Improving student performance and retention in first year biology

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The Questions?

➢ How do you increase enrolment in science/biology courses?
➢ How do you retain those students that do enrol?
➢ How do you bring back the advantage of one-to-one teaching to a course with more than 600 students and a tight budget?
Where to begin

- 1. Extensive literature review
- 2. Travel around Australia looking at programs that were running well
- 3. Meet with experts in the field to discuss the problems and think about the solutions
Decreased enrolment in science courses

- Science is too hard
- Topics are too boring
- No idea of what it means to be a scientist?
- Perceived Limited job opportunities
Should all students at university be required to take a science topic?

- To understand the world in which they live (climate change, disease, technology).
- To be able to understand medical issues that they face.
- To understand what evidence is
How best to teach non-science students science?

➢ Do we want to turn them into scientists?
What we want to do.

- Challenge their beliefs
- Force them to ask questions
- Think critically
- Get excited about the issues
What does the course look like?

- exams?
- practicals?
- field trips?
- weekly critical essays on each topic?
Biology and Society

2006
4.5 unit topic

Shedding light on modern controversies...

HOT ISSUES
➤ GMO: Food for all or an ecological disaster?
➤ Who wants a designer baby?
➤ Does brain sex define a man?
➤ The impacts of mass extinctions?
➤ Addressing the CSI syndrome.
➤ The reality of party drugs.
➤ Biorhythms and the rhythm of life.
➤ Who’s afraid of bird flu?

Fantastic elective!
➤ Designed for all students from every discipline.
➤ No science background required, no prerequisites.
➤ Guaranteed to add value to your degree.
➤ Topic value 4.5 units.

flinders

www.scieng.flinders.edu.au/biology/1c
Fig 1: Enrolment data for the past 3 cohorts of Biology and Society students.

Teaching starts here
When students were asked why they chose to enrol in this topic:

- 44% responded that they had seen the brochure or heard the advertisement
- 22% of students had no previous experience in biology
- Over 50% were non-science students
- Almost all students enrolled in the topic because it sounded interesting, fun and was a good starting point
Student attendance at lecture

- Much higher attendance than in core biology courses
- 80-90% attendance vs. 50-60%
What did we expect them to gain from the course?

Scientific Literacy
The problems with the first year core biology topics. 1. Molecular Basis of Life and 2. Evolution of Biological Diversity

- Approximately 600 students
- No biology pre-requisite required for first year biology (half the group without it)
- Students from 36 different degree programs enrolled
- 8 different lecturers, no communication
What did students think of the course in 2005

- 80% of students with year 12 biology found first year biology just right to too easy
- 85% of students without year 12 biology found first year biology too difficult
- Conclusion: Hitting the middle ground – no one satisfied
The data…

Failure rate for students with and without a Year 12 Biology Background

Males failed 28% *
Females failed 14% *
International students failed 6% *
What we wanted to do

- Help the students without year 12 to achieve higher grades
- Extend the high achieving students
- Deal with transition so we have fewer students withdrawing from the course (huge withdrawal rate)
- Increase academic understanding of material and awareness of how biology fits into the real world
- Make the program more engaging so that students will want to continue taking Biology into the future
How we went about doing it.

A. Prelecture – first lecture of the week

Students without year 12 biology or those who did poorly in year 12 were recommended to attend all prelecture at the start of each week.

Well attended

Students who attended thought prelectures were vital to their success in the topic
B. Improvements to the basic lecture format

- concept-specific questions were embedded within all lectures.
- 550 students split into 2 time slots
  - 9:00 session – used clickers
  - 1:00 session – no clickers (use hand-raising)
The nature of the questions

- Very important to prepare questions that require a fair amount of thought rather than testing memory skills.
- Let them talk about the answers
- Results: No difference between the groups with or without clickers with respect to exam performance – shows that it is the change in lecturing style - embedding questions, that is important rather than the gadget
- There is a difference in exam performance between 2006 and 2005 (show later)
Do they get the answers correct?

- with clickers - **59.2%** of answers were correct
- hand-raising - **81.4%** of answers were correct

p<0.0001
But lecturers could get the wrong idea: The Sheep effect
Correlation analysis of student rate of response to question difficulty
Lecturers gain immediate feedback as to students’ understanding of concepts covered.
Do you think that asking questions during lecture helped understand topic material?

Clicker group: 89.4% said yes (n=170)
Non-clicker group: 87% said yes (n=246)
Will lecturers embed questions if they don’t have a clicker?

- 10 lecturers were asked to embed questions within their lectures.
- Only 1/10 did
- So maybe the tool is vital
C. Large group tutorial-lectorial

- The last lecture of the week gives students the opportunity to apply their knowledge to solve real world problems.
- Work presented in a case-based format.
- Preparation and delivery was more difficult for lecturers than standard lectures but they were viewed as an essential component to solidify student learning and to address relevance of the material being covered.
93% of students thought that the large group tutorials were more interesting than the standard lectures.

98% of students said that they increased their understanding and awareness of how biology relates to the real world.

The purpose was also to extend the brighter students, allow them to see how it all fits together – they love it.
How students view lecturers

- 2005: students commented negatively about lecturer performance 25% of the time.
- 2006: students commented negatively about lecturer performance only 3% of the time.
- Almost all of the same lecturers, more-or-less the same material, different style.
- Students thought that lecturers ‘cared’ more about their achievements.
In a study of PASS sessions

- we assigned a 5% attendance grade on PASS
- 85% of students attended at least 10 of the 12 sessions
- 74% of students made new friends within PASS
- 46% of students studied with group members outside of their session.
E. Topic Convener/Mentor

- One lecturer would teach one lecture each week throughout the entire year
- Students would have someone to go to when things went wrong
- Maintain the continuity of the course for both students and lecturers
Overall Results 2005 vs. 2006

- Failure rate in Biology 1 has fallen by 14%.
- Failure rate of students without year 12 (who had typically failed at twice the rate as those with year 12) showed no difference in 2006 (13.4% vs. 13.6%)
- Prelectures and PASS have helped these students tremendously
Student grades 2005 vs. 2006

Figure 4: Biology 1B final grade distribution for 2006 vs 2005.
### Comparison of Student Evaluation of Teaching for 2005 and 2006

<table>
<thead>
<tr>
<th>SET Question</th>
<th>2005 (n = 339)</th>
<th>2006 (n = 384)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities within the topic provided relevant learning experiences</td>
<td>5.1 (± 1.3)</td>
<td>6.3 (± 0.8) *</td>
</tr>
<tr>
<td>I understood the concepts presented in this topic</td>
<td>4.9 (± 1.3)</td>
<td>5.8 (± 0.9)</td>
</tr>
<tr>
<td>The topic content was presented at an appropriate pace</td>
<td>4.8 (± 1.5)</td>
<td>5.8 (± 1.1)</td>
</tr>
<tr>
<td>The topic was presented at an appropriate level of difficulty</td>
<td>5.0 (± 1.4)</td>
<td>5.8 (± 1.0)</td>
</tr>
<tr>
<td>The teaching materials and resources were helpful in directing my learning</td>
<td>5.0 (± 1.5)</td>
<td>6.1 (± 0.9)</td>
</tr>
<tr>
<td>This topic helped me develop my thinking skills</td>
<td>4.7 (± 1.3)</td>
<td>5.9 (± 1.0)</td>
</tr>
<tr>
<td>I received useful feedback on my learning</td>
<td>4.4 (± 1.6)</td>
<td>5.6 (± 1.2) *</td>
</tr>
<tr>
<td>Overall I was satisfied with the quality of this topic</td>
<td>4.9 (± 1.4)</td>
<td>6.3 (± 0.8) *</td>
</tr>
</tbody>
</table>
So did it work?

- Better grades, better retention, enjoyed the subject more, happier with the lecturers
- But did it cost more?
- No, we just moved the money around a bit.
When asked to comment about their experience in first year biology, we received the following quotations:

- “First year biology was motivational”
- “I enjoyed it, I liked the connection to industry, it gave me the opportunity to relate it to real life”
- “It’s more interesting and interactive, I don’t get bored”
- “A really fun engaging way to learn, much better than standard lectures”
- “Lab sessions are great, they gave me an opportunity to be a real scientist”
Were there any long-term effects?

- 34% reduction in withdrawals in the topic
- Plus a 20% reduction in failure rate in the topic
- 2nd year enrolments in topics following on from Biology 1B are up by 21%