



Bridging the gap – student understanding and the chemistry bridging course

David Youl, Justin Read, Adrian George, Anthony Masters and Siegbert Schmid, School of Chemistry, and **Michael King**, Faculty of Education and Social Work, The University of Sydney
d.youl@chem.usyd.edu.au j.read@chem.usyd.edu.au a.george@chem.usyd.edu.au
a.masters@chem.usyd.edu.au s.schmid@chem.usyd.edu.au m.king@edfac.usyd.edu.au

Introduction

Students commencing university study come from a diverse range of backgrounds. Some students have substantial prior knowledge in areas they intend to study; others may have essentially no prior knowledge of some of their subjects. Universities may partially resolve this problem with streaming in units where cohorts are large. Nevertheless, it remains inevitable that some students will need to undertake preparatory work if they are to be ready to commence university study, and bridging courses are intended to help students to ‘bridge the gap’. The purpose of this paper is to demonstrate that bridging courses can effectively help students to address a knowledge deficit, and to explore some of the ways in which such assistance is best provided, by taking the University of Sydney chemistry bridging course as an example.

The University of Sydney chemistry bridging course is a seven-day intensive course that covers basic chemical concepts. It consists of thirteen one-hour lectures each followed by a two-hour tutorial session, giving students the opportunity to apply the principles covered in the preceding lecture. The efficacy of this bridging course has been briefly mentioned in previous work (Read, George, Masters, and King 2004). That work showed that the percentage of students who failed the end-of-semester exam (based on raw marks) was three-fold lower for students with weak background knowledge of chemistry (which includes bridging course students), compared with students with no prior knowledge of chemistry. However, that work did not elaborate on this finding. This paper expands upon that previous report, providing additional results from the 2003 student cohort, and extending the work to the 2005 cohort. The aims of this study are two-fold: firstly, to confirm that bridging course participants do perform better in the end-of-semester exam than do students with no prior knowledge who do not participate in the bridging course, and secondly, to explore the reasons for any differences observed.

Methodology

For the 2003 cohort, data on the performance and background knowledge for the Chemistry 1 for Veterinary Science student cohort (N=93) were obtained, along with similar data for a sample of the Fundamentals of Chemistry 1A student cohort (N=90). Data were also collected from the 2005 students of Fundamentals of Chemistry 1A, which is a first year unit of study with no assumed prior knowledge, and is designed specifically for students with weak chemistry backgrounds. It is taken by students with a wide variety of pre-existing chemistry knowledge, ranging from little or no prior knowledge to year 12 (HSC – Higher School Certificate) chemistry level. For both cohorts, students were categorized according to their prior knowledge. For the 2003 cohort the classifications were: ‘None’ (no prior chemistry); ‘Poor’ (bridging course or equivalent); ‘Good’ (HSC or equivalent); and, ‘Excellent’ (above HSC). For the 2005 cohort ‘Repeat students’ were treated as a separate group, and the ‘Poor’ category was divided into The University of Sydney bridging course students, and students with ‘Other weak backgrounds’. The previous ‘Good’ and ‘Excellent’ categories were combined into a ‘Strong background’ group, as the ‘Excellent’ background group in Fundamentals of Chemistry 1A is extremely small, primarily because other units are offered for such students.



The research utilised written surveys, unscaled results from the end-of-semester exam (which constitutes only one part of the assessment program), and, for the 2005 cohort (N=318), student interviews. In 2005 two surveys were conducted as the unit proceeded through semester 1, one survey given in week 3 (respondents N=216), and the other given in week 13 (respondents N=144). The surveys included both Likert scale and open-ended questions concerning students' perceptions of their preparedness for their studies, and of the difficulty of the unit. Two sets of in-depth interviews were conducted with 12 students from a range of levels of chemistry background knowledge.

Results and discussion

Results for the 2003 student cohort: Academic performance data

Raw exam performance data from the 2003 student cohort show that, for students with little prior knowledge of chemistry, completion of the bridging course is associated with significantly better end-of-semester exam performance. Figures 1 and 2 illustrate this for the Chemistry 1 for Veterinary Science and Fundamentals of Chemistry 1A units of study, respectively.

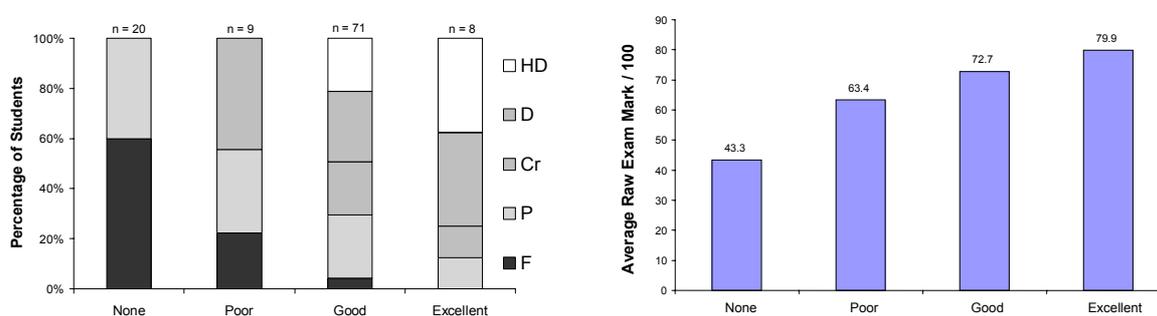


Figure 1. (a) Exam grade distribution and (b) mean exam marks for different levels of prior knowledge in Chemistry 1 for Veterinary Science, 2003.

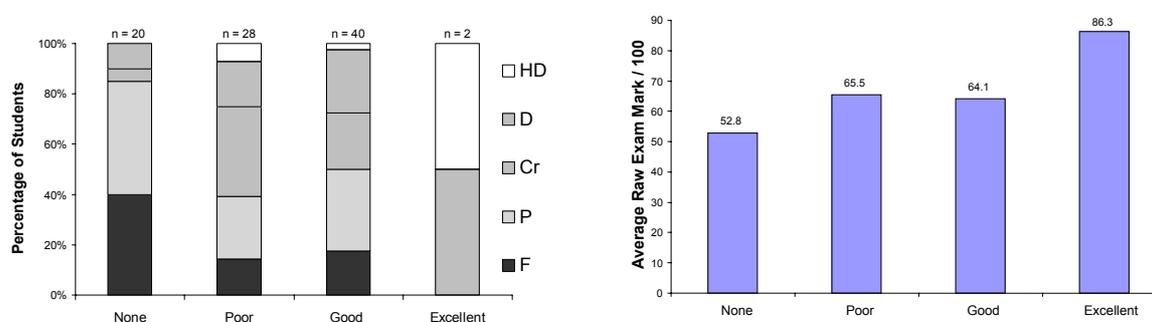


Figure 2. (a) Exam grade distribution and (b) mean exam marks for different levels of prior knowledge in Fundamentals of Chemistry 1A, 2003.

Figure 1(a) clearly shows that exam performance improves substantially with prior knowledge. The poor background students not only have a failure rate roughly one-third the size of the no prior chemistry students but are also showing raw performance at distinction grade standard. These differences are reflected in the statistically significant difference in mean mark of 20.1 marks ($t_{12}=2.13$, $p=0.027$) between these two groups. This trend continues for stronger backgrounds, as seen in Figure 1(b), where good background students outperformed poor background students by an average of 9.3 marks ($t_{78}=1.94$, $p=0.028$). Although the performance gap between good and excellent background students averages 7.2 marks, the small size of the excellent background group means that this difference just fails to reach statistical significance ($t_{77}=1.50$, $p=0.068$).

The qualitative trends seen in Figure 1 are repeated in Figure 2, with exam performance again significantly increasing with prior knowledge. The failure rate of poor background knowledge

students is significantly lower than that of the no chemistry background students, with a statistically significant difference of 12.8 marks ($t_{46}=2.81$, $p=0.0036$) between these groups. The poor and good background knowledge students in the Fundamentals of Chemistry 1A cohort show no statistically significant differences in mean exam mark ($t_{66}=0.412$, $p=0.341$) or exam grade band distribution. The statistically significant mean difference of 22.2 marks between students with good and excellent prior knowledge ($t_{40}=2.24$, $p=0.015$) is of little real importance, as the excellent group is so small.

The results from both units suggest that a bridging course can effectively address knowledge deficits. In Fundamentals of Chemistry 1A, with no assumed prior knowledge, the ‘bridging of the gap’ has resulted in weak background students performing as well as their good background counterparts. In Chemistry 1 for Veterinary Science, with the equivalent of HSC chemistry assumed, there is still very substantial ‘bridging of the gap’ in prior knowledge, with weak background students scoring an average 46% more exam marks than their no prior chemistry study colleagues. The fact that, in a unit with assumed knowledge, good background knowledge students still outperform their ‘poor’ counterparts is hardly surprising, as the risk that weaker students could be ‘left behind’ is high; in fact, the relatively small size of the poor / good performance gap is extremely encouraging.

Results for the 2005 student cohort: Academic performance data

Figure 3(a) shows that the bridging course is associated with a substantial reduction in the failure rate (based on raw marks) and an increase in the rate of achievement of higher merit grades by students in the 2005 cohort. Figure 3(b) shows that there is a strong positive correlation between prior knowledge and performance in the 2005 end-of-semester exam. In light of the 2003 findings it is reasonable to conclude that these differences, although not as prominent an effect as in the 2003 student cohort, are a real effect. This is consistent with findings of Thompson and Zamboanga (2004), who reported a positive relationship between prior knowledge and performance that was not attributable to general aptitude.

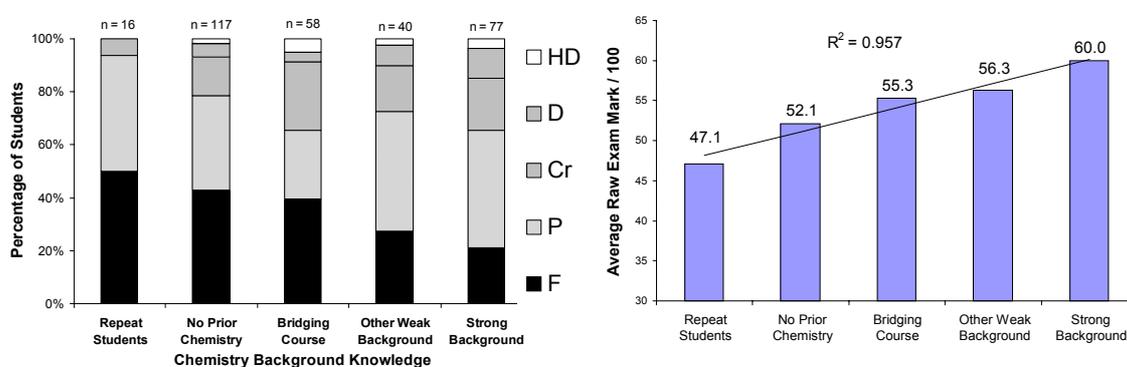


Figure 3. (a) Exam grade distribution and (b) mean exam marks for different levels of prior knowledge in Fundamentals of Chemistry 1A, 2005

Results for the 2005 student cohort: Survey data

Students in Fundamentals of Chemistry 1A in 2005 were also asked about how well prepared they thought they were to commence their university chemistry study. Figure 4 shows students’ responses to this question, which was asked both in weeks 3 and 13, categorised by their prior knowledge. It shows that the bridging course is associated with students reporting a higher level of preparedness for the unit of study, compared to the students with no prior chemistry.

A total of 216 students (67.9 %) in Fundamentals of Chemistry 1A responded to the week 3 survey, including 37 of the 58 students (63.8 %) who had attended the bridging course. In response to the question: ‘In what ways has the bridging course helped?’, most bridging course attendees reported either that their university study to this point was revision of bridging course content (13 comments), or that the bridging course had provided a foundation for their understanding of new material (21 comments). The following are representative examples of these two types of comment:



So far the unit of study has been revision of topics covered in the bridging course.
It has given me a solid grounding in chemistry prior to the commencement of the semester...

Bridging course attendees also reported increased confidence in their learning ability:

It has given me confidence in studying chemistry. I feel more comforted having the ability to understand lecture material.

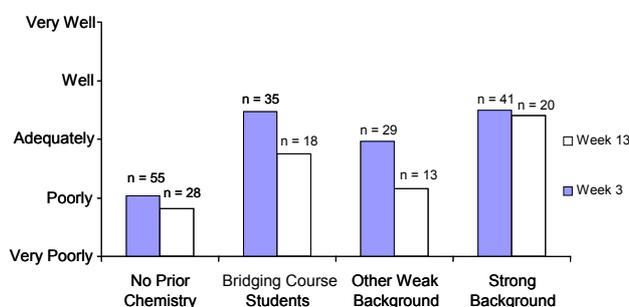


Figure 4. Perceived level of preparedness for students of different levels of prior knowledge in Fundamentals of Chemistry 1A, 2005

Self-efficacy, which Bandura (1997, p.2) defined as ‘beliefs in one’s capabilities to organise and execute courses of action required to manage prospective situations’, has been shown to be an important factor influencing student performance (Zimmerman 2000). Thus, an enhanced level of confidence, leading to an improved self-efficacy perception, could help to improve the academic performance of students who attend the bridging course, and may account for part of the differences in end-of-semester exam performance which are reported in this paper.

Conclusion

The results presented in this paper support the conclusion that students who attended the bridging course developed some understanding of relevant fundamental chemical concepts. This assisted them when interpreting material presented in their university study, and served as a foundation upon which their understanding of new chemical concepts was constructed. Bridging course students also feel better prepared for their studies and this may well be a factor influencing their higher academic performance due to enhanced academic self-efficacy. Qualitative data suggest that participation in the bridging course may produce higher levels of student confidence. Further investigation and detailed analysis will be required to investigate the reasons for the difference in the magnitude of the impact of the bridging course between the 2003 and 2005 student cohorts. Further research will also be required to investigate the relative impact of increased confidence in relation to the other factors affecting student performance, such as prior knowledge.

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