Where will IT end? Using information technology in University education

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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

Formal:
- Lectures
- Tutorials

Informal:
- Study groups
- Duty tutor

On-line:
- WebCT
- ChemCAL
- Self-help problems

Off-line:
- Assignments
- Textbooks
- Lecture notes
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 learning styles
- Keyboard skills
- Computer ability
- Quality Assurance
- External review
- Not responsive to unexpected question
  Excellent for “drill and practice”
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
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

![Bar chart showing reasons for not using ChemCAL](chart.png)
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

![Bar chart showing student responses to the use of ChemCAL]
# ICT & Education: Best and worst

<table>
<thead>
<tr>
<th>Best</th>
<th>Worst</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aids learning and tests understanding</td>
<td>Immediate feedback</td>
</tr>
<tr>
<td>Questions</td>
<td>Drag &amp; drop presentation</td>
</tr>
<tr>
<td>Visual impact</td>
<td>Better than textbook</td>
</tr>
<tr>
<td>24/7 accessibility</td>
<td>Work at own pace</td>
</tr>
<tr>
<td>Technical difficulties/download times</td>
<td>Difficult to access shockwave</td>
</tr>
<tr>
<td>Nothing</td>
<td>Slabs of text boring</td>
</tr>
<tr>
<td>Pages with no interaction</td>
<td>Prefer tutor interaction</td>
</tr>
<tr>
<td>Explanations/hints too brief</td>
<td></td>
</tr>
</tbody>
</table>
ICT & Education: Use of ChemCAL

Examine Log data

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

Reduction of Iron(III) Oxide

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

Balance the equation:

\[ \boxed{\text{____ } \text{Fe}_2\text{O}_3 + \text{____ } \text{CO} \rightarrow \text{____ } \text{Fe} + \text{____ } \text{CO}_2} \]

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 CO\(_2\) can be formed? ______ 18.8 ______ mol

d) What mass of CO\(_2\) can be formed? ______ 827 ______ grams
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 then 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

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 \( l \)?
\[
\begin{align*}
m_l &= 0 \\
m_l &= 1 \\
m_l &= 0, 1, \ldots (l-1) \\
m_l &= 1, 2, \ldots l \\
m_l &= -(l-1), \ldots 0, \ldots (l-1) \\
m_l &= -l, \ldots 0, \ldots l
\end{align*}
\]
ICT & Education: Quantum numbers

How many marks do students attempt?

For students that attempted 8 marks, what was their score?
 ICT & Education: Nucleophilic substitution

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.

\[
\text{substrate} + \text{OCH}_3\text{(methanol)} \rightarrow \text{product} + \text{Br}^-
\]

List of nucleophiles:
- \(\text{CH}_3\text{CO}_2\text{aq}\)
- \(\text{HO}_2\text{aq}\)
- \(\text{NH}_3\text{aq}\)
- \(\text{CN}\text{aq}\)
- \(\text{OCH}_3\text{methanol}\)
- \(\text{OCH}_2\text{CH}_3\text{ethanol}\)
- \(\text{CH}_3\text{S}^-\text{ethanol}\)
- \(\text{C}^-\text{C}^-\text{CH}_3\text{benzene}\)
- \(\text{Cl}^-, \text{Br}^-, \text{OTos}\)

Drag the nucleophile to the reaction site.
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 is:

\[ \text{rate} = -\frac{d[A]}{dt} = k[A]^2. \]

This can be integrated to give:

\[ \frac{1}{[A]} - \frac{1}{[A]_0} = kt. \]

The data shown is for the reaction:

\[ 2 \text{NO}_2(g) \rightleftharpoons 2 \text{NO}(g) + \text{O}_2(g) \]

To see a graph of [NO\textsubscript{2}] vs time click:

<table>
<thead>
<tr>
<th>time (min)</th>
<th>[NO\textsubscript{2}]</th>
<th>ln[NO\textsubscript{2}]</th>
<th>1/[NO\textsubscript{2}]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.780</td>
<td>-0.26</td>
<td>1.28</td>
</tr>
<tr>
<td>1</td>
<td>0.345</td>
<td>-1.06</td>
<td>2.90</td>
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<tr>
<td>2</td>
<td>0.221</td>
<td>-1.51</td>
<td>4.52</td>
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<tr>
<td>3</td>
<td>0.163</td>
<td>-1.81</td>
<td>6.13</td>
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<tr>
<td>4</td>
<td>0.129</td>
<td>-2.05</td>
<td>7.75</td>
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<td>5</td>
<td>0.107</td>
<td>-2.23</td>
<td>9.35</td>
</tr>
<tr>
<td>6</td>
<td>0.091</td>
<td>-2.40</td>
<td>10.99</td>
</tr>
<tr>
<td>7</td>
<td>0.079</td>
<td>-2.54</td>
<td>12.66</td>
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<tr>
<td>8</td>
<td>0.070</td>
<td>-2.66</td>
<td>14.29</td>
</tr>
<tr>
<td>9</td>
<td>0.063</td>
<td>-2.76</td>
<td>15.87</td>
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<td>10</td>
<td>0.057</td>
<td>-2.86</td>
<td>17.54</td>
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On paper, draw two graphs:

a) ln[NO\textsubscript{2}] vs time
b) 1/[NO\textsubscript{2}] vs time

Which graph is closest to linear?

☐ ln[NO\textsubscript{2}] ☐ 1/[NO\textsubscript{2}]
ICT & Education: Kinetics

The data shown is for the reaction:

\[ 2 \text{NO}_2(g) \rightleftharpoons 2 \text{NO}(g) + \text{O}_2(g) \]

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

- UMELB 81%
- USYD 56%

On paper, draw 2 graphs:
- a) \(\ln[\text{NO}_2]\) vs time
- b) \(1/[\text{NO}_2]\) vs time

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%**

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

The rate law for a second order reaction, $\frac{d[A]}{dt} = k[A]^2$, can be integrated to give: $\frac{1}{[A]} - \frac{1}{[A]_0} = kt$

The data shown is for the reaction:

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On paper, draw two graphs:

- a) $\ln([\text{NO}_2])$ vs time
- b) $1/[\text{NO}_2]$ vs time

Which graph is closest to linear?

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

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8th February 2004  RACI (Chemistry Education) Hobart  32
• 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