Australian Physics

Volume 48, Number 1, Jan–Feb 2011

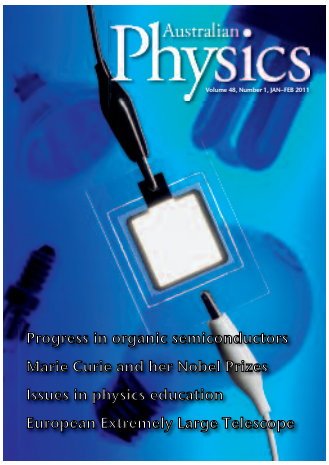
Progress in organic semiconductors

Marie Curie and her Nobel Prizes

Issues in physics education

European Extremely Large Telescope

CONTENTS



Cover
A prototype white organic light-emitting diode [courtesy: Novaled AG, Dresden]. See the article by Chris McNeill on page 17.

Australian Physics

A Publication of the Australian Institute of Physics

Promoting the role of physics in research, education, industry and the community.

SUBMISSION GUIDELINES
Articles for submission to *Australian Physics* should be sent in electronically. Word or rich text format are preferred. Images should not be embedded in the document, but should be sent as high resolution attachments in JPG format. Authors should also send a short bio and a recent photo. The Editor reserves the right to edit articles based on space requirements and editorial content. Contributions should be sent to the Editor.

ADVERTISING
Enquiries should be sent to the Editor.

Published six times a year.

Pub. No. PP 224960 / 00008
ISSN 1837-5375

PRODUCTION
Control Publications Pty Ltd
Box 2155 Wattletree Rd PO, VIC 3145.
science@control.com.au

Physics Education: Resources and Recovery

Joe Wolfe

With the award of the AIP Education Medal, which I received with delight, came the request to speak about education at the AIP Congress in Melbourne in December 2010 and to write an article for *Australian Physics* magazine. I thought that I could usefully talk and write about two topics in education. One is a learning and teaching project in introductory physics, while the other is the struggle over physics in high schools, a struggle that physicists may be losing.

A multi-level, multimedia resource

Physclips is a multi-level, multimedia introduction to physics, covering the levels from late high school to first-year university. Thus far, it covers mechanics, waves and sound, and provides resources in other areas. It is made by George Hatsidimitris, John Smith and myself, and supported by the Australian Learning and Teaching Council and the School of Physics at UNSW.

For teachers, Physclips is a collection of film-clips, animations, sound files and images that may be downloaded for use in lessons, or as reference material. For students, we intend it to be a flexible resource for learning, revision or reference.

Physclips combines film clips of experiments with animations, diagrams and explanations in both voice-over and text. Often, film-clips are integrated with material such as vectors, plots and histograms animated to represent time-varying quantities in the clips.

Each chapter has a brief multimedia overview, typically ten minutes, which branches via links to extensive supporting material giving broader and deeper discussion. In the recent chapters, laboratory sections are included to provide hands-on activities utilising a computer plus some common, inexpensive components.

Physclips attracts over 2000 individual visitors per day. Its teaching elements are incorporated into lessons at MIT and Harvard, as well as in schools in outback Australia, Africa and elsewhere (see [1]).

Putting physics into the high school physics syllabus – Can we regain some of the lost ground?

Like many others, I read the draft national curriculum for physics and thought that, if interpreted and taught with appropriate understanding and emphasis, it *could* be exciting, useful and educational. Unfortunately, that seems unlikely to happen. The problem is that, as it is currently written, it could also be interpreted as resembling the subject known as Physics in the NSW high school system, introduced several years ago [2]. This would be a national tragedy. Nevertheless, powerful stakeholders will certainly push it in this direction.

The original draft national syllabus must therefore be rewritten in a way that makes it clear it is a physics curriculum. Together with colleagues Elizabeth Angstmann and Richard Newbury (head of physics at UNSW), I wrote our school's response to the national curriculum (see [3]).

Briefly, our suggestions are these:

- The quantitative and predictive nature of physics and the importance of problem solving must be stressed, and it must be made clear that description, history and social studies are only minor elements. The best way of doing this is the usual way: state the important laws and principles in terms of equations. Including more than a small section without equations misleads students about the nature of physics.

- The national curriculum should also include a subject called General Science (and perhaps even General Physics). This subject would cater to students who wanted to learn *about* science but who did not wish or did not have the abilities to *do* science. Along the lines of the current Senior Science course in NSW (and much of the HSC Physics course in NSW), General Science could cater for students who wish to continue learning about science and the historical and sociological aspects of the subject, without the rigour required to study physics or chemistry. It would be understood that this subject would not, on its own, be a suitable introduction to further study in science, engineering, etc. Such a subject would free Senior Physics from the pressure to appeal to students who do not like physics and/or have no talent for it.
- The curriculum should make it clear that the most important component of the course is solving physical problems, mainly quantitative ones. Quantitative problem solving skills are not only of great importance to those who continue to university study in science and engineering, but to those seeking work in a wide variety of fields.
- We are concerned about the prominence given to history and sociology. Students should learn how to *do* physics, rather than just learn *about* it. We are not opposed to the humanities. However, just as we do not expect that physics be taught in humanities subjects, we oppose giving more than a small fraction of assessment in physics to humanities subjects.

Why is there so little physics in current 'high school physics'?

Strong pressures from powerful interest groups have led to this unfortunate result:

- *Teachers* Many high school physics teachers are frustrated by the new syllabi – but not all. In high schools, physics is often taught by teachers who have not been trained in physics. Very many more science teachers have training in biology than in physics, so there are not enough physics teachers to go around. Teachers who are not trained in physics may not always be unhappy to see the physics content reduced.
- *Students* There will always be students who love physics. And there will always be those who hate it. For some students, history and sociology are easier than physics. Such students are not disappointed when the physics is displaced from the physics curriculum.
- *Parents* In a real physics exam, students who spend long hours memorising facts do not necessarily do well. This can seem unfair to some hardworking students and their parents. Perhaps the NSW curriculum seems attractive to some because hard (but mindless) rote learning can be rewarded by good exam scores.
- *Educational theorists* Many education specialists are trained in the humanities. To such specialists, teaching the history of a subject rather than teaching the subject itself does not seem crazy.

Pressure of this sort from these groups will continue. The curriculum should therefore include the specification that history and sociology are to be only a very minor part of study.

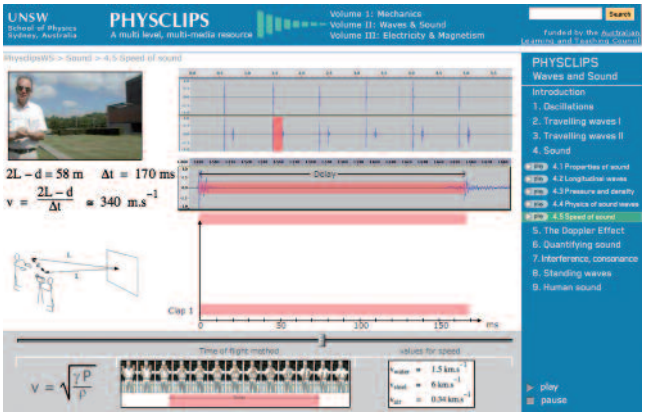


Fig. 1. A Physclips screen grab comes from a film-clip of measurements of the speed of sound using the time-of-flight method. In the upper panel, the sound of clapping hands travels to the microphone both directly and via an echo from a wall 30 m away. The icon below the scrollbar shows an alternative method using a distant source.

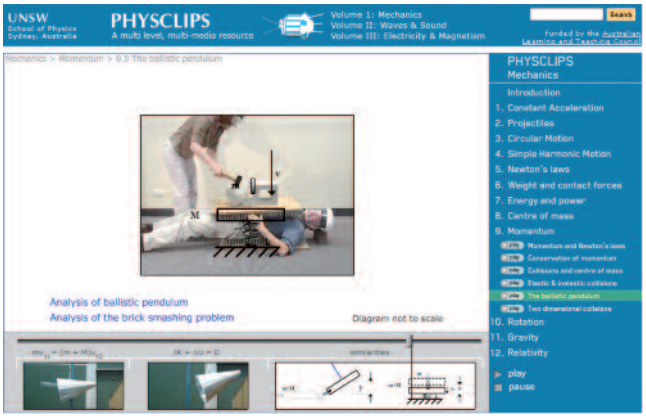


Fig. 2. This screen grab shows a section that discusses similarities in different problems. The ballistic pendulum (icons at lower left) involves an inelastic collision (momentum approximately conserved) and a pendulum swing (mechanical energy approximately conserved). In the circus stunt of the main picture, an inelastic collision of hammer and brick is followed by a (happily elastic) deformation of the presenter's chest.

What and whom is senior high school physics 'for'?

Senior high school physics must necessarily serve a range of users. Many will never study physics again, others will study disciplines in which some physics ability and knowledge is useful, and some will go into engineering, technology or physical sciences.

This last group is a minority, but its needs are disproportionately important, because of the importance of science, technology and engineering to Australia's future. These students should have the opportunity, while in high school, to discover that they are good at physics.

"Physclips attracts over 2000 individual visitors per day. Its teaching elements are incorporated into lessons at MIT and Harvard, as well as in schools in outback Australia, Africa and elsewhere."

For those who will rarely or never use physics after high school, it is important that those taking the subject Physics to find out what physics is like should actually find out what physics is like. The history, sociology and qualitative descriptions are available in any number of popular books, often written by very good physicists for this purpose. These can be learned outside school.

For those who have a real distaste for analytical thinking, quantitative analysis and modelling real world problems, senior high school physics will be unattractive – or at least should be! It is not a compulsory subject. Those attracted to history already have the opportunity to study it. Those attracted to physics should have the opportunity to study it.

Therefore, for all users, it is important that the quantitative nature of the subject, only hinted at in the draft curriculum document, should be made strongly explicit.

What can we do?

Don't do nothing – our discipline needs you, and you can influence those who will make the decisions. According to the Australian Curriculum, Assessment and Reporting Authority (ACARA), further consultation is planned for 2011 (see e.g. [4]). The AIP's education convenor is Dr Mark Butler, a previous recipient of the Prime Minister's Prize for Excellence in Teaching. Mark is one of the consultants for the Physics Curriculum and can be contacted at drbutler@ozemail.com.au. The AIP Executive can be contacted at executive@aip.org.au.

Notes

[1] Physclips can be found at www.animations.physics.unsw.edu.au.

[2] Over several years, there has been a reaction against the NSW syllabus and recent exams have had less Humanities content. This is an important improvement and those responsible deserve our congratulations.

[3] Our response to the National Curriculum is available as a PDF at www.phys.unsw.edu.au/~jw/NationalCurriculumResponse.pdf.

[4] See the websites at www.acara.edu.au and www.australiancurriculum.edu.au.

ABOUT THE AUTHOR

Joe Wolfe is a professor of physics in the School of Physics at the University of New South Wales. He has also held positions at Cornell University, CSIRO, the ANU and the Ecole Normale Supérieure. His early research was in cellular biophysics. Currently, his lab investigates the acoustics of the voice, the ear and musical instruments, publishing in high profile journals including *Nature* and *Science*. Wolfe has won several international and national awards for research and also for teaching. Outside the lab, he is a composer of orchestral and chamber music. His trumpet concerto will have its fifth performance this year, but he is more notorious for a suite of orchestral versions of the rock classic 'Stairway to Heaven', with movements in the styles of Schubert, Beethoven and several others. Joe can be contacted at j.wolfe@unsw.edu.au.