

# **Scholarship in Teaching Project: Evaluation of a Virtual Laboratory for Distance Chemistry Students Final Report**

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## **Introduction**

This is the final report for the 2004 Scholarship in Teaching project, titled "Evaluation of a Virtual Laboratory for Distance Chemistry Students". The members of the project team were Dr Barney Dalgarno, Senior Lecturer in Information Technology, William Adlong, Educational Designer, Dr Andrea Bishop, Senior Lecturer in Chemistry and Dr Dan Bedgood, Lecturer in Chemistry. This report includes background information about the project, a summary of project outcomes, a description of dissemination strategies and a summary of expenditure. A copy of a paper presented at the 2005 CELT Learning and Teaching conference which presents the key results from the project has also been attached.

## **Background**

The primary intent with this project was to evaluate the provision of a tool to enable first year distance education Chemistry students to prepare better for their laboratory-based residential schools. Anecdotal feedback to the chemistry lecturers had suggested that distance education students often felt overwhelmed by the first laboratory experiences and were interested in improved ways of preparing for the residential school. Thus an underlying premise of the project was that the anxiety and high cognitive load of the unfamiliar environment of the first residential school hindered student learning. The two subjects that were the primary focus of the project were CHM104 and CHM108. Most students taking these subjects do so, not because of a specific interest in chemistry, but as requirements for other courses such as Agriculture, Pharmacy, Equine Science, Wine Science and Viticulture.

The Virtual Laboratory allows students to explore an authentic 3-D representation of the chemistry laboratory, reading information about apparatus, finding the locations of equipment in the laboratory and choosing the correct equipment to put together as would be required in a common experiment. It was developed as part of Barney Dalgarno's PhD research. Based on previous evaluations of the Virtual Laboratory with internal students we thought that use of the Virtual Laboratory would give students a sense of familiarity with the laboratory setting and locations and functions of equipment, thereby reducing anxiety and enabling learning.

The Virtual Laboratory had been made available online to chemistry distance education students the previous year (2003) but a survey of the students showed that technical problems had obstructed most students who had attempted to access it. As part of this project those technical problems were addressed and the Virtual Laboratory was sent out on a CD to all distance education students enrolled in CHM104 and CHM108 in Autumn session 2004. Without the support of this project the school would not likely have provided the CD to students: the expense would have been unjustifiable without evidence of the value of the tool to students.

Students of the two subjects were surveyed at their residential schools (in all 95 survey responses were received) using an instrument that was initially developed and pilot tested

with internal students. Sixteen interviews were also conducted at the residential schools with both students who had and had not used the Virtual Laboratory.

In addition to evaluating the effectiveness of the Virtual Laboratory as a preparatory tool, the project was designed to explore students' experience of residential schools and the strategies that they used to prepare for them. We thought that the results of this exploration would be generalisable to other science-based distance education subjects. We also expected that the project would indicate the direction for further development of the Virtual Laboratory.

## **Outcomes**

This study, based on the self reporting of students, allowed the development of a number of conclusions about the value of virtual laboratories as preparatory tools for laboratory sessions in science education. Statistical comparison of survey responses of those who used the virtual laboratory with those who did not suggests that there was no difference between the confidence levels in their first practical session of students who used the virtual laboratory and those who did not. Nevertheless, many of the students who used the virtual laboratory were positive about the value of the virtual laboratory in contributing to their confidence and reducing their anxiety about practical work. Many of these students indicated that the virtual laboratory helped them to locate items of apparatus, and to work out which items to use, which we expect would have improved their confidence. Responses of users indicated, however, that, in its current form, the virtual laboratory provides no improvement in student ability to assemble and operate items of apparatus.

Students were asked to rank the relative importance of various preparatory resources and strategies and the rankings were very diverse. The fact that there was such diverse ranking of important items for student preparation suggests that students utilize a wide range of approaches in their study and preparation for their laboratory sessions. Evidence from this study suggests that provision of a virtual laboratory caters to the particular learning preferences of a minority of students. As such, we consider virtual laboratories as just one of the suite of options for addressing some of the identified problems with preparation for laboratory sessions. Despite mixed impressions of the virtual laboratory, the majority of students indicated in their survey responses that they would recommend its use before attending residential school.

Aside from the findings in relation to the virtual laboratory, one of the key outcomes from this study was the reinforcement of our initial view that many students experience anxiety approaching their first laboratory and/or are unconfident about their ability to successfully complete it. Additionally, as we expected, we found that prior laboratory experience was a big factor in reducing anxiety and increasing the confidence of those student having such experience. Somewhat surprisingly, most students did not indicate that they had difficulty with the procedures carried out during the laboratory sessions. Some students indicated in their interviews that they were more worried about their level of understanding of the theory in the subject and the effect this lack of understanding would have on their ability to complete their laboratory exercises, rather than about the use of laboratory equipment and apparatus. If this view is common then our efforts in continuing to develop the virtual laboratory may be better directed towards the integration of chemistry theory into the resource than on further enhancements relating to familiarity with laboratory procedures.

## Dissemination

Results of this project have been broadly disseminated via one national refereed conference publication<sup>1</sup>, one national unrefereed conference presentation<sup>2</sup> and two CSU conference presentations<sup>3,4</sup>. A final paper from this project is now in preparation, and will be targeted towards an international education journal such as the *Journal of Chemical Education*. Dissemination of the results of this project within CSU has occurred via the two CSU conference presentations, one in Wagga Wagga, and the other Bathurst. A copy of the paper presented at the CELT conference in 2005, which, of the four publications, contains the most complete report of the project outcomes, has been attached to this report.

<sup>1</sup> “What factors contribute to students’ confidence in chemistry laboratory sessions and does preparation in a virtual laboratory help?” (2004) Dalgarno, B., Bishop, A.G., Bedgood Jr, D.R., Adlong, W. *Proceedings of Scholarly Inquiry into Science Teaching and Learning Symposium* UniServe Science: Sydney. pp 15-21, 2004.

<sup>2</sup> “The Potential of Virtual Laboratories for Distance Education Science Teaching: Reflection from the Initial Development and Evaluation of a Virtual Chemistry Laboratory.” Dalgarno, B.; Bishop, A.; Bedgood, Jr., D.R. Royal Australian Chemical Institute CEC 2004 – Chemistry Education Conference. Hobart, Tasmania, February 5-10, 2004.

<sup>3</sup> “An exploration of the residential school laboratory experience of distance chemistry students.” (2005) Bishop, A., Dalgarno, B., Bedgood, Jr., D.R. and Adlong, W. Presentation at Charles Sturt University Student Experience Conference Sept. 5-7, 2005.

<sup>4</sup> “Factors Affecting Confidence at Residential Schools and Effectiveness of a Virtual Environment as a Preparative Tool” (2005) Bedgood, Jr., D.R., Adlong, W. Bishop, A., Dalgarno, B. In *Bright Ideas and Evolving Evidence*, Proceedings of the 2005 Charles Sturt University Learning and Teaching Conference, CSU Bathurst Sept 27-28 2005.

## Expenditure Summary

Category	Description	Budget	Actual Expenditure
Time Release	Time release for Barney Dalgarno, Andrea Bishop and Dan Bedgood for development of questionnaires, preparation for and conduct of interviews, data analysis, writing publications and delivering seminars	\$3,188.38	\$2,548.32
Research Assistance	Payment to William Adlong for development of questionnaires, preparation for and conduct of interviews, data analysis, writing publications and delivering seminars	\$985.50	\$985.50
Technical assistance with CD production	Payment to research assistants for testing and minor production work	\$115.94	\$463.76
Admin support	Questionnaire data entry, interview transcription, literature searches and journal access	\$1,014.48	\$1,992.75
CD Production and Postage		\$1750.00	\$908.02
Travel	Travel and conference registration as part of dissemination	\$233.00	\$370.00
<b>Total</b>		<b>\$7,286.79</b>	<b>\$7,268.35</b>