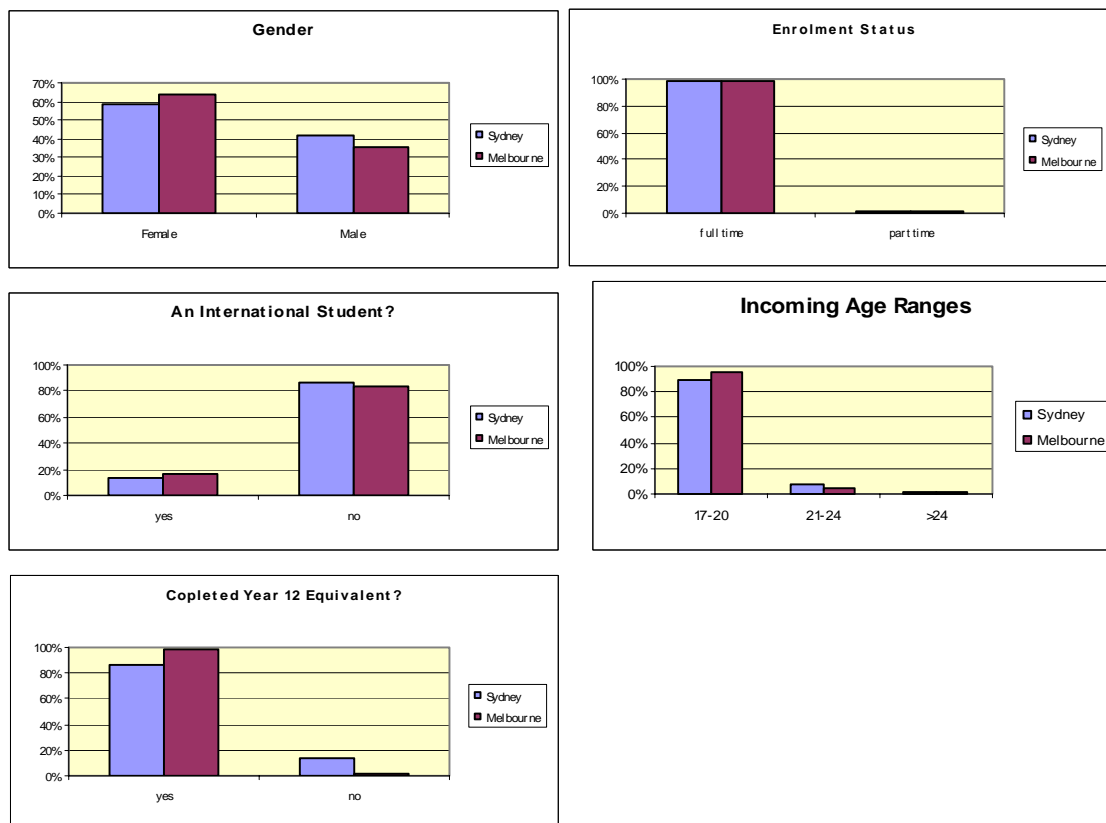


Section 6: Comparison of the use and perceptions of usefulness of the ChemCAL on-line learning modules, in supporting the learning of chemistry

The same survey instrument (Appendix 6A) was used at the University of Melbourne and University of Sydney to obtain student perceptions of one particular on-line learning resource. This resource, ChemCAL (Appendix 6B) is used in chemistry 1 at both Universities. A compilation of the quantitative data for the University of Sydney is given in Appendix 6C. A summary of the qualitative feedback from the surveys from both universities is given in Appendix 6D. The following provides a summary of some of the findings and presents additional data, obtained from log data, relating to how students use the resource.

Demographics

The population returning the surveys appeared representative of the wider student cohort. The demographics were very similar for both Universities.



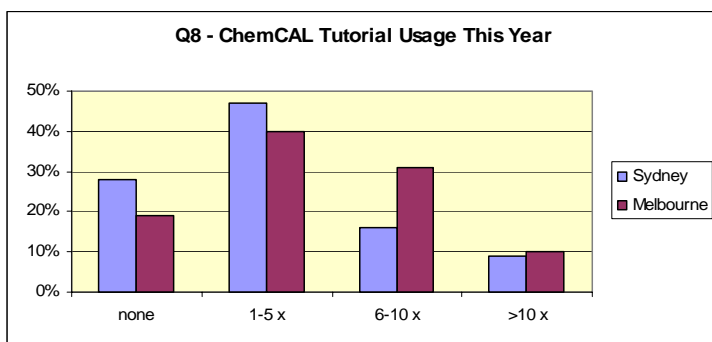
ChemCAL

ChemCAL is a series of on-line learning modules used at both the University of Melbourne and University of Sydney. The resource allows asynchronous delivery of high quality information with formative assessment questions supporting the content.

- It is constructed of a series of modules with information, animations, questions, hints and explanations
- It is available to all first year chemistry students
- It forms part of a raft of resources
- It is not compulsory

Resource Usage

Students were asked how often they used ChemCAL (n=737 USyd, 460 UMelb). The majority of students use ChemCAL at least a little. Log data indicates a mix of steady use during the semester and cramming at just before exams.



Students were asked this question 2/3 through the semester; more may resort to ChemCAL as a revision only resource

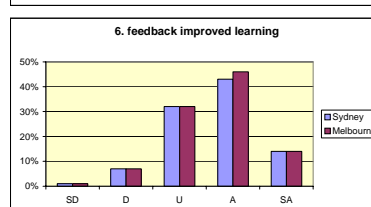
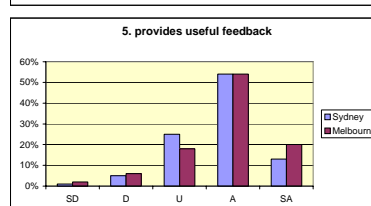
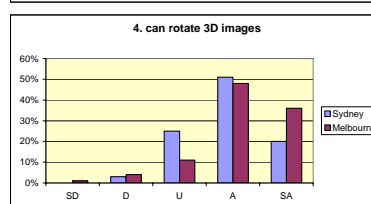
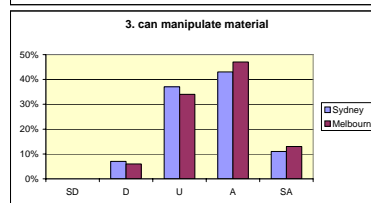
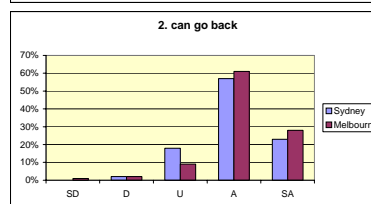
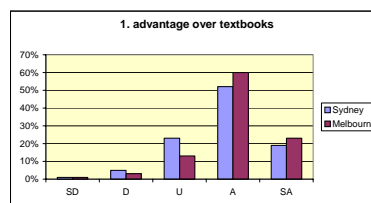
The use of ChemCAL is likely to reflect a number of factors:

- Availability of other resources considered helpful eg whether there are good lecture notes on the web;
- How widely ChemCAL is advertised to a particular class; and
- Ability of the class and need for it for example advanced classes appears to need the basic information provided by ChemCAL less than other classes.

Advantages of ChemCAL

Students were asked to respond on a five point scale (strongly disagree to strongly agree) to aspects relating to their use of ChemCAL in the following questions:

1. The step-by-step approach used to explain concepts in ChemCAL is an advantage over textbooks
2. If I miss important information in ChemCAL, the choice to go back over it is valuable
3. Using ChemCAL means I can manipulate material to help my learning in a way not possible with other means
4. The ability to rotate three dimensional objects in ChemCAL allows for better understanding than just using two dimensional images from classes and textbooks
5. ChemCAL provides me with useful feedback on my understanding of Chemistry
6. The individual feedback provided by ChemCAL has improved my learning



Students were asked what were the most helpful aspects and least helpful aspects of ChemCAL and why:

50% from both universities felt ChemCAL aided their learning and understanding and achieved this by immediate feedback. Fewer responded to the question of what they

would like to change but of those that did, 1/3 found technical aspects (problems with using ChemCAL on the home computer) were problems and 1/4 said they would not change anything.

How students use ChemCAL

An indication of how students use the ChemCAL modules may be obtained from the log data collected from the host server. For each page served that requires some interaction, the nature of the interaction is recorded. Information about whether students have answered the questions correctly, how many attempts they have had at answering the questions, whether they asked for hints or for explanations or just clicked on ‘show me’ [the answer]. Analysis of this data can build an impression of student engagement with the material: whether the student just clicks through the questions and requests the correct answers or whether they submit their own answer for marking.

One page on each of four different modules was examined and student use at the two Universities compared. The modules were:

- Stoichiometry – a familiar topic to most students
- Quantum chemistry – a new topic for almost all students
- Kinetics – a page that required considerable student input including use of graph paper
- Nucleophilic substitution – a topic that did not require mathematical expertise

1. Stoichiometry

Correct answers to earlier sections must be obtained (by student or by ‘show me’) before the next section is revealed. In this way mistakes that may be made by students are not propagated.

For clarity, results from UMELB only are graphed (N=400). USYD results are remarkably similar (N=100).

ChemCAL Online Chemistry 610-141 Stoichiometry

Reduction of Iron(III) Oxide

The metal iron can be produced by the reaction of iron oxide with carbon monoxide.

Balance the equation:

$$\text{Fe}_2\text{O}_3 + 3 \text{CO} \rightarrow 2 \text{Fe} + 3 \text{CO}_2$$

Given 1.00 kg of iron oxide:

- How many mole of Fe can be formed? ... 12.5 mol
- What mass of Fe can be formed? ... 698 grams
- How many mole of CO₂ can be formed? ... 18.8 mol
- What mass of CO₂ can be formed? ... 827 grams

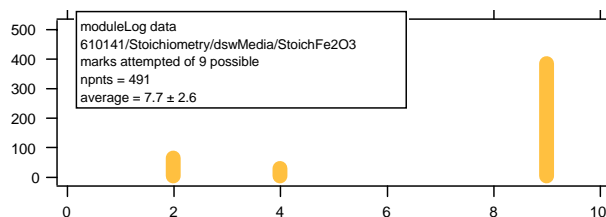
2/9

How many marks do students attempt (out of 9 possible marks for this page)?

Most students attempt all marks; some leave after only 2 marks (balance the equation in this case). This turns out to be a common kind of behavior, with most students working through to the end; the others just have a look and leave.

In summary:

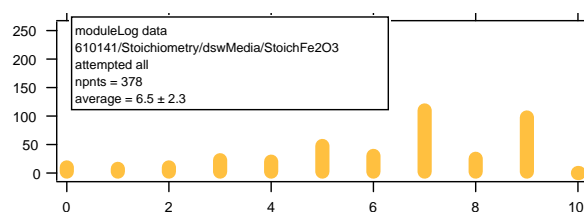
- Full page worth 9 marks
- Most seem to pull out after attempting 2 marks or see it through to the end



- Of those that see it through to the end the average scores are very similar (6.5 UMELB, 6.5 USYD) and of those that leave after 2 marks the score is again similar (1.0, 0.9 respectively)
- For Q1 only 47% (232 of 493) UMELB users got the balancing task correct at first attempt with 33% (35 of 106) at USYD
- 21% from UMELB did not get a single coefficient correct, 16% from USYD

For students who attempted all questions (9 marks), what was their score?

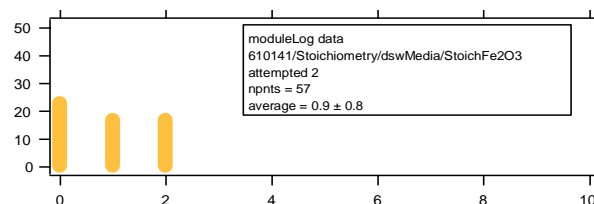
There was a broad spectrum of results, with an average around 70%. While those that find stoichiometry particularly difficult, a score of 0 is more likely to be someone clicking through to obtain the answers without attempting the questions themselves.



Note students have to see the answer of one question before going onto the next one.

For students who attempted only Q1 (2 marks to balance an equation), what was their score?

Some get it correct and leave. They may think is all too easy or do not want to get into the calculations. There are plenty who do not get it correct!

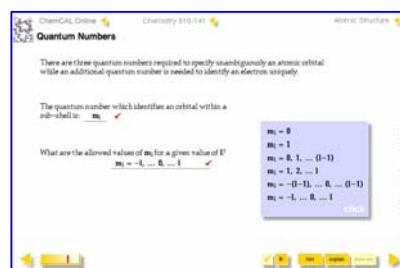


Overall the results, if they indicate student ability of a high school topic, are a little depressing. In summary:

- Less than 50% get the equation balance correct at their first attempt
- Less than 50% correctly calculate the number of mole of iron from 1 kg of iron oxide (based on an equation which is now correct)
- About 60-70% can turn that number of mole into a mass of iron correctly
- Hints and explanations were used, but only by ~10-20% of users

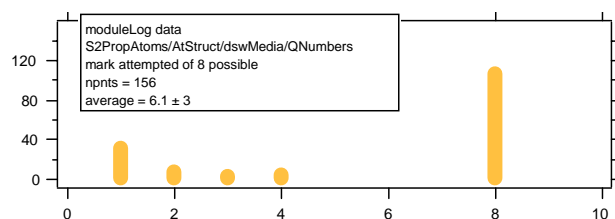
2. Quantum Chemistry

New information is presented, which student could rote learn, rather than understand, if they chose.



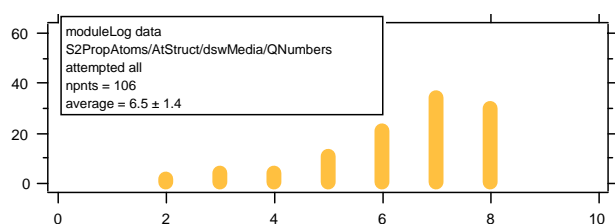
How many marks do students attempt (out of 8 possible marks for this page)?

Nearly all students attempt all questions (max 8 marks).



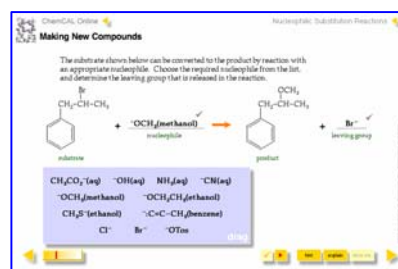
For students who attempted all questions (8 marks), what was their score?

The majority of students attempting all questions get full or nearly full marks ... 7/8 or 8/8.



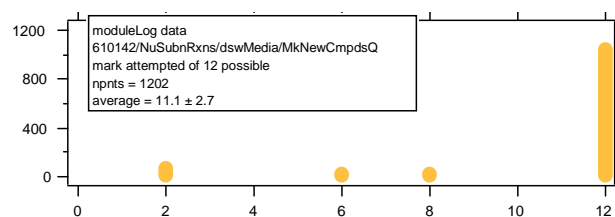
3. Nucleophilic Substitution

This page provides some drill and practice type of questions about nucleophilic substitution.



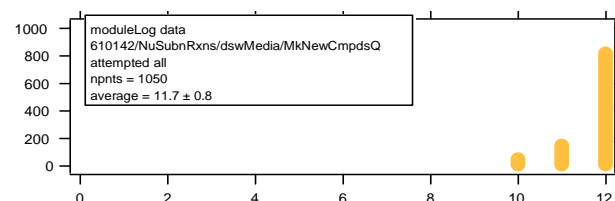
How many marks do students attempt (out of 12 possible marks for this page)?

Again, nearly all students attempt all questions (max 8 marks).



For students who attempted all questions (12 marks), what was their score?

Similarly, these students scored highly.



4. Kinetics

This is quite a complex page ... student fill in the first points in the table, then the rest are revealed; they can have look at the original concentration/time graph (if they choose to); they need to make their own plot to decide which of two possibilities is more linear and to then calculate a rate constant from it.

Kinetics page show a range of marks; we can interpret the log files to see how students approach this kind of complex page and task. In summary:

- Data shows 554 of 649 (85%) attempting this page at UMELB and 75 of 100 (75%) at USYD look at the optional concentration time plot
- For those attempting all the questions, 381 of 469 (81%) UMELB and 35 of 63 (56%) USYD correctly calculate the first two values of $\ln[\]$ and $1/[\]$. This may reflect a greater proportion of Fundamentals of chemistry students at USYD, with little mathematics background. For those calculating the second two values, the percentages getting it correct rose to 86% UMELB and 75% USYD.
- A very small percentage opted out of calculating the first and second two values of the data table and went for the 'show me' option (25 of 469 (5%) UMELB and 2 of 63 (3%) USYD).
- Responding to the question as to which of the two plots were linear, 336 of 469 (72%) UMELB and 43 of 63 (68%) USYD got the correct answer.
- Responding to the question as to whether the reaction was first or second order, 415 of 469 (88%) UMELB and 54 of 63 (86%) USYD got the correct answer.
- The final question requested the rate constant for the reaction. Data showed 279 of 469 (59%) UMELB and 36 of 63 (57%) USYD got the correct answer at first attempt; 41 of 469 (9%) UMELB and 8 of 63 (13%) USYD got the wrong answer at first attempt and 105 of 469 (22%) UMELB and 12 of 63 (19%) USYD students went for the guess and 'show me' option.

Conclusions from log data

Student use of the ChemCAL modules targeted appeared to be very similar at both Universities. The data suggests that:

- All or nothing approach but generally high level of engagement
- Some of the basics (eg stoichiometry) can not be assumed – 'underpinning' material needs to be available
- Students do perform well on questions given time (how does this translate to pressure of exams?)

Non-use of ChemCAL

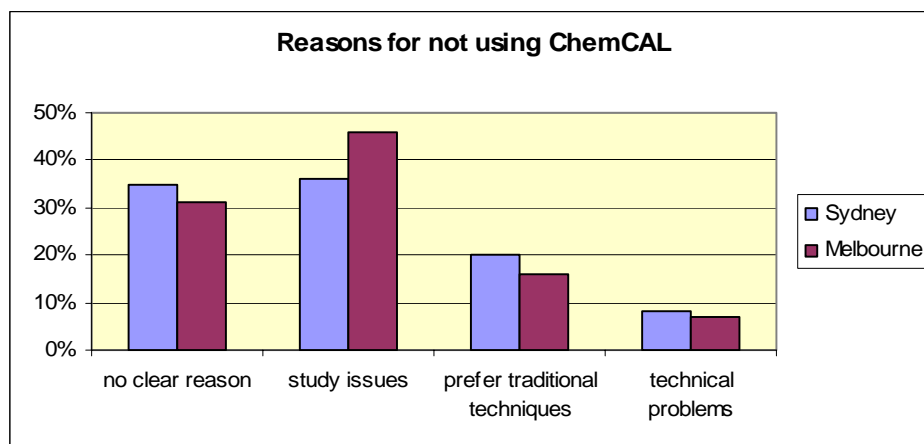
Those that did not use ChemCAL were asked why (N=~170 USYD; ~90 UMELB).

No clear reason – at USYD these are almost entirely students that claim not to have heard of ChemCAL. While there is an assumption that all courses will use a text book, students are less clear on what to assume for on-line resources.

Study issues – refer to time management, lack of access computers to computers etc.

Traditional techniques – many students are quite happy using a text book on the train in the morning (we do not aim at one techniques fits all!).

Technical problems – log on difficulties.



General Conclusion

- There is remarkable similarity between student reactions to the ChemCAL on-line resource at the two Universities. The survey left a strong impression that the students do use this resource and feel they benefit from it.