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Education Forum

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Contents

Editorial

This issue of education Forum has several items with links to science as a cultural activity. We have an article by Joachim Allgaier exploring aspects of the public understanding of science. There are reviews of television programmes and details of web-site resources linking science to biography, history and culture. No recent issue of Education Forum would be complete without one of John Cartwright's Poems of science – culture in a literary form.

Monday the 2nd of May is the deadline for copy to be with me for the Summer issue of Education Forum.

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Articles

Poems of Science

John Cartwright

Those dreadful hammers:
Tennyson and the crisis of faith in mid Victorian Britain

Near the end of the nineteenth century the poet and scholar A E Housman used the metaphor of disinheritance to describe the impact of the great ideas of his age:

> "man stands today in the position of one who has been reared from his cradle as the child of a noble race and the heir to great possessions, and who finds at his coming of age that he has been deceived alike as to his origin and his expectations"
>
> (1892 in Ricks, 1980, p. 272)

Housman was a classicist and an atheist and was alluding here to the fact that three great movements in the nineteenth century had served, for many, to undermine traditional religious belief. They were: the "higher criticism" of the Bible (basically the employment of historical and sociological perspectives to investigate the factual basis of this text), discoveries in geology, and developments in evolutionary biology. In respect of these latter two disciplines, it is to Tennyson, however, that we should turn to read one of the most sensitive appreciations of the impact and import of scientific ideas.

Tennyson was born in 1809, the same year as Darwin. This was also the year that the French naturalist Jean Baptise Lamark published his Philosophie Zoologique in which he suggested that individual species were not immutable and fixed, but transformed themselves to progressively higher forms. It was as if Creation was not a rigid Chain of Being but rather more like some giant escalator, with spontaneous generation supplying new life to hop on at the lower end.

In Britain, the reception of Lamark's ideas was mixed. With the Napoleonic wars at their height the idea of the transmutation of species smacked of French radicalism and the few naturalists who were attracted to the idea kept their heads down. Someone not so cautious was the Edinburgh book dealer Robert Chambers (1802-71). Chambers was a self-taught amateur scientist and in 1844 he published his own synthesis of ideas from geology and biology entitled Vestiges of the Natural History of Creation. The book was a national sensation and it both shocked and enthralled the reading public. It went through four editions in the first six months alone, yet all these and subsequent editions up to Chambers' death were published anonymously. When his future son in law asked him why he never owned up to his authorship Chambers is said to have pointed to his house and eleven children and said "I have eleven reasons". The fact that Chamber's firm was a leading publisher of bibles must have added to his discretion.

Chambers argued that two great laws could explain the mysteries of nature: gravitation for the inorganic realm, and the law of development for plants and animals. For all its faults, the book was remarkably insightful on the significance of, for example, the unity of structure between different species (homologous structures suggest common descent) and the gradation of animal forms in the fossil record. Chambers even recognised the importance of variation, so crucial to Darwin's later theory. On this point Robert and his brother William had their own evidence since they were born fully hexadactyl, that is, they had six digits on both their hands and feet.

What fascinated the reading public was Chambers' idea that humanity was not static: humans had evolved from simpler creatures and they would go on evolving to higher forms. In addition, although Chambers used such terms as the "Almighty Conception", the "Great Father" and the "Eternal One" it was clear that God was being relegated to a vague deistic first cause who had set out a divine plan of progression and left animals to it. Alarmed at its popularity, Hugh Miller wrote a repost called Footprints of the Creator. The more conservative members of the Anglican Establishment were less polite. Darwin's former tutor and Cambridge don, Adam Sedgwick, thought it to be a product of the frail intellect of a woman (privately he suspected Byron's daughter Ada Lovelace) and called it a "filthy abortion" that would "undermine the whole moral and social fabric"(Desmond and Moore p. 321)

For Tennyson, however, Vestiges, only confirmed the implications inherent in the direction geology and biology were heading; and it was this poet's honesty in recording his anxieties that made him popular with scientists and the lay public alike. Indeed, Tennyson maintained a steady interest in science throughout his life. When he died in 1892, Huxley claimed that he was "the first poet since Lucretius who has understood the drift of science". In his youth he read the work of the French naturalist Buffon and was familiar with the nebular hypothesis of the formation of the solar system advanced by Laplace. His tutor at Cambridge was the redoubtable philosopher of science Whilliam Whewell. At Cambridge, he would, like Darwin, have encountered the influence of Paley's natural theology. So when they appeared in print, Tennyson also eagerly seized upon Lyell's Principles (1830-33) and Chambers' Vestiges (1844).

The impact of these ideas is recorded in perhaps his finest poem In Memoriam, a confessional elegy written over the years 1833 – 1849. The poem charts Tennyson's attempt to come to terms with the death in 1833 of his dear and brilliant young friend Arthur Henry Hallam, and, in parallel, to assess the implications for his Christian faith of new ideas emerging from the sciences of biology and geology. The personal and the ideological run in tandem as he narrates his journey on both levels from grief and despair to acceptance and reconciliation.

Early on in the poem Tennyson expresses his fears about the lack of meaning in an indifferent universe.

O Sorrow, cruel fellowship,
O Priestess in the vaults of Death,
O sweet and bitter in a breath,
What whispers from thy lying lip?

'The stars,' she whispers, 'blindly run;
A web is wov'n across the sky;
From out waste places comes a cry,
And murmurs from the dying sun:

'And all the phantom, Nature, stands–
With all the music in her tone,
A hollow echo of my own,–
A hollow form with empty hands.' (I.M., poem 3)

This theme of a directionless universe governed by purposeless mechanical laws, a hollow form with stars blindly moving about, pervades the whole work. Sections 55 and 56 are perhaps the most penetrating and philosophically interesting in the entire poem. Here Tennyson confronts directly the implications of geological time, the extinction of species and the immense suffering that lies at the heart of natural processes. First, he offers the conjecture that the very wish for immortality is evidence of an internal apprehension of a Creator God

The wish, that of the living whole
No life may fail beyond the grave,
Derives it not from what we have
The likest God within the soul?

But if this is the case why is Nature so wasteful and indifferent to the suffering of individuals:

Are God and Nature then at strife,
That Nature lends such evil dreams?
So careful of the type she seems,
So careless of the single life;

That I, considering everywhere
Her secret meaning in her deeds,
And finding that of fifty seeds
She often brings but one to bear,

In section 56 Tennyson advances the argument by noting how species ('types') themselves become extinct; the implication also being that there is no such thing as spirit – it is just another name for a physiological process such as breathing:

So careful of the type?' but no.
From scarped cliff and quarried stone

She cries, 'A thousand types are gone:
I care for nothing, all shall go.

'Thou makest thine appeal to me:
I bring to life, I bring to death:
The spirit does but mean the breath:
I know no more.' ….

Then Tennyson considers the irony of human endeavour: our noblest goals may prove to be pointless and our ultimate fate to become just another fossil:

Man, her last work, who seem'd so fair,
Such splendid purpose in his eyes,
Who roll'd the psalm to wintry skies,
Who built him fanes of fruitless prayer,

Who trusted God was love indeed
And love Creation's final law–
Tho' Nature, red in tooth and claw
With ravine, shriek'd against his creed–

Who loved, who suffer'd countless ills,
Who battled for the True, the Just,
Be blown about the desert dust,
Or seal'd within the iron hills?

Finally, the terrifying conclusion is that human ethics is an aberration: the brutality of gigantic creatures of the past (the 'dragons' or dinosaurs) was at least in harmony (mellow music) with the natural order. The overall effect is crushing: individuals perish, humanity is doomed and our very value system is invalid by naturalistic standards:

No more? A monster then, a dream,
A discord. Dragons of the prime,
That tare each other in their slime,
Were mellow music match'd with him. (I.M. poems 55-56)

It would seem impossible to escape such despondency, and Tennyson does so only by resorting to faith and that very Victorian notion: progress. Hence to counter his doubts about the future of humanity as a whole, he turns Chambers' idea that the grand law of development would eventually lead to "a nobler type of humanity which shall complete the zoological circle on this planet and realise some of the dreams of the purest spirits of the present race" (Vestiges, p. 278). Indeed, the idea that evolution was somehow progressive directional and that humanity could with exertion improve itself was a grain of comfort that many found in evolutionary ideas before and after Chambers. The key statement of this idea by Tennyson appears in the highly important section 118. He relates how the earth began from 'fluent heat' and then gave rise to man who is but a "herald of a higher race"(l.14.) He looks forward to a time when humans will evolve past their sensual (the 'faun') and subhuman (the ape and tiger) past:

Arise and fly
The reeling Faun, the sensual feast;
Move upward, working out the beast,
And let the ape and tiger die. (I.M. poem118)

Similarly, in the Epilogue he imagines that his sister on her wedding night (Cecilia Tennyson was married in October 1842) will conceive a child that will be another step towards that “crowning race” where humans will be :

No longer half-akin to brute,
For all we thought and loved and did,
And hoped, and suffer’d, is but seed
Of what in them is flower and fruit; (I.M. Epilogue)

What is especially significant is a section of In Memoriam that typifies the changed relationship between science and theology. Tennyson finally rejects the argument from design so commonly employed by preceding thinkers such as Paley: the intricate structure of a bird’s wing or an insect’s eye can no longer be regarded as irrefutable evidence of the great designer. Instead, we must search within:

I found Him not in world or sun,
Or eagle’s wing, or insect’s eye;
Nor thro’ the questions men may try,
The petty cobwebs we have spun:
If e’er when faith had fall’n asleep,
I heard a voice ‘believe no more’
And heard an ever-breaking shore
That tumbled in the Godless deep;
A warmth within the breast would melt
The freezing reason’s colder part,
And like a man in wrath the heart
Stood up and answer’d ‘I have felt.’ (I.M., poem 124)

In Memoriam was published on June 1st 1850 and instantly secured Tennyson’s reputation as an interpreter of his age. On June 13th of that year he was married to Emily Sellwood after a frustrating twelve-year engagement. In the same year, as if on cue, Wordsworth died leaving vacant the laureateship. The Queen appointed Tennyson poet laureate on November 13th.

The immediate popularity of In Memoriam seems to derive from the fact that many thought it voiced their own doubts and yet also provided a resolution to the pressing tensions between science and faith. When Tennyson visited Queen Victoria in 1862, shortly after the death of her husband Prince Albert, she informed him that: “next to the Bible In Memoriam is my comfort” (Quoted in Ross, 1973,p. 100). Agnostics also admired the work - perhaps because it did not simply fall back on scriptural authority, and possibly because Tennyson recognised the sincerity of the doubters when in section 96 he noted:

There lives more faith in honest doubt,
Believe me, than in half the creeds.

Tennyson's solution did not entirely allay the fears of his fellow writers. Just one year after the publication of In Memoriam Mathew Arnold wrote his beautiful and elegiac Dover Beach lamenting the "melancholy, long, withdrawing roar" of the "the Sea of Faith". And in that same year the writer, art critic and amateur geologist John Ruskin wrote to his friend Henry Acland about the effect of geology on his own faith:

> You speak of the Flimsiness of your own faith. Mine, which was never strong, is being beaten into mere gold leaf, and flutters in weak rags…. If only the Geologists would let me alone, I could do very well, but those dreadful Hammers! I hear the clink of them at the end of every cadence of the Bible verses.
>
> (Cook and Wedderburn, 1909,Vol 36,p. 115)

Those dreadful hammers continue to shock. In October of 2004 a new hominin species was announced: Homo floresiensis, whose remains were found in a cave on the Island of Flores in Indonesia. It was a diminutive creature that perished only about 18,000 years ago. It looks to be a late descendent of Homo erectus that is now, as Tennyson would say, "seal'd within the iron hills".

Bibliography and references:

Cook, E. T. and A. Wedderburn (1909) *The Works of Ruskin*. 39 vols. London: G. Allen.
Desmond, A. and Moore. J. (1991) *Darwin*. London, Michael Joseph.
Chambers, R. (1844) *Vestiges*. London: John Churchill, Princes Street
Ricks, C., Ed. (1980) *A. E. Housman Collected Poems and Selected Prose*. London, Allen Lane.
Ross, R.H. (1973) *In Memoriam by Tennyson*. London: W W Norton.

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Science education for a public understanding of science or for a public understanding of voodoo formulas?

Joachim Allgaier

Basically two arguments are used to account for the reasons and purposes of science education in schools. One could call the first the citizenship argument: Many political issues and debates that are at stake for decisions are interrelated with scientific theories, knowledge, and explanations. It is argued therefore, that to become informed and build a personal opinion it is necessary for citizens to develop an idea how scientific experts gain their knowledge and expertise. Furthermore, it is argued that citizens require some understanding of the processes of science so that they are aware that scientific knowledge cannot be automatically equated with certainty and truth. The argument suggests that when citizens know how to deal with scientific information and knowledge they will be more capable of participating and deciding about issues with a scientific content. Scientists alone cannot provide solutions to socio-scientific problems, because in many cases scientific expertise is met by an opposing counter-expertise. Scientists in public often seem to fail in providing certainty. Here practically, the argument is that this approach requires a general and broad education ideal, developing transferable skills so that citizens can critically assess new information about science and participate in decisions about scientific issues.

Some science educators, however, oppose the idea of bringing ideas about science from other disciplines into the science classroom:

> "In case you haven't noticed, science over the past two decades has come in for a lot of stick, mainly from an alliance of environmentalists, post-modernists and sociologists who argue, to put it simply that it is a system of belief that is no more privileged than any other.
>
> Science, they suggest, fits theories to data. It is male-dominated and bears no necessary relationship to reality. Fortunately, most of this nonsense has not trickled down to the classroom. However, science is in danger if we forget what makes science distinctive, namely, the commitment to evidence as the basis of belief."
>
> (Osborne, 2004)

In this regard science education should be about the teaching of the so-called scientific facts and theories alone. This second argument for science education in schools is deeply rooted in the economic and professional sphere. One could therefore call it the professional-employment argument. Here science education in schools should primarily serve the requirements of the small minority of students that plan to become professional scientists or pursue another career where scientific knowledge is required. Following this argument leads to the idea of a general education in the facts and methods of science (in compulsory education) leading to increasing specialisation (in post-compulsory education). In addition to this links are made between specialised science education, economic growth and the ability to cope with the competition in a global marketplace. This view is not brought forward by educationalists very often, but the argument that more specialisation in science education would automatically lead to more research, which would then lead to a boom of the economy seems to be present among science policy practitioners and politicians in reports and quotes in the media. However, it seems reasonable to remark that many scientific research projects are already trans-national in nature and many scientists from different countries work together in international co-operations and research projects. At the same time much of industrial research, which might advantage the economy, is taking place within globally operating corporations and here it seems questionable if these multinationals still feel obliged to national economies. Another question is, whether cost-intensive basic research (if something like this still exists) using particle accelerators or in the depths of space inevitably yields economically applicable results.

In general the term scientific literacy is used to describe the outcome or the result, that science education should achieve. But the ideas about what scientific literacy actually means seem to vary among scholars.

In reviewing the literature on scientific literacy Durant's (1993) contribution is particularly helpful. He describes and distinguishes three separate aspects of scientific literacy. In his view only the three aspects taken together can ensure that people are able to understand what science is, how it is conducted and what the links between science and society are. These three aspects of scientific literacy are:

1. Knowing a lot of science. This refers to content and the teaching of scientific "facts" and formulas. In Durant's view the teaching of facts alone is <u>not</u> enough to become scientifically literate. To understand the "issues of the day", Durant writes, new current scientific knowledge is required. And new scientific knowledge by its nature would be uncertain and often controversial.
2. Knowing how science works. Here he refers to the processes of producing and generating scientific knowledge. This would imply a basic understanding of scientific concepts, technical terms and an understanding of methods of science for testing models of reality and an understanding of the impact of science and technology on society. Also required would be the understanding that there is no such a thing as one single "scientific method". Different sciences use diverse methods and approaches.
3. Knowing how science really works. Here Durant refers to the social institutions and control mechanisms wherein science takes place and that science is also a socio-cultural activity. Science is actively performed by people who belong to a professional community of scientists. It would therefore be important for scientifically literate people to understand that scientific knowledge production is also a social process.

Durant regards the encounter of pupils with factual textbook knowledge alone in school as a poor preparation for science as it is generally encountered in daily life by citizens. Science present in the public sphere is mostly new, and often it is in the process of active debate among experts, who are trying to judge its quality and significance. In this regard it is interesting that Nicolson and Holman (2003: 26) see it as a component of scientific literacy,

> "to make sense of science stories in the media, to evaluate the evidence they are based on, to consider associated risks and benefits and to appreciate how society makes decisions about the acceptance of new discoveries or developments."

There are good reasons why pupils could benefit from a broader, less specialised science education. It is often claimed that we nowadays live in a scientific age. Results of scientific work surround us almost everywhere in our professional and everyday lives and do in fact form part of our culture. It is therefore probably a good idea to first of all get children interested in scientific questions and issues. Science education should at least try to listen to the different needs and interests of heterogeneous groups of pupils. That means that science teachers could build on the knowledge or ideas that children already have about science and acknowledge their views and thoughts. Science teaching that presents equations and formulas as objective truth without explaining where they are coming from could scare off children from the sciences for the rest of their lives. There is already a somewhat distorted image of who scientists are and what they are doing in the media. There one often encounters emotionalised versions of scientists as either genially evil masterminds in lab-coats or almost superhuman clever-dicks. The teaching of the history of science could provide a somewhat more realistic picture of who scientists are and what they are actually doing. Excursions in the history of the sciences would also help to understand that the scientific facts of today were not easily accepted as facts at the time of their origin. Scientific findings are in many cases closely connected to the person and biography of their discoverers. In treating specific historical case studies children might find out that in many cases of ground-breaking scientific research the creativity and intuition of the specific researcher played a key role in the scientific advancement. Following this, children might find out that this version is opposing a view that portrays science as the employment of one single scientific method as neutral and objective way of generating scientific truth. Additionally teaching the history of the sciences has the benefit that the historical contexts of scientific research and findings can be reflected. Metaphors, models and descriptions of the physical world contain values and ideas of the current cultural, social or religious contexts during their emergence. This insight could be used to establish a connection with how scientific practice is carried out today.

It is, of course, impossible to predict which branches of the sciences will prosper and prove as successful in the next decades. It is also not feasible to select an authoritative basic vocabulary that will suffice to understand contemporary or future scientific topics and controversies in detail. Therefore it does make sense to help the citizens of tomorrow to understand the modes of operation and the processes of science. Science is done by human beings that actively have to make sense of their research findings and have to spread and establish those findings amongst a special group of professional people, the so-called ‘scientific community’.
The teaching of the social processes and historical aspects that surround scientific work science could not only contribute to a better “Public Understanding of Science” (PUS). If those pupils that decide to follow the path of a more specialised further science education in order to become professional scientists have encountered the relationship between science and the public or the historical roots of the sciences in their compulsory education, it might also contribute to a better “Scientists’ Understanding of the Public” that is often demanded at the time. This approach might also prevent future scientists from drawing a distinctive line between the ‘hard’ sciences and the ‘soft’ humanities from early on, when they understand how they are both related. For instance in German the term “Wissenschaft” includes both academic traditions, the sciences and the humanities. As a result what is called for is a better “Public Understand of the Sciences and Humanities” (PUSH).

In this context it is remarkable that the erudite Jacques Barzun (1963) already in 1945 considered the distinction between scientific and humanistic content in science education as futile, if not dangerous. Barzun suggests that children that believe that science is neutral, objective and fact-based would be more isolated in an ivory laboratory than the poets and thinkers in their towers and become a plain menace to society. To counter such developments it would therefore be helpful to reflect on the origins and histories of the sciences as well as the biographies of some of the important scientific personalities in science education. In Barzuns eyes it makes perfect sense to introduce the sciences in the college curriculum as humanities at the earliest possible moment. His intention is to show that the sciences are made by human beings with all their interests, hopes and errors, exactly the same way as poetry, philosophy or human history itself:

> "A good scientists-historian would exhibit the assumptions and habits which affected scientific opinion at important turning points. He would unite science to other thought by discussing the nature of its evidence at various periods. And he would show the role of pure imagination in all great scientific work. […]
> But science has not yet managed to get along without ideas, and these come only from men of special, powerful, and irreducible aptitudes. The chronological study of these men and ideas is the proper subject matter for an undergraduate course in the history of science. […]
> Lastly, the course imparted a fair amount of matters of fact and showed how wrong was the man who said: "You don't have to teach the history of science to make a man understand that water is H_20." It is precisely what you have to teach, unless you are willing to barter understanding for mere voodoo formulas."
>
> (Barzun, 1963).

Bibliography and references

Barzun, J. (1963) : The Ivory Lab. In: Locke, L.G. ; Gibson, W.M. und Arms, G (eds.) : Toward liberal education. New York : Holt, Rhinehart and Winston, Pages 496 – 505. First published in: Barzun, J. (1945): Teacher in America.

Durant, J. (1993): What is scientific literacy? In: Durant, J. und Gregory J. (eds.): Science and culture in Europe. London: Science Museum. Pages 129 – 137.

Nicolson, P. and Holman, J. (2003): The National Curriculum for science: looking back and forward. In: School Science Review 85(311): Pages 21 - 27.

Osborne, J. (2004): Behind the big bangs. In: SCIENCE, Association for Science Education Annual Conference, Page 2, Supplement of: The Times Education Supplement, 2 Jan 2004.

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Notices

Eighth IHPST Group International Conference

The eighth conference of the International History, Philosophy and Science Teaching Group will be held in Leeds, England, July 15-18, 2005. The conference is being held in conjunction with the British History of Science Society conference. Sessions of both conferences will be available to participants, and there will be some shared social events.

Details about conference can be found at web site: www.ihpst2005.leeds.ac.uk , or by contacting the conference secretary, Mick Nott (enquiries@ihpst.leeds.ac.uk).

The deadline for submission of 500 word Abstracts was the end of January 2005 (email further enquiries to: enquiries@ihpst.leeds.ac.uk)

Einstein Year

To celebrate Albert Einstein and his achievements, the centenary year of 2005 has been declared the World Year of Physics. To support activities the Institute of Physics is offering awards of up to £1500 through the Einstein Grant Scheme. The closing date for the second round of funding will be 25th February 2005.

Apply now rather than delay and forget. Application forms and further information for funding are now available at www.einsteinyear.org/get_involved/funding or, contact Caitlin Watson, the Einstein Year project manager on Caitlin.Watson@iop.org

Wellcome Trust study grants

Wellcome have grants of up to £12,000 for projects that:

- produce a body of work using the Wellcome Library's historical collections;
- communicate ideas about medicine and science to the public;
- stimulate thought and debate about the wider social impact of medicine and science.

Projects must span historical, social, ethical or cultural topics relating to medicine.
Successful applicants will receive:

- £2,000 per month for a minimum of three months and a maximum of 12 months;
- extended access to Wellcome library and collections.

Applications can be made at any time of the year.

Visit	http://library.wellcome.ac.uk/alchemy
Or contact Sam Cairns	0207-611-8659
e-mail	s.cairns@wellcome.ac.uk

Reviews

Television Programmes

Light Fantastic

A series of four programmes broadcast on BBC4 between 9 and 10 pm on Wednesdays December 1st, 8th, 15th, 22nd. Presented by Simon Schaffer.

There is an accompanying web-site at:
http://www.bbc.co.uk/bbcfour/documentaries/features/light.shtml
The web-site goes beyond the content of the programmes themselves and makes a useful resource for learning about other aspects of the history of science.

With each programme broadcast there was an opportunity to find out more about astronomy (and win a telescope) by pressing the red interactive television button on the viewer's handset.

Here are the programme makers' own notes for **Light Fantastic**.

> "Light Fantastic explores the phenomenon that surrounds and affects nearly every aspect of our lives but one which we take for granted - light.
>
> 1.*Let There be Light*
> Greek and Arab scholars, and later Europeans such as Descartes and Newton all tried to understand light to gain a better understanding of God. Episode one shows how much of modern science's origins came from the desire to penetrate the divine nature of light.
>
> 2. *The Light of Reason*
> The second programme explored the link between the development of practical tools that manipulate light and the emergence of new ideas. For example, Galileo's observation that the sun did not go around the earth, was made with a telescope that had been invented for Venetian soldiers and traders.
>
> 3. *The Stuff of Light*
> Episode three charted the discovery of the true nature of light and its impact on the modern world. All of today's technologies – electricity, mobile communications and our ability to illuminate the world 24 hours a day – stem from unravelling the mystery of light.
>
> 4. *Light, The Universe and Everything*
> In the final programme Simon Schaffer finds that as more people were able to manipulate light, the more puzzling and tricky it became. This led to investigations into the strange relationship between light, the eye and the mind, and the development of new technology such as photography and cinema."

I watched these programme with interest. They appear to be pitched at the level of a beginner's guide. Those interested in the history of science will be irritated by the history being somewhat linear in trajectory, the scientists heroic in their deeds, the ideas and evidence being unambiguous, unstopable and rarely contested. However, those interested in science as a cultural enterprise may possibly be more indulgent. Gaps are inevitable in any survey that has such an ambitious broad sweep: and in just four programmes. The programmes are not definitive. They are good starting points and this makes sense if viewed conjunction with the web-site as a further resource.

Simon Schaffer is an enthusiastic presenter. His enthusiasm can get in the way. He has a style of verbal delivery which comes close to hectoring. This was particularly so in broadcast 3 (The Stuff of Light) when he spent quite a bit of time wandering the back streets of Cambridge talking about things that had little to do with the background in view.

As editor of Education Forum I would be interested in publishing other people's views on the programmes, the interactive video and the web-site.
Please e-mail me at martin.monk@gtep.co.uk

Days that Shook the World.
Programmes, usually of paired events, broadcast between late September and Xmas 2004 on BBC Four, Monday evenings at 10:30 pm. Repeats shown later in the week.

These are not programmes about the history of science. They are history programmes where science can be used to interpret events: to put a gloss on them that is illuminating and links the events into the evolution of technical and scientific knowledge. Science teachers who see science as a cultural enterprise could use the programmes to illustrate particular aspects of scientific understanding. Or, much more demandingly, use them to structure a short, unusual and stimulating scheme of work.

Each of the paired topics is generally covered in half an hour: one hour for the pair. The, usually, paired programmes included:

- Kristallnacht paired with The Birth of Israel;
- Disaster in the sky: Challenger and the Hindenburg;
- WWI Christmas Truce (one hour);
- Attack on Pearl Harbor (one hour);
- Grand heist: The Great Train Robbery with The Crown Jewel Theft of 1671;
- Conspiracy to kill: Day of the Jackal (de Gaulle) with Wolf's Lair (Hitler);
- Reach for the stars: Galileo's Trial with Yuri Gagarin's Flight;
- Dinosaurs and Duplicity: Fossil Discovery with Piltdown Man;
- Terror made in America: Assassination of Abraham Lincoln with Oklahoma Bombing;
- Spy Swap: Gary Powers with Rudolf Abel;
- Affairs of the Crown: Anne Boleyn with Edward VIII.

With some of these, the science leaps out at you. So with Galileo's Trial and Yuri Gagarin's Flight , the science association is fairly obvious. A science teacher should easily be able to pick up on the science and capitalise on it. With Galileo the science is in the ideas and evidence that separated an Earth centred and Sun-centred view of the universe. With the flight of Yuri Gagarin there is the science of gravity, energy and the concept of fields; pressure, containment, space suits and capsules; respiration and recycling etc. There is also a common theme of the technology of communications – internal to events (word of mouth as against radio) and external in public knowledge (the printed word as against television). These aspects of science are latent in all the programmes. The science teacher would need to have activities to guide learners to interpret the historic events in terms of the science.

With the Challenger disaster the science is in fuels, combustion, energy changes; materials and the temperature dependence of their properties. With the Hindenburg disaster there is an obvious link into floating and sinking and relative densities of gases; forces, stress and strain, breaking strengths; combustion, fuels and enthalpy changes etc. Again, there is also the possibility of exploring a common theme across the paired programmes of the technology of communications, media and public knowledge.

With some of the paired programmes the science is more in the comparison of circumstance. Perhaps this can be seen with Terror made in America: the Assassination of Abraham Lincoln paired with the Oklahoma Bombing. Lincoln was a lone victim, killed with a gun. In Oklahoma many died from the structural inadequacies of the building, which were exposed by a relatively minor explosion that happened, by chance, to be well (!) placed. The science is in guns and buildings. It needs a bit more extraction. Two explosions: two different consequences.

Paired programmes like Affairs of the Crown: Anne Boleyn with Edward VIII, need a lot of work on the part of a science teacher to extract science directly relevant to the events described. Again that common theme of media, communications and public knowledge are suggested. At the same time, there is a wealth of readily accessible science in terms of daily life, world-views and ideas. The science is there, but it is in understanding the contextualisation of events.

Sadly, I can't see many science teachers making use of these well presented (with docu-drama and split screen effects), interesting programmes. Few teachers would have the courage and stamina, let alone the time, to fight the current system of science education to be able to create the exciting scheme of work they suggest to me. Watch the repeats when they are next shown (as BBC Four often does repeat and re-repeat) and make a judgement your self.

Books

"Cell: The Birth of the Cell" by Henry Harris.
Published by Yale University Press 1999, paperback 2000. 220 pages. ISBN 0-300-07384-4, hardback. ISBN 0-300-08295-9 paperback.
Reviewed by Patrick Gavin

The history of science has benefited in recent years from the writings of specialists who have written on their subjects in fruitful and reflective retirement, giving us detailed accounts and personal perspectives e.g. the physicist Abram Pais. Sir Henry Harris, Regius Professor of Medicine Emeritus at Oxford falls into this category with this book on the cell, written in a clear, concise style. Brief references are given in the Notes at the end and an Appendix gives, for the specialist, extended quotations from the original sources. There is a full index. Small portraits are given for every scientist. The present reviewer is not competent to comment critically on the biology, but feels that several topics of interest to historians of science are presented.

In this historical account the author is at pains to evaluate fairly individual contributions in the light of his own work and research among the original papers and books. Harris is particularly good in presenting the facts of the controversies and the flavour of the discussions: thus we encounter such statements as "It contains a further acerbic polemic against Strassburger…" ; and "Haekels writings are so voluminous and so permeated with theories that have subsequently been discredited…"

No particular attention is given to aspects of instrumentation such as the resolving power of microscopes, but mention is made of "…a new achromatic compound microscope made by Simon Plössl of Vienna in 1832…"; and "…Remak introduced the systematic use of hardening agents…"

For English readers this book could well provide salutary reading: the scientists working in this field in the crucial period of the 1830s were predominantly German, with some notable contributions from Belgians. One is reminded of the fact that culturally "Germany" extended from Dorpat (now Tartu, in Estonia) to Zürich, and throughout the Austro-Hungarian Empire. The large network of universities and the constant exchange of academic posts provided a favourable milieu which was not found in England. Germans could read the French papers; the French could not read German.

In the first Chapter on the early microscopists the work of Hooke and van Leeuwenhoek is outlined together with the controversy concerning the priority of work on plants by Grew and Malpighi: their discoveries, as Harris shows, were in fact made independently.

The disputes as to whether cells are common to plants and animals are traced. Harris is particularly interested in emphasising the importance of the contributions of Purkyně (Purkinje in German) who, he considers, has been unduly neglected. This neglect arose partly because, after an early distinguished career at Breslau, Purkyně returned to Prague and his later work was published in Czech.

The final chapter deals with the discovery of chromosomes, the work of Boveri and the American contributions c 1900. No woman is mentioned in the whole book.

"Degrees Kelvin: the genius and tragedy of William Thomson" by David Lindley.
Published by Arum Press 2004. 366 pages including bibliography, notes and index. £16.99.
ISBN 1-84513-000-6.
Reviewed by Martin Monk

Having visited the old British Telecom Museum at Puddledock, down by Blackfriars in London, I knew that William Thomson – Lord Kelvin - had once been dismissive of radio. I was therefore ready to accept that within the covers of this biography I was to find someone who was a bit of an old fuddy-duddy, comfortable in his own ways of doing things and not much taken by modern fancy fashions. I also knew of the story when a young Ernest Rutherford, on lecturing on radioactivity in front of Lord Kelvin, had the intelligence to gloss Kelvin's dating of the age of the Earth with the comments that Kelvin had worked out the date he had with the proviso that no new source of energy was discovered. Thereby, Rutherford diplomatically protected Kelvin's ego and prevented an open confrontation. Who said scientists just need bench skills?

David Lindley shows how the precocious schoolboy William Thomson grew into the role of nineteenth century sciences' greatest statesman, Lord Kelvin. In that transformation William became a victim of his own early success and his own polymath interests. Lindley portrays William Thomson as a genius, but one who was all too easily distracted by the next puzzle on the fringes of the first. In this way his genius was dissipated and he satisfied himself as an intellectual butterfly flitting about between the flowers of mathematics and natural phenomena. This is not to say he did not have successes. Obviously we wouldn't have any knowledge of him at all if he had not been successful. Intellectually, the greatest success was probably in his codification and dissemination of ideas on heat and what has come to be known as thermodynamics. Practically, his greatest success has to be his work as a consultant working on the laying of sub-marine telegraph cables. In between there is work on navigation and compasses, the generation and transmission of electric power, fluid mechanics and of course the age-of-the-Earth controversy. Who said scientists are single minded?

It is in discussing the age-of-the-Earth controversy that David Lindley particularly points to Peter Guthrie Tait, one of Thomson's friends and intellectual partners, as being the man who led Thomson into taking positions he might otherwise have avoided. Tait was Thomson's terrier. He was happy to growl and snap at those who challenged Thomson's estimate of the age of the Earth. Lindley sees Tait as the one who shortened the time estimate Thomson made and so irritated the geologists more and more. Tyndale, when at the Royal Institution in Albermarle St., became a target for Tait as the exchanges became heated and vituperative. Who said scientists are dull?

The sub-title to David Lindley's biography flags-up the book will not be a hagiography. Kelvin was a nice man. He was not a saint. But nor was he a sinner. I had thought Thomson opposed the geologists and Darwin on the age of the Earth out of religious conviction. I was wrong. Thomson opposed the geologists because he had no more convincing evidence, theory or reason to think otherwise. David Lindley shows Thomson to be a pragmatist. Just as he flitted from phenomenon to phenomenon from calculation to theory, he would shift his position when he could be convinced to do so. Who said scientists only trade in immutable facts?

As a young man Thomson was angelically good looking in a golden haired boyish way. As a Young man he was as supple with his body as he was with his mind and enjoyed rowing and messing about in boats. When older and money started to flow in from his various patents he bought a comfortable yacht, the Lallah Rookh, and was able to invite family and friends, like the German physicist Hermann von Helmholtz, to spend time on long summer voyages around the Scottish Islands. Sadly, due to an accident at Largs, when out on the ice curling in the winter of 1860/1 he had fallen and broken his leg. The doctors disagreed on what to do. From then on William scooted around with his left leg two inches shorter than his right. Who said scientists don't have their tragedies?

How can the text be used for educational purposes? Mmmm! The lessons I take away are those of environment and hard work. Thomson was precocious because he spent a lot of time in his early years in the academic environment of a university: his father was a professor in Belfast and then Glasgow. His school was the university. Thomson also put in the hours. He carried a notebook at all times and could always slip into mulling over personal puzzles. But these observations only tell me how genius may occur. They don't particularly tell me how to introduce aspects of William Thomson's life into teaching about natural phenomena. I am left with a gap I can't see how to bridge.

I very much enjoyed David Lindley's book, "Boltzmann's Atom" (reviewed in Education Forum issue 35) and this is also a good read. Lindley writes with warmth and enthusiasm for his biographical subjects. If the test of a good biography is to leave the reader wanting to have met the subject, then Lindley's biographies have left me wanting to meet both Boltzmann and Thomson.

"Remarkable Physicists-from Galileo to Yukawa" by Ioan James. Published by Cambridge University Press, 2004. 389 pages.ISBN 0 521 81687 4 hardback, £60.00. ISBN 0 521 01706 8 paperback, £19.95.
Reviewed by Patrick Gavin

Ioan James FRS, formerly Professor of Geometry at Oxford, has turned his attention to the History of Science and has written two companion books ‘Remarkable Mathematicians’ and ‘Remarkable Physicists’, the latter being the subject of the present review. Fifty physicists are selected and presented chronologically and a small portrait is given for each. For convenience they are divided into ten chapters. Each physicist is allotted about seven pages. There are no equations or diagrams. James makes it clear that his purpose is not to expound the development of physics as such, but to bring out the human and personal aspects so that we can get some feeling for the person, his inspirations, his trials and tribulations, behind the names so familiar to us as “Ohm’s Law” or “Schrödinger Equation”. He commends W.H. Cropper’s ‘Great Physicists’ which deals in more detail with the actual physics and which we reviewed recently in these pages (Endeavour vol 28(1) p5 2004). References are not cited in the text, which helps the flow of reading, but an appendix ‚Further Reading, lists one hundred and twenty autobiographies, biographies and related books. A further appendix, Collections, gives the sources for the collected works of these physicists.

James has studied the lives of the physicists with a keen eye for the fine details of the personal aspects, as well as the science. What was the family background ? What was the inspiration? Were his interests broad or narrow ? Thus, perhaps displaying the traits of a mathematician, dates of birth are given in full with day, month and year; so, for example : “Yukawa was born in Tokyo on January 23, 1907, during the fortieth year of the Meiji era. The child was the middle one of five brothers, the fifth of seven children altogether”. The family backgrounds on both the father’s side and on the mother’s side are traced, as well as the careers of siblings and of children. In some cases, such as the Bernoullis, the de Broglies, the Curies and the Thomsons (JJ and GP) the family connections are clearly important. The author’s own interesting reflections are given in the Prologue and in the Epilogue, which also lists the fifty physicists in order of death, going from Kepler in 1630 to de Broglie in 1987, though he does not indicate why he thinks this parameter is significant. In many instances James gives extended quotations when he feels that this gives a valuable perspective, for example Heisenberg on the discussions between Bohr and Schrödinger.

Many readers will probably dip into this book as curiosity takes them, but if read through certain trends appear. At the time of the Revolution, say 1800, French physicists and mathematicians appear conspicuous. In the last centuary, 1900 to 1940, German physicists seem to predominate. Scotland, with Thomson (Kelvin) at Glasgow and Maxwell at Edinburgh, was for a long time ahead of England where Oxford and Cambridge seemed to lack initiative in science.

Galileo was not the only scientist to have problems with authority: Lavoisier, Oppenheimer and Kapitza had theirs. (I would rather have been interviewed by Bellarmine than by Beria.)

Having recently been impressed by a performance of a Mass by Bruckner I noted (following James’s style) that Boltzmann had piano lessons from Bruckner. Lise Meitner and Born were very fond of music. Planck and Ehrenfest were very good pianists; Einstein was a good violinist. Planck experimented with tuning, comparing ‘just intonation’ with ‘equitempered’: surprisingly he found that the ear prefers the latter. When discussing Planck’s life and his personal misfortunes James offers an explanation for the rise of the Nazis.

Because of the constraints of brevity many points are not developed or not made clear. If Oersted was a passionate disciple of Kant, did this influence his science for better or worse ?

Clavius did not embrace Copernicanism: but was that because of Tycho's system and the parallax argument ?

Physicists' rationality does not always extend to personal habits: "A heavy smoker, Oppenheimer died of throat concer." And : "Maria Goeppert-Mayer, an inveterate chain-smoker, began to experience health problems." Bolzmann and Ehrenfest committed suicide, probably due to depression. Count Rumford (Benjamin Thompson) and Schrödinger were prolific philanderers. Madame Curie had an affair with Langevin.

One surprising inclusion is the Jesuit mathematician and astronomer Boscovich. James summarises Boscovich's 'atom' (a point source of repulsive force) with a quotation from Cavendish. The present reviewer recently heard a nuclear physicist refer to the electron as being almost a 'Boscovichean point'. James does not mention it, but readers would quickly recognise in Boscovich's force/distance curve of 1760 our present description of intermolecular forces.

These remarkable physicists come from a wide variety of backgrounds and display a wide variety of temperaments. What they share is a passionate- witness Bohr- desire to understand the physical universe. An outstanding ability to identify the key problems and to concentrate intensely is evident. In several cases, for example Bose and Fermi, there was an extraordinary ability to grapple with advanced texts with relatively inadequate training. James has sensitively added flesh to the bare bones with which we are familiar so that "Young's Modulus" or "Maxwell's Demon" have now a more human touch to them; he has given us a bit of gossip as well.

"Extreme Measures: the dark visions and bright ideas of Francis Galton: a biography of one of the Victorian age's most eccentric and prolific scientific minds" by Martin Brookes. Published by Bloomsbury 2004. 298 pages with no index. £16.99. ISBN 0-7475-6666-6.
Reviewed by Martin Monk

"Galton, perhaps, is not the kind of individual to inspire widespread affection. He was far too extreme for that. But peel away the less attractive aspects of his character, and there is still much to admire."

"As we look forward to the future, and a new technological century of genetics, all indications suggest that the ghost of this witty, uncompromising, phlegmatic, wayward and single minded man will continue to haunt us."

These are quotations from the last pages of Martin Brookes' biography of Francis Galton. The very name of Francis Galton can evoke a reflex action of distaste on the part of some who only know him for his pioneering work on eugenics. To the modern mind, this can make his image repellent. Galton could be a man of extreme views because he was a man of independent means. He was an example of the Victorian gentleman scientist. He never had to work for his living. The family money had originally come from the making of guns. So he could afford to follow his own interests and inclinations, wherever they led, and not worry over-much about the consequences. Across the globe, his inclinations and interests led him down the Danube, unaccompanied, when little more than a schoolboy; down the Nile to the Sudan in his early twenties; and into the sands of Namibia for two years when he was twenty-eight. In 1855 he published his best selling book "the Art of Travel" which Martin Brookes says is still in print in some form. Francis Galton started with geographical adventure and discovery, moving on to intellectual adventure and discovery.

As with the travels of his cousin, Charles Darwin, Francis Galton's travels allowed him to see more difference – in geography, culture, habits and anatomy, than most would ever see. He also shared that Victorian interest in ordering things. Measurement was one way of ordering, categorising and classifying. So it is not at all surprising he became interested in fingerprints, the distance between the eyes, the size of the skull and all those other things now dear to Home Secretaries who want to introduce ID cards. His anthropometric laboratory at the international exhibition in London was a great success: visited by thousands. He could catch the popular imagination. Initially his interest was that of curiosity. In this, he was no more racialist than many of his contemporaries. In fact, from his travels, he was probably less jingoistic than most who had never crossed the Channel, which he did regularly for holidays.

Before he came to eugenics, Francis carried out blood transfusions on reproducing rabbits – one black and one white – and thereby showed his cousin, Charles Darwin's woolly ideas on how somatic characteristics appeared in gametes were wrong. It was a well conceived and executed piece of experimentation to test a hypothesis. Generally, Francis was well respected by his fellow Victorian scientists and explorers. He was awarded prizes and given medals for his tireless work. Of course he did make enemies, but during his lifetime they were few. It is only after his death, early in 1911, with a wider uptake of eugenics, that his ideas became questioned. It is only after the Nazi's use of eugenics in their programmes of genocide that Francis Galton has come to be seen as the father of a terrible evil. Of course, with modern knowledge of the human genome, Martin Brookes is right to suggest the ghost of Francis Galton will continue to haunt us. But we may have to rediscover who Galton was and what he actually did. Martin Brookes' book goes someway to achieving that.

How could I use this in my teaching? Well, for a start, the story about the rabbit transfusions (chapter 10: Rabbit Stew) is well worth introducing to any class working on natural selection and the mechanisms of inheritance. It is a classic tale of ideas and evidence. On that alone, Karl Popper would have promoted Francis Galton as an archetypal scientist.

Resources

In our time – Science archive
Melvyn Bragg explores the history of ideas including science, philosophy, literature and culture. You can listen to all the programmes on-line.

http://www.bbc.co.uk/radio4/history/inourtime/inourtime_science.shtml

These are recordings of programmes that continue to be broadcast on Radio 4.
The programmes available include:

Carl Gustav Jung – discovering the self

Higgs Boson – the search for the God particle
Electrickery – the origins of electricity
The Origins of Life – how it all began
Pi – the number that doesn't add up
Planets – the astronomy of the 21st century
Zero – everything about nothing
Hysteria – the normal state of human beings?
Theories of Everything – still the holy grail of physics
Dreams – is there science in dreams

Rutherford – the father of nuclear physics
Cryptography – secret history of ciphers and codes
Lamarck and natural selection – the Lamarckian heresy
Ageing the Earth – a journey in geological time
Infinity – a brief history
James Clerk Maxwell – great 19th century physicist
Nature – from Homer to Darwin
Vulcanology – significance of volcanoes
The Lunar Society – scientific ferment 200 years ago
Memory – and the brain

Supernovas – the life cycle of stars
Meteorology – why does it still fascinate us?
Chance and design in evolution – design in nature
Disease – the fight against diseases and plagues
The calendar – a history of the calendar in all its forms
Psychoanalysis – do people crave dictatorships
The scientists in history – missionary or monster?
History of drugs – their role in medicine and the arts
Schrodinger's cat – quantum mechanics
Chaos theory – is the universe chaotic or orderly?
ET – new life within our solar system
Anatomy – 2000 years of anatomical study

The Dictionary of Nineteenth-Century British Scientists.
General Editor: Benard Lightman, York University, Toronto.

This resource comprises four volumes of newly written material that has more than 1, 200 entries which are cross-referenced and fully indexed. The enyries provide a broad interpretation of science that covers traditional subjects as well as new sciences. There are, for instance, entries on the well known figures such as Charles Darwin and Michael Faraday, but also many not previously mentioned in such reference works including Lousia Clark, William Halse Rivers and Ronald Triman. (The mention of those names should make you want to rush off and consult a copy of this dictionary.) Ecah entry contains a biography, critical assessment and a primary and secondary bibliography.

Now comes the rub. With four volumes and a restricted purchasing base the set of four books costs a whopping £750.

You can check out more details at:
www.theommes.com/dictionaries/science_dic.htm

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