

Comments on the High School Physics Syllabus in NSW (Australia). What can be done about it?

Page 8 is worth close inspection. It lists the objectives. Of the topics of which students are to have knowledge and understanding, number 1 is "the history of physics"; the important topics in physics come last. Among the skills to be acquired "developing scientific thinking and problem-solving techniques" is fourth in a list of five.

I should have preferred "developing scientific thinking and problem-solving techniques" to be number 1 on the list, rather than number 14 and the history, however interesting, to be last, rather than first.

The syllabus does include kinematics and dynamics, energy, waves, fields and matter as knowledge and understanding objectives 6-10. Our worry is that knowledge is examined more than understanding, and they are insufficiently used to develop 'scientific thinking and problem-solving techniques'.

Successes: The new HSC Physics syllabus in NSW is reported to be easier to teach by teachers with little background in physics, easier to pass by students not gifted in physics, more attractive to students not interested in physics and more appealing to educational theorists unfamiliar with physics.

Failures: It doesn't require skills in comprehension, quantitative analysis and solution of problems in physics. Physics is not well served by getting more people into a subject called physics if they then study largely history and social studies (and then perhaps enter university science or engineering thinking that they are actually good at physics).

For those with the responsibility of training tomorrow's scientists, engineers and technologists, perhaps the best way to proceed is to clarify our goals, and then discuss how to get there from where we are.

Our goal: To encourage students enrolling in physical sciences or engineering at universities to arrive with skills in comprehension, quantitative analysis and problem solving in physics at a level that prepares them to enter a world class university programme. Ideally, but not necessarily, this would involve collaboration with the Board of Studies.

Observations about the goal:

i) Different interest groups have different goals. We discuss some other goals below. This goal is unashamedly elitist. But Australia needs an elite. Physics and engineering must train students as an elite, but we must also find the right students to train. **If we continue to base our entry on an examination that doesn't require elite performance in abilities and skills central to physics and engineering, there is the possibility that students gifted in these areas may never realise that they have these gifts.**

ii) On scales smaller than the cosmological, physics seems to be uniform in the universe. We can see no need why the entrance standard for universities in different countries, let alone different states should be different. So we aim for a national or international entrance standard. The International Bac would be one possible standard. A national entrance standard would be another.

The problems are also somewhat uniform: the Heads of Physics Schools of Australian Universities report similar problems in other states. So we can reduce the work and improve the quality by working together.

How to approach this goal?

Some Australian University Physics Schools could run two (or more) levels of physics in first year. One of these would be the subject that we should all like to teach to first year students majoring in physics, electrical engineering and some other programmes: a world-class, serious first year physics course--let's call it Physics 1. We could make entry to Physics 1 conditional on passing an entrance test. We could run another subject, Physics 0, whose only prerequisite would be high school mathematics and which would be something like a good quality high school physics subject.

Students coming straight from NSW HSC Physics would be advised either to enrol in Physics 0, or to take a bridging course, that could be taught by universities, colleges or high schools, to prepare them for Physics 1. (The bridging course at UNSW has an excellent reputation and is much better preparation for studying physics or engineering than is HSC physics.)

What to do with the current HSC Physics subject?

Let it wither. It would be almost impossible to change it.

There is a market and a need for a subject that addresses the history and social studies of physics. There is a similar need for a subject that addresses the history and social studies of chemistry and biology. Why not combine elements of the existing HSC physics, chemistry and biology subjects into a Science Studies subject? This subject would be useful to future scientists and technologists, but useful to all future citizens as well. There would be no need for difficult analytical or quantitative material, so it would retain the attractions of the current subjects¹. The loss of material might not be important, because there would be no need for scientific completeness, and because there are parallel or analogous cases in the different sciences.

Schools do have teachers who can teach physics, and students who want to do it. Why not have a real physics subject for HSC (and perhaps other real science courses), offered in parallel with a Science Studies subject? The HSC currently recognises that students may require or be suited for different levels of maths and so offers separate subjects. Why not Science Studies (made from bits of the current syllabi) for all, and in parallel some real science subjects for students heading towards science, technology and engineering?

A physics syllabus should teach students how to *do* physics, not just teach about it. In this it is different from say history or some other humanities subjects. One could even say that it is more analogous to swimming: knowing facts about crawl is less important than being able to swim crawl. The knowledge about it may be quite interesting (especially, for Cadigaleans, if it really was invented at Wiley's Baths) but this is less useful than being able to do it. Australia needs scientists and engineers who can do physics.

Two quotes sum it up. The first is from a physicist who had just read the 2003 HSC Physics Exam:

Now I understand why my son — whose natural strengths are in the arts and humanities and not in science — did so well in HSC Physics (indeed it was his top mark): because he is very good at rote learning and social science!

The second is from a nearly tearful first year student, enrolled in first year physics, who had come with his father to talk to his first year university lecturer about his problems with the subject:

But I used to be so good at physics at high school. I never dreamed that it would have all this maths in it.

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The author is heavily involved in outreach to NSW high school physics students. He runs a bulletin board to answer students' and teachers' questions, wrote the HSC Physics FAQ and contributed substantially to a resource set. All of these are available at <http://www.phys.unsw.edu.au/hsc/>