ATTRACTING MORE STUDENTS TO SENIOR PHYSICS

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DEST SET Skills Audit (7/06)

- Domestic students studying SET at all levels has remained static or declined over the past decade.
- Shortage of suitably qualified secondary science teachers
- Poor SET careers advice.
- The community has a negative perception about SET careers
- Increasing spending on R&D by OECD countries may drain SET skills from Aust.
Growth in employment 1996/7 – 2004/5*

Physics and astronomy 33%
Mathematical sciences 52.1%
All Engineering 7.1%

Predicted growth 2004/5 – 2012/13

Physics and astronomy 49.6%
Mathematical sciences 32.5%
All Engineering 13.5%

Supply of science professionals from education predicted to fall short of demand by 20,000 by 2012/13

*2006DEST SET Skills Audit
THE CRISIS IN SCIENCE EDUCATION
RE-IMAGINING SCIENCE EDUCATION ACER: AER51(Tytler 2007)

- Increasingly negative attitudes to science developed over the secondary schooling years
- Decreasing participation in the enabling sciences in senior high school
- Shortage of SET trained people in the workforce
- Shortage of qualified science and mathematics teachers
OECD Conference Nov 2005: In some countries, the number of graduates in mathematics, physics and chemistry has declined by 30-50% over the last 8-10 years and there is a shortage of S & T teachers in most countries.
http://www.caos.nl/ocw/programme.html

http://www.phy.ilstu.edu/pipeline/Executive_Summary_10.doc

UK 2005: “An independent report directly linked the steep decline in the number of students taking A-level physics to the shortage of expert physics teachers. With over 30% of physics teachers due to retire in the next ten years, the need to recruit more physics teachers is now more important than ever before.”
www.physorg.com/news8362.html
Who’s Teaching Science?
The Deans of Science Survey (2005)

- 24% of Junior Science teachers have studied first year university Physics.
- 16% had not studied any of the four key science disciplines.
- 43% of Senior Physics teachers lack a physics major and 25% have not studied Physics beyond first year.
Macquarie University's SET Study (2004)

- High school students have poor understanding of SET careers.
- A good experience in HS Science is the main reason students follow onto SET careers.
- 92% of HSC Physics students trust their Physics teacher for information on Science careers. (c.f. 36% for Careers Advisors).
What is happening to enrolments in senior high school physics?
Physics Candidature as a percentage of total HSC Candidature
SC graduates who complete HSC Physics (%)
Female HSC Physics Candidature (%)
Year 11 Physics Students who fail to complete HSC Physics (%)
Female Year 11 Physics Students who fail to complete HSC Physics (%)
Why should more students study physics?

- We are not producing enough scientists and engineers to satisfy demand.
- Our Citizens need a minimum level of technological literacy to take an active part in our modern world.
- Scientific and technological innovation is a key driver of economic success.
- Physics is a part of our culture and history.
- Because many student delight in studying physics.
What are we Teaching in Senior High School Physics?
The Curriculum Dilemma

- Can one curriculum:
- Cater for students who will not pursue a science related career
- and simultaneously
- provide the fundamental knowledge and skills required by those students who wish to continue to study science?
NSW Syllabus
(85p)

- Syllabus quite prescriptive.
- Four core units in yr11 (Motion, Waves, Current Electricity and Cosmology).
- Three core units in yr12 (Space, Electromagnetism, Ideas to Implementation) and one ‘option’ unit.
- Does this syllabus reflect best practice?
- How does it compare with other States?
Physics Syllabuses in other States

- Queensland:
  - Syllabus updated in 2005 for implementation 2007
  - 10 'Key Concepts' (e.g. Energy is conserved) each with several key ideas are specified in the syllabus
  - Teachers design a course of study with 6 to 12 units of work and ensure that each key concept must be addressed in at least two units
  - At least one unit in yr11 and one unit in yr12 must be context based
The VCE Physics Syllabus was updated in 2005

Four units, each with two compulsory areas of study and a third area selected from three option topics (content is prescribed).

e.g. UNIT 2:
1) Movement
2) Electricity
3) Astrophysics, Aerospace or Alternative Energy Sources
- **ACT**
  - A sample syllabus provided that schools may modify, extend etc.

- **South Australia & NT**
  - Syllabus updated 2004
  - Schools design their own courses in stage one (year eleven) from nine possible topics.
  - In Stage two the course content is mandated and includes; Motion in Two Dimensions, Electricity and Magnetism, Light and Matter, and Atoms and Nuclei.
Teachers design units to cover four core areas (Newtonian mechanics, electromagnetism, waves and atomic and nuclear physics)
Western Australia

- Previously had two courses but replaced both with a single course in 2006.
- The Physics course focused on student achievement of four outcomes: Investigating, Communicating scientifically, Science in daily life, Acting responsibly, Science in society and Energy and change.
- The introduction of this outcomes based course was very controversial in WA
.... “In your answer discuss why only modern cars have airbags, describe in detail how the air bag protects the driver from injury and, examine the ethics of making air bags compulsory in all vehicles.” ....Even a ten year old with no training in physics could write an essay and answer this sample question.

Prof Roy Gilbert (Education)
Edith Cowan University
The WA Curriculum Council Reworked the Syllabus

- The 2007 Physics course of study focuses on student achievement of three outcomes:
  1) Understanding and Communicating in Physics
  2) Energy
  3) Forces and Fields.
National Curriculum

- ACER: State physics syllabuses have 90% of core content and skills in common (electronics/static electricity)

- National Curriculum in science by 2011

- Australian Certificate of Education?
All state syllabuses have been updated recently with little/no affect on student numbers.

A National Syllabus is unlikely to attract significantly more students.
To attract more students to physics we must ensure they have a ‘good’ experience in H.S. science?
Key positive influences in school *

1) The Quality of the Science Teacher
2) The way science is organised and taught
3) Extra-curricular science activities

* Woolnough IOP Physics Education 29 1994
1) The Teacher

- Well qualified graduates who are enthusiastic about, and have expert knowledge of, the subject they teach.

- Must have the time and inclination to give personal encouragement, support and careers advice to their students.
UK 2004: “In the UK over 50% of scientists and engineers surveyed said that they had been influenced in their careers by a visit to a scientist or engineer's place of work and nearly 80% of respondents had been influenced by a teacher.”

http://www.royalsoc.ac.uk/page.asp?id=2785
Where will these teachers come from?

- Vic 2002: The subject areas with the lowest number of expected graduate teachers per vacancy are: LOTE, Physics, Maths, Technology and Computer science.
  

- Aust 2005: 41% of schools nationally report difficulty in finding physics teachers
  
  ‘Who’s Teaching Science’ Report Council of Dean’s of Science

- Aust 2005: “Physics graduates in Aust. are in such demand for research that there are few left to take up the challenges of physics in industry and teaching.”
  
AIP Policy:

- Provide more science training for primary teachers.
- Remove the HECS anomaly for science teachers.
- Provide scholarships for Physics graduates to complete teacher training.
- Ensure salary scales recognise qualifications (in addition to experience).
- Create alternate career paths for talented teachers.
- Instigate industry/university placements for teachers.
- Fast track teacher training for experienced scientists/engineers

See: DEST Australia’s Teachers: Australia’s Future or AIP Education Policy
2) The way science is organised and taught

- Teaching in yrs 7-9 must ensure students gain success and enjoy science
- Must be well-structured, but allow student input
- Must be relevant (contextual?) and intellectually stimulating (syllabus as floor)
- Practical work should be personally challenging through student investigations
- Teachers must teach within their area of expertise
Key influences on how science will be taught in Australia

- The National Curriculum
- Re-imagining Science Education. (Tytler’s AER51 Report 2007)
- Other Projects:
  - ATSE - STELR Project
  - Academy Science-Science Connections
  - Quality Teaching Programs
  - ASSISTM Projects
- Recent changes to Teacher Education
3) Extra-curricular Activities

- Competitions
- Excursions
- Talks by scientists and engineers
- School/industry links
- School/university links
- Science extension activities
- Evaluation of programs?
Rethinking Science at Gosford High School

Why Students Choose to Study the Enabling Sciences (& why they don't)

- Personal Reasons
- Social Reasons
- Extra-curricular reasons
Personal Reasons and Responses

- Interest (Programs, SEG, extra-curricular)
- Ability (Build self confidence)
- Enjoyment/fun (Programs, SEG, extra-curricular)
- Previous success (Ensure students reach goals)
- Prerequisite (Explicit knowledge required)
- Keeping options open (Students need to know)
- Knowledge of what subject entails (Yr 10 program)
- Knowledge of career prospects (Teacher, visits, speakers)
- Gender (Roll models, teachers, guest speakers, past students)
Social Reasons and Responses

- Socio-economic background
- 'Science friendly' home
  (Try to influence this)
- Friends (Advice, study-buddies)
- Family (Involve them)
- Other students (Advice day)
Extra-curricular Reasons and Responses

- TV, books, movies (Encourage)
- Science role models (Attend talks, use visiting scientists, talk about careers and scientists)
- Excursions/workshops (Facilitate)
- Competitions (Science Fair, Olympiad, etc.)
- Work Experience (Facilitate)
- Research projects (Program and encourage)
- Timetable constraints (Remove if possible)
How Science has Changed at Gosford High School

- From 1998 to 2003 the participation rate in senior Physics and Chemistry increased by over 50%. (from ~ 60 to 90 students)
- The participation rates have continued to increase (2008 yr11 student numbers: 114 Physics and 106 Chemistry)
- A much greater proportion of students now pursue Science and Science related careers.
2006 Yr 11 GHS Survey Results

- What influenced your decision to study Physics in year 11?
  - 92% were influenced by the yr.10 Physics Unit.

Most Important Influence?
- 43% Yr. 10 Physics Unit.
- 37% Possible future career.
- 10% To keep options open.
- 10% Other
Summary

- Head Teachers: Must ensure Mathematics and Science have high profiles in the school.
- Teachers: Expert knowledge, enthusiastic, caring, teach in their specialist area, discuss Science careers regularly (use scientists/engineers as guest speakers).
- Science courses: Enjoyable, fun, challenging, student-centred, differentiate Physics, Chemistry and Biology in yr 10.
- Extra-curricular: All students encouraged to engage in a wide range of activities and supported to do so.
The future of physics is in our hands.