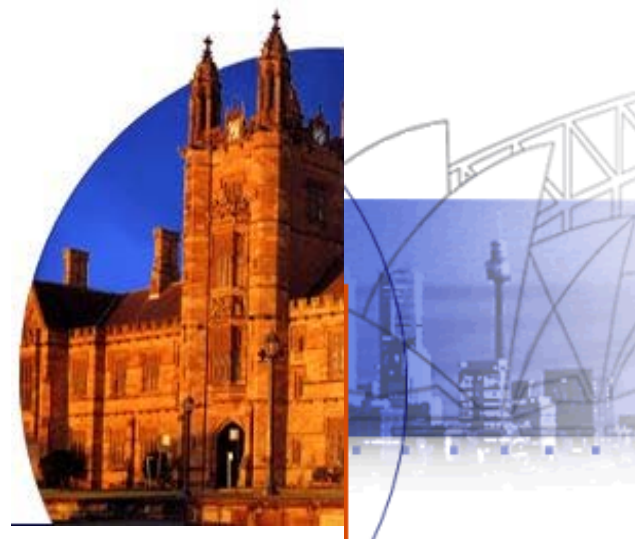


Where will IT end? Using information technology in University education

Adrian V George
University of Sydney

Peter Tregloan
University of Melbourne



ICT & Education: This lecture will explore

Some general issues involved with using ICT in education at a

- University level
- Department level
- Student level

Sample quantitative and qualitative data collected from 'ChemCAL'

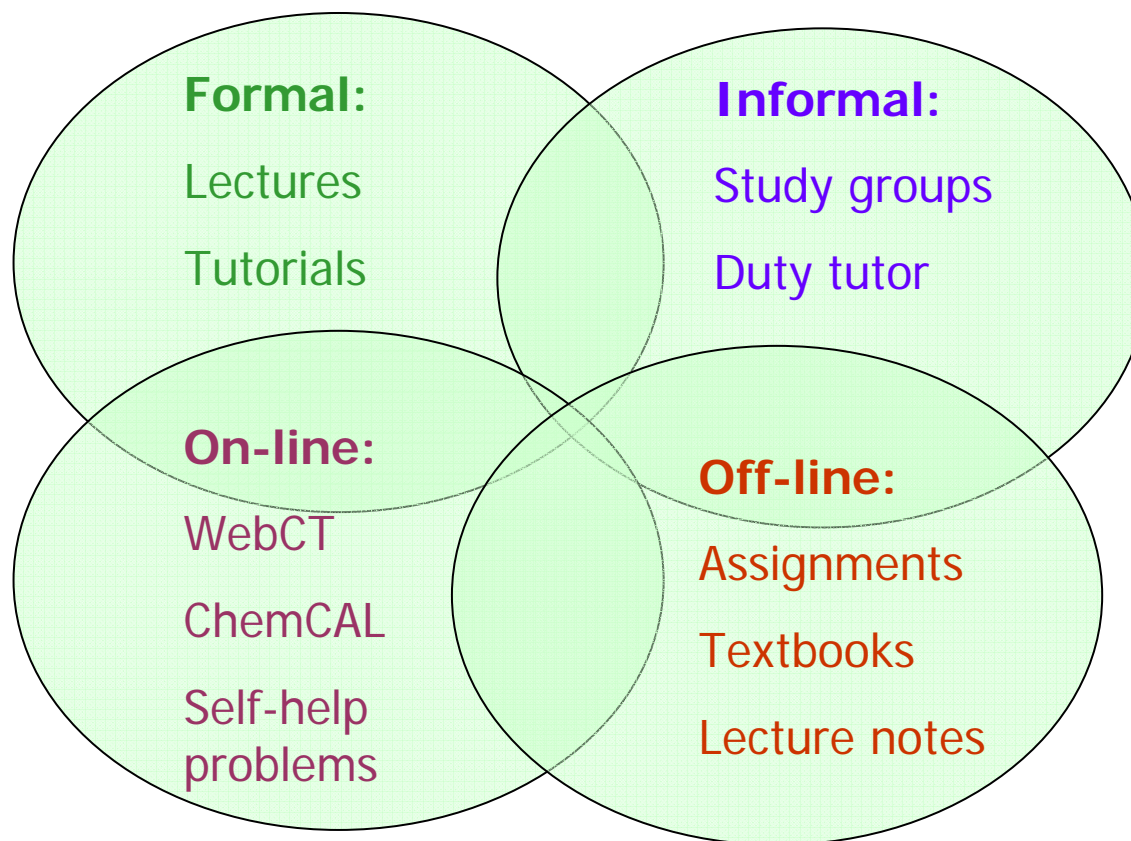
- How students use ChemCAL
- Does this indicate anything about study habits?



ICT & Education: **Current climate**

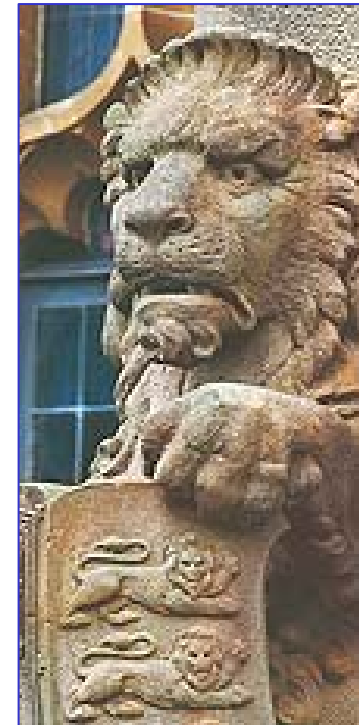
- Contracting resources
- Increasing pressure on academics
- Higher expectations of quality and efficiency
- Expanding student base

ICT & Education: **Web of Learning**



ICT & Education: **University Issues**

- Reputation of University
- Integration
- How to review progress
- Major cultural shift for staff and students
- Provision of central or local resources (hardware + personnel)
- Mission statement



ICT & Education: Department Issues

- Cost and efficiency – applications/staff
- Design of material - are the learning objectives changed?
- Who pays for continued support and development?
- Does it work?



ICT & Education: Student Issues

- Expectations of University – ‘modern’ learning
- Access to computer – home or University facility?
- Speed and time of access – are there issues at home for the students?
- Time management – can not use on-line material on the bus!



ICT & Education: **Advantages to students**

Flexible learning

- Multi layered program possible
- Comfortable environment
- Feedback at time of work
- Less time on campus (jobs)
- Self paced learning
- Access 24-7



ICT & Education: Educational benefits

- Learning styles
 - No single educational package for all
 - Keyboard skills
- Computer ability
 - Excellent for “drill and practice”
 - Not responsive to unexpected question
- Quality Assurance
 - ‘External’ review



ICT & Education: Educational benefits

Learning styles

- No single package for all
- Keyboard skills

Computer ability

- Excellent for “drill and practice
- Not responsive to unexpected

Quality Assurance

- ‘External’ review



ICT & Education: **Evaluation**

Method

- Request for on-line feedback
- Computer usage data
- Student surveys
- Word of mouth

Purpose

- Ensure educational benefit
- Improve programs/applications
- Justify current and future resources



ICT & Education: **The big question**

Does it work?

- Evaluate what we have
- Review what is new
- Keep this process going



ICT & Education: Applications in Chemistry

Replace “wet labs” – simulations

Communication

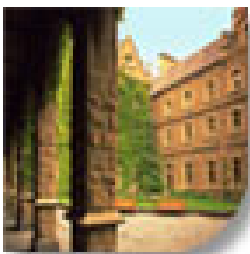
Support of content

- Presentations
- Asynchronous learning
- Formative and summative assessment



ICT & Education: ChemCAL

Aim of this study

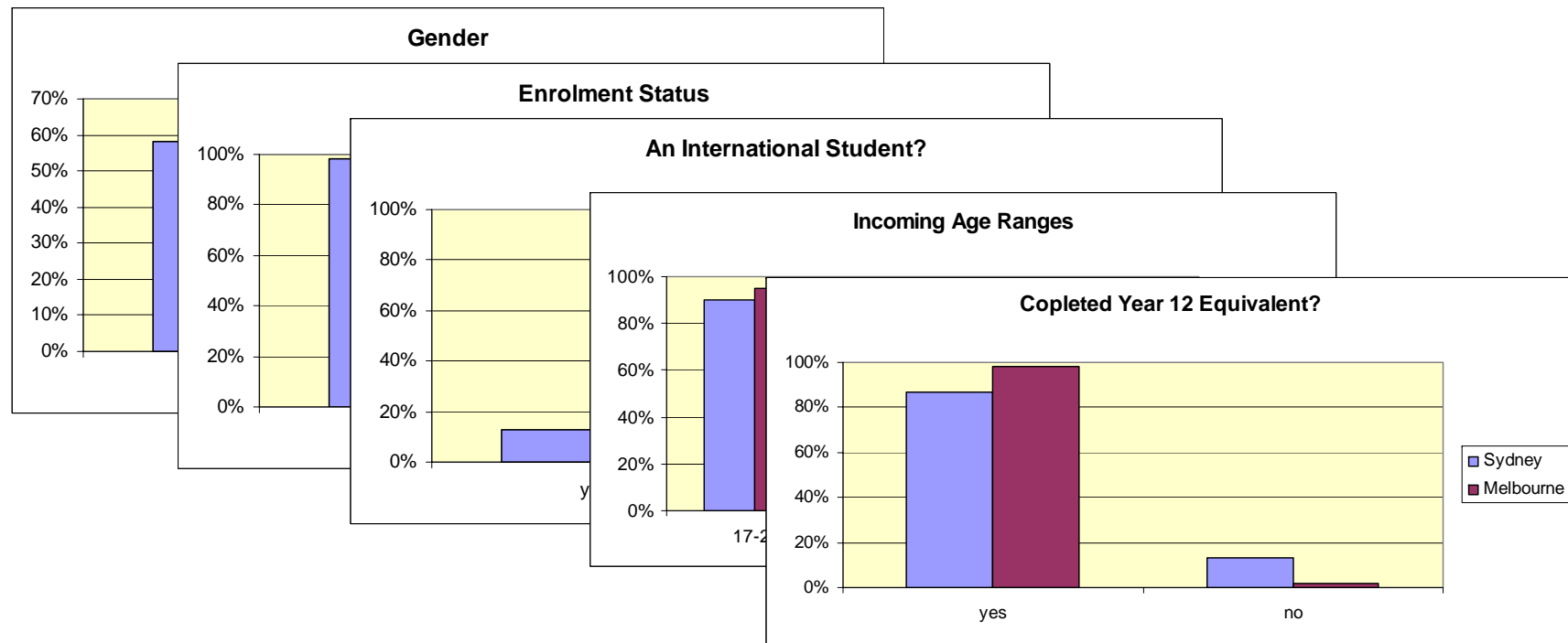


- Benchmark USYD and UMELB
- Examine how students use this resource - log data
- Student perception of this resource – questionnaire (N = 737; 460)

ICT & Education: Check of demographics

The population returning the surveys appeared representative of the wider student cohort

Very similar demographics at both Universities



ICT & Education: *Use of ChemCAL*

- ChemCAL is used at both USYD and UMELB
 - 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

ICT & Education: ChemCAL program

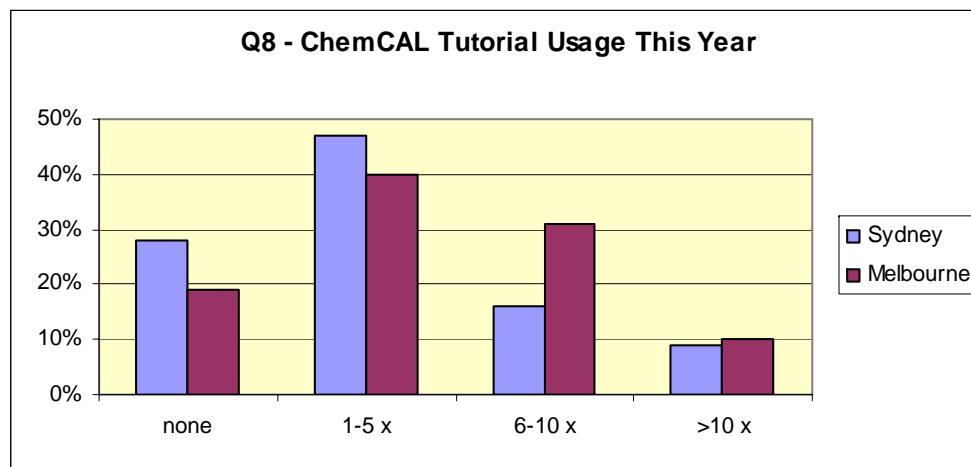
The image displays four overlapping screenshots of the ChemCAL program interface, which is accessed via Microsoft Internet Explorer.

- Top Left Screenshot:** Shows the "Semester 1 Index" page. It features a navigation menu with links to:
 - Stoichiometry
 - Behaviour of Gases
 - States of Matter
 - Electrochemistry
 - Chemical Energy
- Top Right Screenshot:** Shows the "Absolute Temperature Scale" page. It explains the Kelvin scale and includes the formula:

$$T = \text{Absolute temperature in Kelvin} = (\text{temperature in } ^\circ\text{C}) + 273.15$$
 It also includes a question: "1. The normal boiling temperature of liquid nitrogen is -196°C . What is this temperature in Kelvin? _____ K" and a hint: "Temperature in kelvin = temperature in Celsius degrees + 273".
- Bottom Left Screenshot:** Shows the "Boyle's Law" page. It includes a graph of Pressure vs. Volume showing an inverse relationship, and a diagram of a gas cylinder with a piston. The text states: "When a sample of gas is compressed, the pressure rises. When the sample is expanded, the pressure falls."
- Bottom Right Screenshot:** Shows a continuation of the Boyle's Law page with a question: "When a sample of gas is compressed, the pressure rises. When the sample is expanded, the pressure falls." Below the text are two buttons: "compress gas" and "expand gas".

ICT & Education: Use of ChemCAL

Students were asked how often they used ChemCAL (N=737, 460)

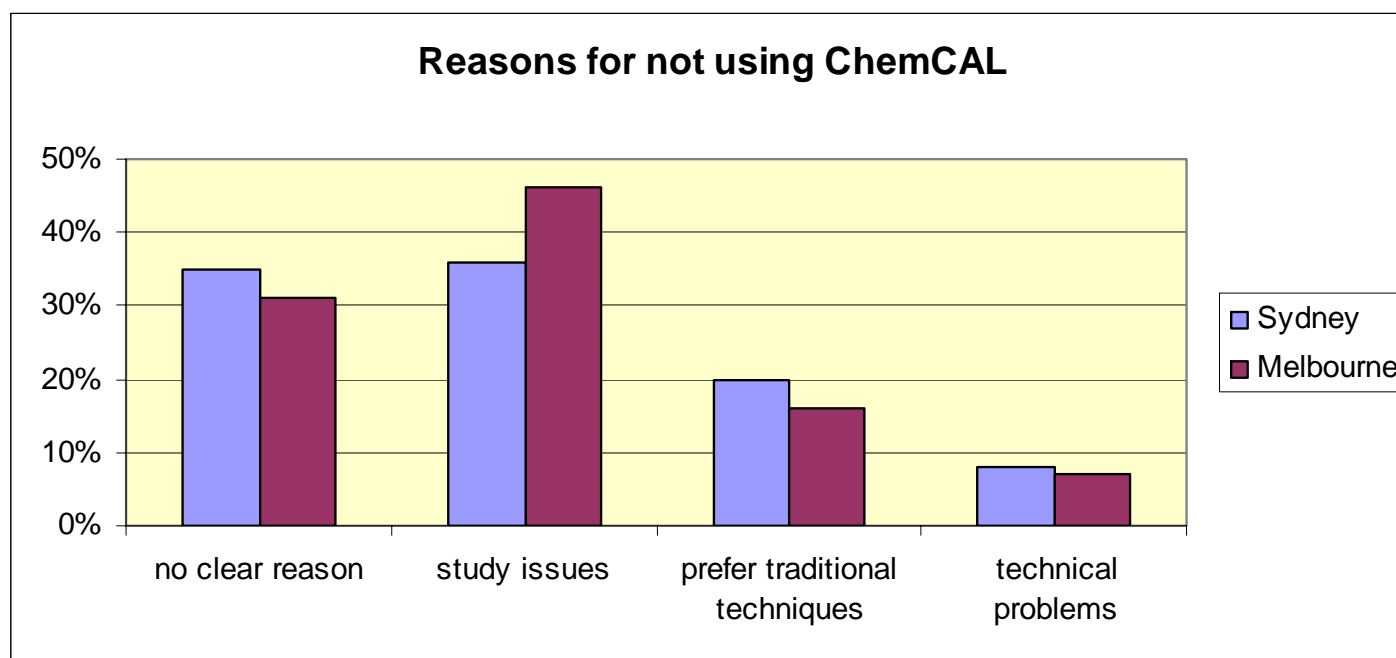


The majority of students use ChemCAL at least a little

Log data indicates a mix of steady use during the semester and cramming at just before exams

ICT & Education: Use of ChemCAL

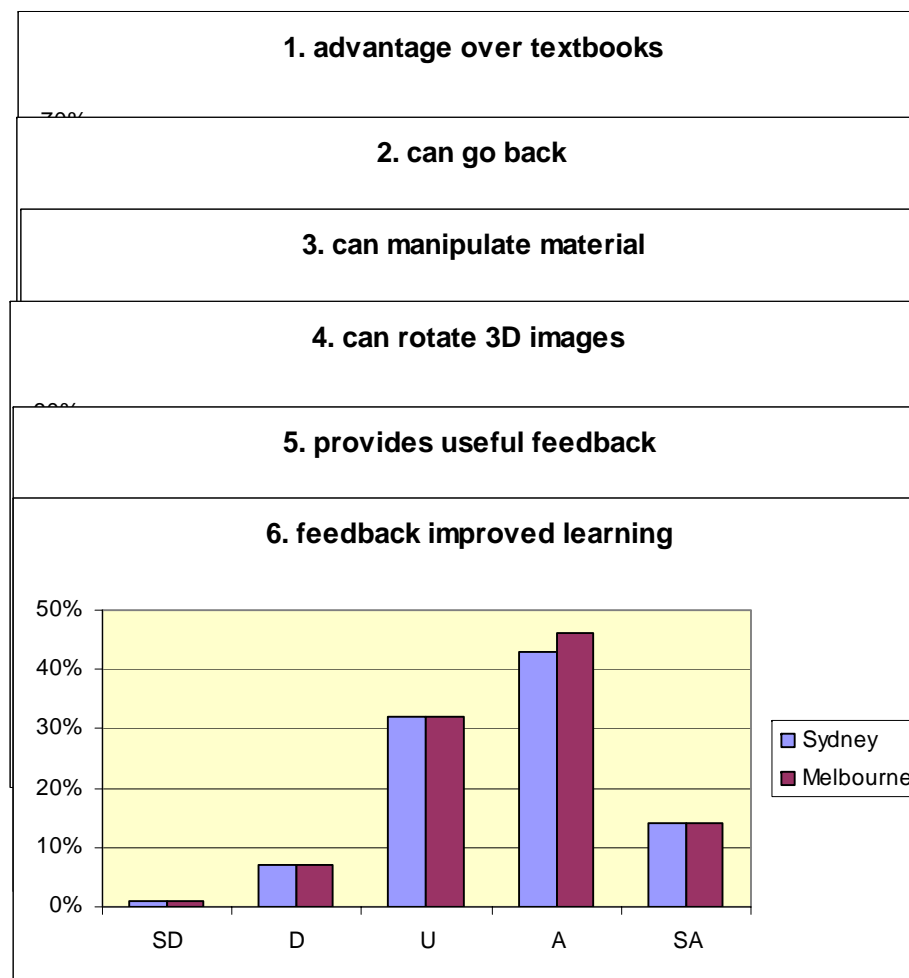
Those that did not use ChemCAL were asked why



ICT & Education: Use of ChemCAL

The students that did use ChemCAL were asked:

1. advantage over textbooks
2. can go back
3. can manipulate material
4. rotate 3D images
5. provides useful feedback
6. feedback improved learning



ICT & Education: Best and worst

Aids learning and tests understanding

Questions

Visual impact

24/7 accessibility

Immediate feedback

Drag & drop presentation

Better than textbook

Work at own pace

Technical difficulties/download times

Nothing

Pages with no interaction

Explanations/hints too brief

Difficult to access
shockwave

Slabs of text boring

Prefer tutor interaction

ICT & Education: Use of ChemCAL



Examine Log data `{[0][0]ES}{[0]ES}{[1]}{[1]}{[1]}{[1]}{!}`

Look at a number of modules – a familiar topic

- Stoichiometry

New topics, looking at qualitative and quantitative problems

- Quantum numbers
- Nucleophilic substitution
- Kinetics

ICT & Education: Stoichiometry



ChemCAL Online

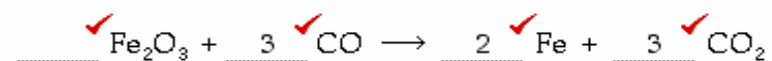
Chemistry 610-141

Stoichiometry

Reduction of Iron(III) Oxide

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

Balance the equation:



Given 1.00 kg of iron oxide:

- a) How many mole of Fe can be formed? 12.5 ✓ mol
- b) What mass of Fe can be formed? 698 ✓ grams
- c) How many mole of CO₂ can be formed? 18.8 ✓ mol
- d) What mass of CO₂ can be formed? 827 ✓ grams

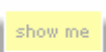
2 / 9

School of Chemistry, The University of Melbourne 2003



atomic masses...

0 / 2

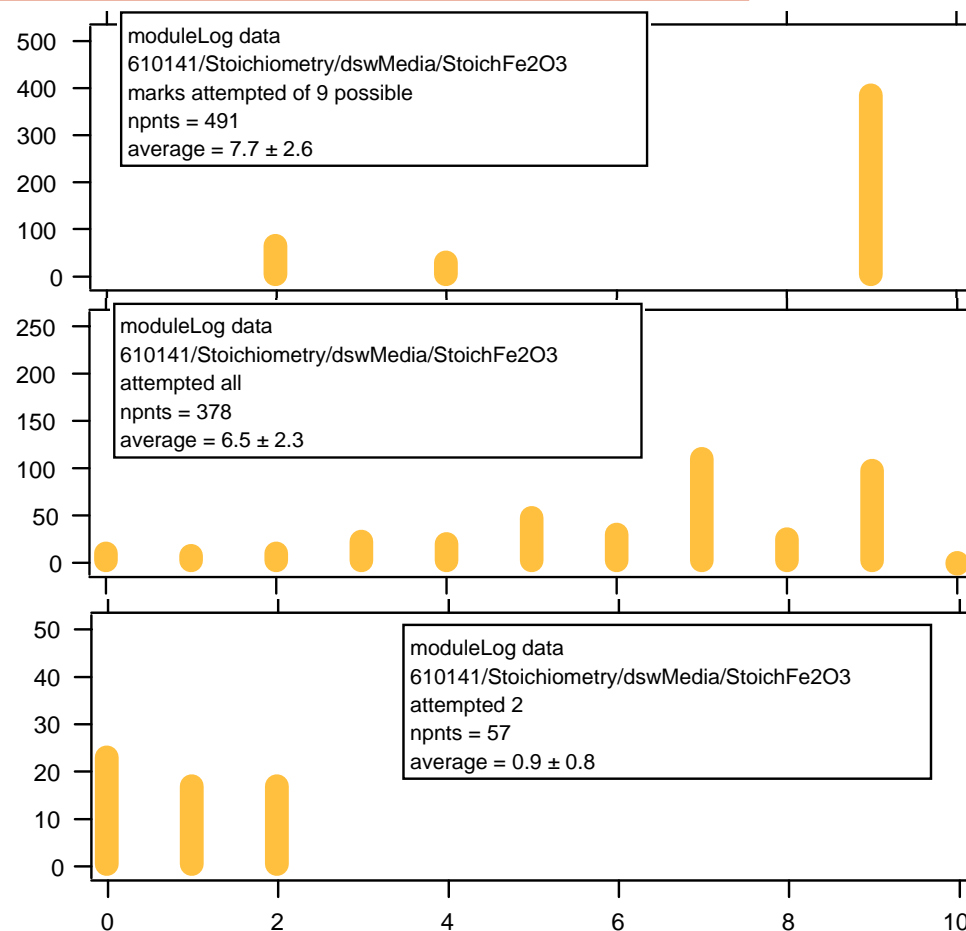


ICT & Education: Stoichiometry

How many marks do students attempt?

For students that attempted 9 marks, what was their score?

For students that attempted only Q1, what was their score?



ICT & Education: Stoichiometry - summary

Less than 50% get the equation balance correct at their first attempt.

Less than 50% calculate the number of mol of iron from 1 kg of iron oxide (based on an equation which is now correct)

About 60-70% can turn that number of mol into a mass of iron correctly

Hints and explanations were used, but only by ~10-20% of users

ICT & Education: Quantum numbers



ChemCAL Online ◀

Chemistry 610-141 ◀

Atomic Structure ▶

Quantum Numbers

There are three quantum numbers required to specify unambiguously an atomic orbital while an additional quantum number is needed to identify an electron uniquely.

The quantum number which identifies an orbital within a sub-shell is: m_l ✓

What are the allowed values of m_l for a given value of l ?

$m_l = -l, \dots 0, \dots l$ ✓

$m_l = 0$
 $m_l = 1$
 $m_l = 0, 1, \dots (l-1)$
 $m_l = 1, 2, \dots l$
 $m_l = -(l-1), \dots 0, \dots (l-1)$
 $m_l = -l, \dots 0, \dots l$

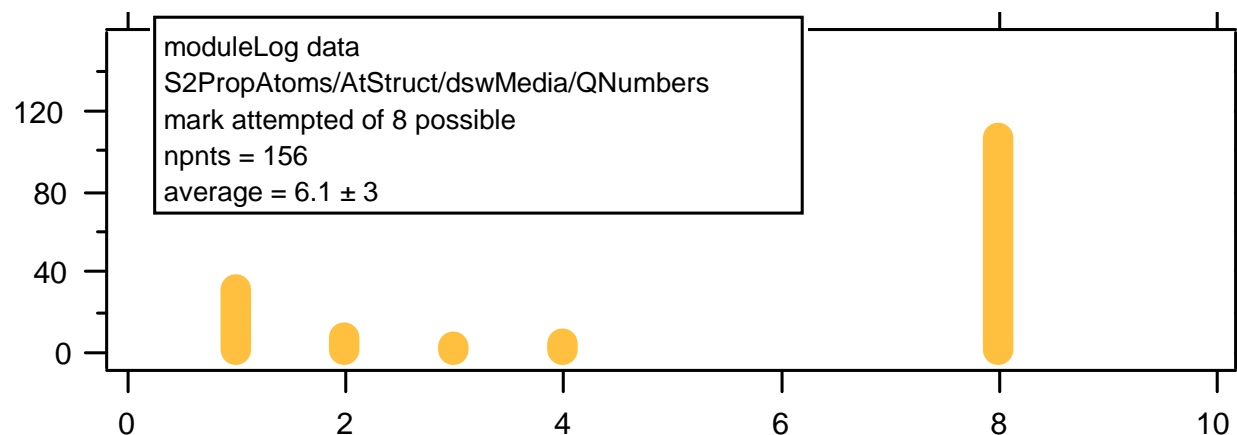
click

School of Chemistry, The University of Melbourne 2003

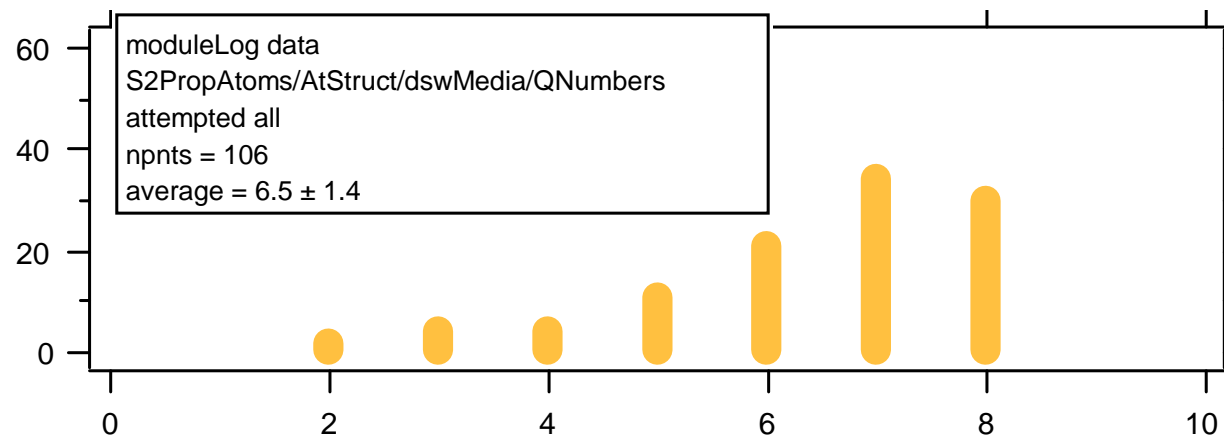


ICT & Education: Quantum numbers

How many marks do students attempt?



For students that attempted 8 marks, what was their score?



ICT & Education: Nucleophilic substitution



ChemCAL Online

Nucleophilic Substitution Reactions

Making New Compounds

The substrate shown below can be converted to the product by reaction with an appropriate nucleophile. Choose the required nucleophile from the list, and determine the leaving group that is released in the reaction.



CH_3CO_2^- (aq) ^-OH(aq) $\text{NH}_3(\text{aq})$ ^-CN(aq)
 $\text{^-OCH}_3(\text{methanol})$ $\text{^-OCH}_2\text{CH}_3(\text{ethanol})$
 CH_3S^- (ethanol) $\text{:C}\equiv\text{C-CH}_3(\text{benzene})$
 Cl^- Br^- ^-OTos

drag

School of Chemistry, The University of Melbourne 2003



hint

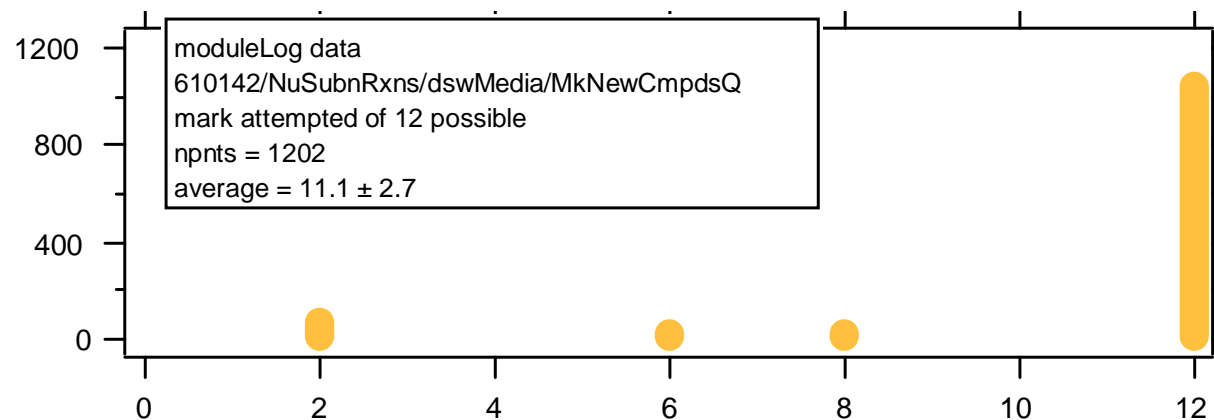
explain

show me

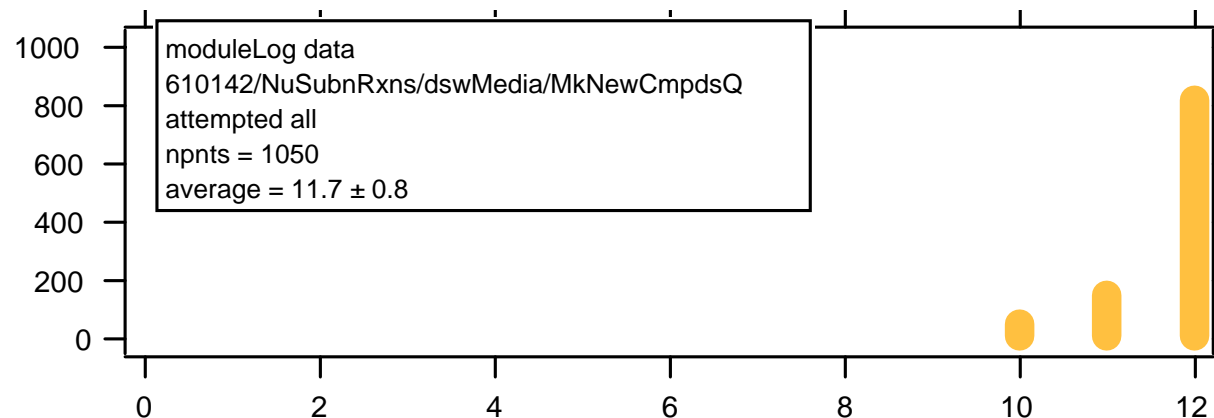


ICT & Education: Nucleophilic substitution

How many marks do students attempt?



For students that attempted all 12 marks, what was their score?



ICT & Education: Kinetics



Second Order Reactions

In a first order process, a graph of $\ln[A]$ vs time is a straight line.

The rate law for a second order reaction, $\text{rate} = \frac{-d[A]}{dt} = k[A]^2$,

can be integrated to give: $\frac{1}{[A]} - \frac{1}{[A]_0} = kt$

The data shown is for the reaction
 $2\text{NO}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{O}_2(\text{g})$

To see a graph of $[\text{NO}_2]$ vs time click:

[\[NO₂\] vs time](#)

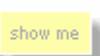
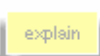
On paper, draw two graphs:

- $\ln[\text{NO}_2]$ vs time
- $1/[\text{NO}_2]$ vs time

Which graph is closest to linear?

- $\ln[\text{NO}_2]$ $1/[\text{NO}_2]$

time (min)	$[\text{NO}_2]$	$\ln[\text{NO}_2]$	$1/[\text{NO}_2]$
0	0.780	-0.25 ✓	1.28 ✓
1	0.345	-1.06 ✓	2.90 ✓
2	0.221	-1.51	4.52
3	0.163	-1.81	6.13
4	0.129	-2.05	7.75
5	0.107	-2.23	9.35
6	0.091	-2.40	10.99
7	0.079	-2.54	12.66
8	0.070	-2.66	14.29
9	0.063	-2.76	15.87
10	0.057	-2.86	17.54



ICT & Education: Kinetics

UMELB 86%
USYD 75%

UMELB 81%
USYD 56%

UMELB 85%
USYD 75%

$\frac{1}{[A]_0} = kt$

The data shown is for the reaction
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Just show me: **UMELB 5%; USYD 3%**

ICT & Education: Kinetics

Plot graphs; which is linear?:
UMELB 72%; USYD 68%

First or second order?:
UMELB 88%; USYD 86%

From slope determine k
correct first attempt: **UMELB 59%; USYD 57%**
correct second attempt: **UMELB 9%; USYD 13%**
guess & show me: **UMELB 22%; USYD 19%**

In a first order process, a graph of $\ln[A]$ vs time is a straight line.

The rate law for a second order reaction, $\text{rate} = \frac{-d[A]}{dt} = k[A]^2$,

can be integrated to give: $\frac{1}{[A]} - \frac{1}{[A]_0} = kt$

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4	0.129
5	0.107
6	0.091
7	0.079
8	0.070
9	0.063
10	0.057

ICT & Education: Conclusions - ChemCAL

- Student do use resource & feel they benefit from it
- All or nothing approach but generally high level of engagement
- Some of the basics (eg stoichiometry) can not be assumed – ‘underpinning’ material need to be available
- Students do perform well on questions given time (how does this translate to pressure of exams?)

ICT & Education: **Big issues**

University

Ongoing support for ICT developments supported by one-off grants
Workload issues for academics involved

Department

Can we help students use their own IT and communication for self-learning networks

Student

Social and technical issues with students studying at home