work, a level of support which I understand is not common in China. I was also filmed demonstrating a practical introduction and was told this would be good training for the Chinese teachers at NJUT.

During my first visit, I had the opportunity to look at equipment and take photographs, so that I would now be able to prepare for the higher level practicals.

Second visit to China, delivery of Year 2 practicals

During my second visit, I delivered a repeat of the Year 1 course to the new intake of students, which went very smoothly. The six new practicals were much more challenging and it had been necessary to order new equipment and chemicals to cope with the higher level work. I found that their spectroscopic skills were lacking, so I needed to deliver a lecture to cover the missing aspects of their theory, which they used during the more challenging practicals this time. Although the practicals proved to be more demanding, the students did exceptionally well. They showed confidence in techniques acquired the previous year, and quickly picked up extensions of techniques and new methodology. The assessment was similar to that for Year 1, a combination of pre-laboratory preparation and marking and in-lab marking. I found their laboratory notebooks to be of a very high standard. These students paid real attention to detail and worked to ensure they were meeting the standards I had set. The final part of the assessment was a report they executed outside the laboratory. The grading was the same as for Sheffield students and overall the group were very successful and passed the assessments.

The final year, delivery of Year 3 practicals

For Year 3, to which the students have been guided during the last two years, I am expecting high standards. Challenging Level 2 practicals have been selected for delivery in China. The practicals will not be adapted as regards language and the assessment will be the same as that for the Sheffield students. The aim is that the Chinese students should be able to successfully join the new Level 3 Sheffield cohort in September 2014. So far all the evidence is pointing to the fact that the students will be prepared.

Summary

Although the project is ongoing, I believe that the programme delivered to the students in Nanjing has been of sufficient quality for them to gain the required practical skills and to become competent chemists to enable their progression onto the Level 3 course in Sheffield. Working with Professor Shi and the technician Shirley has been successful; without their positive contribution the delivery of the practical side would not have been so smooth.

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