# Pioneers of Science Education


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In this series I will look at some of the pioneers of science education, either in terms of pedagogy, curriculum development or science education research. Some of them have an Irish connection, but all have had an influence on the teaching and learning of science in Ireland. In PoSE #1 we looked at Maria Edgeworth, who was a friend of Jane Marcet (PoSE #3), and in PoSE #2 at Richard Dawes, a pioneer of child-centred science in context. In PoSE #3 we looked at the life of Mrs Jane Marcet, one of the earliest popularisers of science, especially for women. Last time we looked at the work of James Wilson (PoSE #4), who pioneered science in English public schools, and served with Thomas Huxley on the BAAS committee on science education in schools.

## #5 Thomas Henry Huxley (1825-1895 ): propagandist for science

### Introduction

Thomas Huxley is best known as 'Darwin's Bulldog' for his vigorous defence of evolution and dissemination of Darwin's ideas in the late 19th century. We could justifiably describe Huxley as the Richard Dawkins of his day but he was known for much more than his anti-Christian polemic. In the second half of the 19th century Huxley was also a propagandist for the role of science in education, both at school and at university. He campaigned to make science a core subject in schools and to have an equal place at university level along with classics and mathematics. His advocacy for science complemented the work of James Wilson on behalf of science in the public schools (PoSE #4), but Huxley was more prominent in public life and strode a larger stage. Huxley was the pre-eminent public scientist in the late 19th century. This article will focus on his work to promote science education, evidenced by the essays and talks in his book *Science and Education*, rather than on his work as a scientist and as a promoter of Darwinism. Of all our Pioneers of Science Education, Thomas Huxley is probably the person with the largest literature, both of his own voluminous writings (9 volumes of *Essays*) and of people writing about him. The book that focuses most on his educational work is the biography by Cyril Bibby, *T H Huxley: Scientist, humanist and educator* (Bibby, 1959). Table 1 shows the main dates in his life. When Huxley started his career as a lecturer and researcher in 1854, education at all levels in Britain was dominated by the church (mainly the Church of England), which controlled the schools and universities, the curriculum and provided many of the teachers and lecturers, and science was largely the province of amateurs. When Huxley died this was no longer the case and science had become a respected and independent profession and the control of the church over education had largely gone.

**Table 1: Dates in T.H. Huxley's life**

| | |
|---|---|
| 1825 | Born 4th May in Ealing to George Huxley and Rachel Huxley (nee Withers) |
| 1841-45 | Medical education in London |
| 1846-1850 | Voyage of the *Rattlesnake* as Assistant-Surgeon |
| 1851 | Fellow of the Royal Society |
| 1852 | Royal Society - Gold Medal |
| 1854 | Struck off the Navy List and appointed at the Royal College of Mines, Jermyn Street |

| | |
|---|---|
| 1864 | Founder member of the x Club. |
| 1866 | Published *Lessons in Elementary Physiology* |
| *1875* | Published *A Course of Practical Instruction in Elementary* Biology (with H.N. Martin |
| 1876 | Geological Society of London - Wollaston Medal |
| 1878 | Published *Physiography: An Introduction to the Study of Nature* |
| 1885 | Retired (but remained as Professor and Dean of Science until his death) |
| 1888 | Royal Society – Copley Medal |
| 1890 | Linnean Society of London - Linnean Medal |
| 1894 | Royal Society – Darwin Medal |
| 1895 | Died 29th June at Eastbourne |

## Early life: 1825-1854

Huxley's father was a failed schoolmaster in Ealing and Thomas was the 7th of 8 children. He had only 2 years of formal schooling and he was largely self-taught, reading widely and voraciously, a habit he kept up for life. He spent 3 years as a medical student, winning prizes in chemistry, anatomy and physiology. Failing to get a full-time medical appointment he joined the Royal Navy as an Asst. Surgeon on H.M.S. Rattlesnake, in her voyage of exploration to the Antipodes (1846-1850). This was to change the whole course of his life and like Charles Darwin and Joseph Hooker before him, this experience as a naturalist on a voyage to unexplored regions, with strange animals and plants, made him into a scientist rather than a doctor. On this voyage he made his first forays into scientific research, published his first papers, and met his future wife, Henrietta Heathorn, in Sydney. Thomas put in 8 years hard labour before he was able to marry Henrietta in 1854, having obtained his first permanent teaching post in London and enough money to live on. His research work was enough to have him elected a Fellow of the Royal Society in 1851 and in 1852 he was awarded their Gold Medal, their highest honour, especially for a young and relatively unknown scientist.

**Figure 1: Huxley as a young man aged 32**

## His career in science: 1854-1885

In the years between returning from the voyage and finding a job, Huxley almost despaired of finding a job and earning enough money to marry. He wrote to his fiancée: *"A man of science may earn great distinction, but not bread. He will get invitations to all sorts of dinners and conversaziones, but not enough income to pay his cab fare." (*Bibby, 1859, p. 10). Having resigned his commission in the Navy, he tried for academic jobs in Sydney, Toronto, Aberdeen, Cork and King's College, London but with no success. Eventually in 1854 his friend Edward Forbes moved to Edinburgh and offered Huxley a Professorship in Natural History and Palaeontology at the Royal College of Mines in Jermyn Street, London. In those days a Professorship meant being appointed to give a certain number of lectures a year, rather than a full-time appointment or a head of department. In addition Huxley gave lectures at the School of Art and at the Royal Institution, each bringing in its own emolument, so that at last Huxley had enough income to be able to get married to his long-suffering Australian fiancée. Huxley was to stay in London, essentially in the same place, until he retired early due to ill-health in 1885, even though in later years he was offered more prestigious posts elsewhere, including Oxford. The last 10 years of his life were marked by poor health, although he remained quite active as a speaker and writer, but not with the same intensity as before. Huxley made major contributions to biology in the area of comparative anatomy and to palaeontology, as well as frequent forays into philosophy and theology. He loved being controversial and demolishing weak arguments, but he seems to have remained on good terms with his opponents and he was an excellent committee member. Whenever the Government needed someone for a scientific commission they asked Huxley and he was on ten Royal Commissions, as well as committees for the British Association for the Advancement of Science (BAAS). The Commissions included the Royal Commission on Scientific Instruction and the Advancement of Science (1870-75), the *Commission on the Royal College of Science for Ireland* (1866) and the *Commission on Science and Art Instruction in Ireland* (1868).

## Educational work

Huxley's educational activities were manifold but we can discuss them by their target audiences. He had a finger in almost every educational pie to do with scientific or technical education in the second half of the 19th century, from elementary to university education.

a) **Elementary and secondary education**

Huxley campaigned to have science accorded a firm place in school education, from the earliest years and at all levels. Up until the mid 19th century the school curriculum was dominated by the classics, with a little mathematics (see PoSE #4). Various Royal Commissions and the BAAS Committee Report of 1867 made the case that science should be included in the secondary curriculum and Huxley supported this wholeheartedly. He was a governor of Eton College from 1879-88, where he ensured that science, particularly biology, was fostered.

He criticised the quality of education at school in his 1869 essay in *Science and Education* on 'On scientific education' (Huxley, 1895,116-117), as a preparation for the study of medicine. *"A young man commencing the study of medicine is at once required to endeavour to make an acquaintance with a number of sciences, such as Physics, as Chemistry, as Botany, as Physiology, which are absolutely and entirely strange to him, however excellent his so-called education at school may have been. Not only is he devoid of all apprehension of scientific conceptions, not only does he fail to attach any meaning to the words "matter," "force," or "law " in their scientific senses, but, worse still, he has no notion of what it is to come into contact with Nature, or to lay his mind alongside of a physical fact, and try to conquer it, in*

*the way our great naval hero told his captains to master their enemies. His whole mind has been given to books, and I am hardly exaggerating if I say that they are more real to him than Nature. He imagines that all knowledge can be got out of books, and rests upon the authority of some master or other; nor does he entertain any misgiving that the method of learning which led to proficiency in the rules of grammar will suffice to lead him to a mastery of the laws of Nature. The youngster, thus unprepared for serious study, is turned loose among his medical studies, with the result, in nine cases out of ten, that the first year of his curriculum is spent in learning how to learn. Indeed, he is lucky if, at the end of the first year, by the exertions of his teachers and his own industry, he has acquired even that art of arts."*

In the same essay he makes the case for science for all, boys and girls, but not just science.

*"The next question to which I have to address myself is, What sciences ought to be thus taught? And this is one of the most important of questions, because my side (I am afraid I am a terribly candid friend) sometimes spoils its cause by going in for too much. There are other forms of culture beside physical science; and I should be profoundly sorry to see the fact forgotten, or even to observe a tendency to starve, or cripple, literary, or aesthetic, culture for the sake of science. Such a narrow view of the nature of education has nothing to do with my firm conviction that a complete and thorough scientific culture ought to be introduced into all schools. By this, however, I do not mean that every schoolboy should be taught everything in science. That would be a very absurd thing to conceive, and a very mischievous thing to attempt. What I mean is, that no boy nor girl should leave school without possessing a grasp of the general character of science, and without having been disciplined, more or less, in the methods of all sciences; so that, when turned into the world to make their own way, they shall be prepared to face scientific problems, not by knowing at once the conditions of every problem, or by being able at once to solve it ; but by being familiar with the general current of scientific thought, and by being able to apply the methods of science in the proper way, when they have acquainted themselves with the conditions of the special problem."* (*ibid*, p. 122)

He went for election to the newly constituted London School Board in 1870, which was part of the reorganisation of elementary education, and while on the Board he was able to contribute in a major way to defining the elementary school curriculum. Huxley wanted science to be taught to all from the beginning and in a famous phrase:

"A *comprehensive scheme*, *indeed*, *would involve* an *educational ladder from the gutter to the university*, *whereby children* of *exceptional ability might reach the place for which nature had fitted them."* (Bibby, 1959, 157)

Not content just to sit on committees he also gave lectures to school children, which became a course of science based on physical geography, which he called Physiography, later published as a book in 1878 (*Physiography*) and widely used an elementary textbook. He also wrote other successful and influential textbooks: *Lessons in Elementary Physiology* (1866) and *A Course of Practical Instruction in Elementary* Biology (1875, with H.N. Martin).

### b) **University and higher education**

*"In an ideal University, as I conceive it, a man should be able to obtain instruction in all forms of knowledge, and discipline in the use of all the methods by which knowledge is obtained. In such a University, the force of living example should fire the student with a noble ambition to emulate the learning of learned men, and to follow in the footsteps of the explorers of new fields of knowledge. And the very air he breathes should be charged with that enthusiasm for truth, that fanaticism of veracity, which is a greater possession than much learning; a nobler gift than the power of increasing knowledge; by so much greater and nobler than these, as the moral nature of man is greater than the intellectual; for veracity is the heart of morality."* (Huxley, 1895, 204-205)

Huxley's vision for the future not only saw the enhanced role for science and technology but also the role of the university as a centre for research and not just teaching, for scholarship in its widest sense. He said this: *"The medieval university looked backward: it professed to be a storehouse of old knowledge, and except in the way of dialectical cobweb-spinning, its professors had nothing to do with novelties .. The modern university looks forward, and is a factory of new knowledge: its professors have to be at the top of the wave of progress. Research and criticism must be the breath of their nostrils."* (Huxley, L. 1900, vol. 2, 309) What he describes is the blueprint of a modern university, rather than that of their old role of producing clergymen.

He played a key role in getting science accepted as a *bona fide* subject in the old universities of Oxford and Cambridge, in the new red brick universities, and in getting the City and Guilds to finance their own higher education colleges in London, and in getting London University established with a federal structure. He also made sure that biology (or physiology) became a university subject, often taught by his old students, rather than separate botany and zoology, the traditional biological subjects.

c) **Technical education**

Technical education for the growing army of technicians needed by the industrial revolution was a neglected area in late 19th century education. The upper and middle classes had their public and grammar schools, and universities, but there was no provision for technical education. This was intended to be the role of the City and Guilds Colleges in London (Finsbury College and the Central Institution at South Kensington started in 1881 as a result of Huxley's sustained lobbying), but it was hard to convince employers to send their employees for training or to see the need for hiring trained people. Huxley saw that technical education must start with a good, broad general education (including science) before becoming more hands-on training in specific technical areas.

*"Well, but, you will say, this is Hamlet with the Prince of Denmark left out ; your 'technical education' is simply a good education, with more attention to physical science, to drawing, and to modern languages than is common, and there is nothing specially technical about it. Exactly so ; that remark takes us straight to the heart of what I have to say ; which is, that, in my judgment, the preparatory education of the handicraftsman ought to have nothing of what is ordinarily understood by 'technical' about it." (Huxley, 1895, p. 411-412)*

d) **Popular and informal education**

Huxley believed that the working man had a right to education and to learn about the latest discoveries. Throughout his life he gave lectures to the public on many topics and in many places. One of his most famous essays was 'On a piece of chalk' given to an audience of workmen in 1868 at the BAAS meeting in Norwich and published in *Macmillan's Magazine.* (Huxley, 1868)

Huxley was a prolific essayist and he wrote essays for many publications, like the *Nineteenth Century* and *Macmillan's Magazine*, which reached the literate middle and upper classes. In1894 Andrew Lang remarked (quoted in Irvine, 1960, p. 18) *"In England when people say 'science' they commonly mean an article by Professor Huxley in the Nineteenth Century."* Many of these essays were collected in his nine volumes of *Essays*, anthologised under various headings like *Science and Education* (vol. III) and *Evolution and Ethics* (vol. IX). (All of these can now be freely accessed online.)

e) **Undergraduate education as a teacher**

**Figure 2: Huxley as a teacher with a drawing of a gorilla skull ca 1870**

One tends to forget that Huxley's main job was as a university teacher and each year he gave series of lectures in different institutions. He took great care over the preparation of his lectures, which were illustrated by his own drawings and on the blackboard. He also started a series of yearly summer schools for biology teachers in 1871 in The Normal School of Science, given alongside lectures in Physics and Chemistry (by H.E. Armstrong, PoSE #7). These were given at Jermyn Street, and later in South Kensington, to prepare the teachers to teach science in schools the Huxley way. Among those he taught was H.G. Wells, who went on to be a writer rather than a teacher but who was greatly influenced by Huxley's teaching and philosophy. Huxley's own research students at Jermyn Street acted as demonstrators and many of these went on to distinguished academic careers. Henry Fairfield Osborn, an American scientist, gives an account of Huxley as a teacher (Osborn, 1925).

*"Huxley as a teacher can never be forgotten by any of his students. entered his lecture-room promptly as the clock was striking nine, rather quickly and with his head bent forward "as if oppressive with its mind." usually glanced attention to his class of about ninety and began speaking before he reached his chair. He spoke between his lips, with perfectly clear analysis, with thorough interest, and with philosophic insight which was far above the average of his students. He used very few charts, but handled the chalk with great skill, sketching out the anatomy of an animal as if it were transparent object. As in Darwin's face, and as in Erasmus Darwin's, Buffon's, and many other anatomists with a strong sense of form, his eyes were heavily overhung by a projecting forehead and eyebrows and seemed at times to look inward. His lips were firm and closely set, with the expression positiveness, and the other feature which most marked him was the very heavy mass of hair falling over his forehead, which he would frequently stroke or toss back. "*

f) **Committee work**

Huxley became from the 1860s onwards the go-to person for government committees and commissions with a scientific or educational emphasis, and he seems to have been incapable of saying no to such invitations. This resulted in a considerable overload on top of his teaching, research and writing, and he increasingly suffered from ill-health and had to take

frequent breaks from London. He was a member at one time or another of ten Royal Commissions and many other committees. This work cannot be overestimated as Huxley stamped his views on many areas of science, education and public life. He sat on the

## Conclusion

How do you sum up a life so rich and varied as Huxley's, even in just the one field of education, out of the many he was involved in? Huxley was larger than life and greater than his own country or his own century. Box 1 summarises some of his educational achievements. He also helped establish science as a reputable and salaried profession, rather than being the province of dilettante amateurs.

**Box 1: Major educational activities**

Pioneered adult popular education and promoted technical education.

Member of the London School Board (1870) and helped set the future course of elementary education in Britain.

Helped introduce better science teaching into public schools and secondary schools, through membership of committees, Royal Commissions and as governor of Eton College.

Helped transform Oxford and Cambridge universities into modern universities, and helped establish the University of London as a federal institution.

The prime mover in establishing Imperial College of Science and Technology.

Through his lectures, essays and books promoted the public understanding of science.

Helped give the new national examination system credibility.

Wrote influential textbooks in science and Biology.

Promoted a balanced view of education at school between the classics and the modern subjects like science.

Effectively created the subject of Biology for study in schools and universities and helped train a cohort of teachers to teach it.

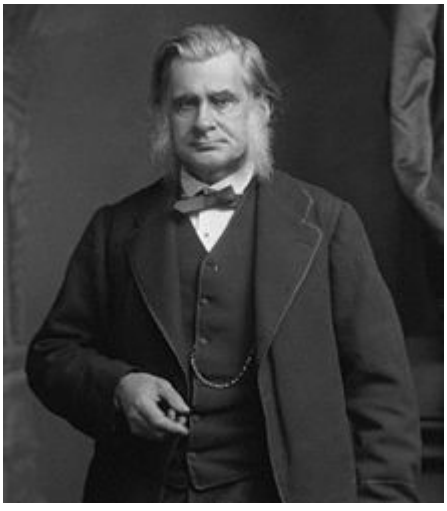

**Figure 3: Huxley in 1883 just before retirement**

His great-grandson, the writer Aldous Huxley, said about T.H. Huxley regarding his educational work (Bibby, 1959, p.xi-xii):
*"Astonished, first of all, by Huxley's extradordinary capacity for work and by his no less extraordinary skill in persuasion, diplomacy and the art of overcoming initial inertia. And astonished even more by the extraordinary up-to-dateness of his views on education. Thius, we find him lecturing the classicists on the importance of science, and in the next breath lecturing the scientists on the importance of the humanities and a training in art and music. We find him anticipating John Dewey in his insistence upon the value of learning through doing and observing, in his denunciation of 'mental debauchery, book guzzling and lesson bibbing'; but we find him anticipating the critics of 'Progressive Education' in his equally emphatic insistence upon the necessity of a thorough and accurate teaching of fundamentals. We find him agreeing with the 'we-teach-children-not-subjects' school of educators to the extent of regarding 'will, energy and honesty' as no less important than knowledge; but we find him sharply disagreeing with them in proclaiming that knowledge of subjects is at least as important as 'life adjustment' or a 'well-rounded personality'."*

Irvine comments (1960, p.19): *"Huxley was superbly endowed for the academic life. Brilliant teachers are not always brilliant investigators. Professors who are brilliant in both teaching and research seldom have much time for administration and educational policy. Huxley's enormous energy enabled him to be brilliant and creative in all three fields, and at the same time actually to look beyond the destiny of his own science and that of all the science and education in Great Britain."*

This article has merely scratched the surface of Huxley's life as a science educator and his influence remains today in many areas of British education. His influence was enhanced by his remarkable abilities as a public speaker and as an essayist (see Box 2, Quotable quotes), and he was one of the most widely read of 19$^{th}$ century authors, never mind scientists.

Despite his work to popularise Biology as a school and university subject, it never really took off in his lifetime and it was not until the 1930s that Biology secured its place in the school curriculum over against Chemistry and Physics, and its precursors, Botany and Zoology. (Jenkins, 1979; Goodson, 1993) Huxley did important work to make both school botany and zoology more systematic, but his reputation as polemicist against organised religion did not help the cause of zoology, which declined after 1900. Jenkins (1979, p. 111) comments: *"The decline may also have been indicative of a mounting antagonism to the ideas of Huxley who had become well-known, even notorious, as an agnostic, evolutionist and ardent supporter of vivisection."*

Huxley's main legacy was probably his disciples, trained under his hand, and spreading out to spread the Huxleyan gospel in universities in England and abroad.

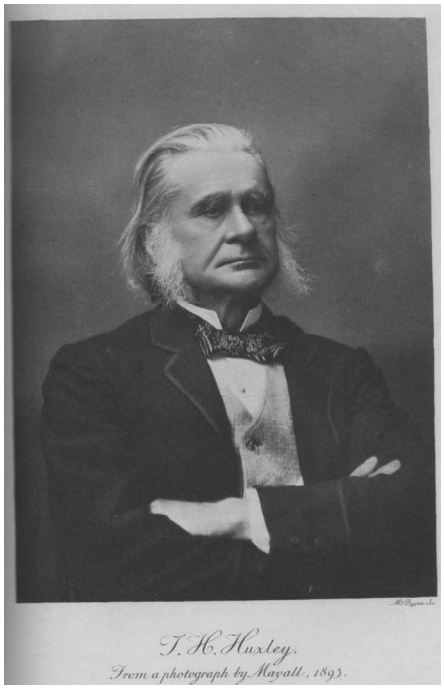


**Figure 4: Huxley near the end of his life (1893)**

**Box 2: Quotable quotes of T. H. Huxley**

*Agnosticism is of the essence of science, whether ancient or modern. It simply means that a man shall not say he knows or believes that for which he has no grounds for professing to believe.*
In *Life and Letters of Thomas Henry Huxley* (1913), Vol. 3, 98, footnote 2.

*Every truth starts life as a heresy and ends life as an orthodoxy.*
*Extinguished theologians lie about the cradle of every science, as the strangled snakes beside that of Hercules; and history records that whenever science and orthodoxy have been fairly opposed, the latter has been forced to retire from the lists, bleeding and crushed if not annihilated; scotched, if not slain.*
*Darwiniana: Essays* (1896), 52.

*For every complex problem, there is a solution that is simple, neat, and wrong.*
*I really see no harm which can come of giving our children a little knowledge of physiology. ... The instruction must be real, based upon observation, eked out by good explanatory diagrams and models, and conveyed by a teacher whose own knowledge has been acquired by a study of the facts; and not the mere catechismal parrot-work which too often usurps the place of elementary teaching.*
*Science and Culture* (1882), 92

*Science is, I believe, nothing but trained and organised common-sense, differing from the latter only as a veteran may differ from a raw recruit; and its methods differ from those of common-sense only so far as the guardsman's cut and thrust differ from the manner in which a savage wields his club.*
Lecture at St. Martin's Hall (22 Jul 1854), printed as *On the Educational Value of the Natural History Sciences* (1854), 12.

*Science seems to me to teach in the highest and strongest manner the great truth which is embodied in the Christian conception of entire surrender to the will of God. Sit down before fact as a little child, be prepared to give up every preconceived notion, follow humbly wherever and to whatever abysses nature leads, or you shall learn nothing. I have only begun to learn content and peace of mind since I have resolved at all risks to do this.*
Letter to Charles Kingsley (23 Sep 1860). In L. Huxley, *The Life and Letters of Thomas Henry Huxley* (1903), Vol. 1, 316.

*Some experience of popular lecturing had convinced me that the necessity of making things plain to uninstructed people, was one of the very best means of clearing up the obscure corners in one's own mind.*
'Preface'. In Man's Place in Nature and Other Anthropological Essays. *Collected Essays* (1894), Vol. 7, Preface, ix.

*The investigation of nature is an infinite pasture-ground where all may graze, and where the more bite, the longer the grass grows, the sweeter is its flavour, and the more it nourishes.*
From Address to the Members of the Midland Institute, 'Administrative Nihilism', printed in *The Fortnightly* (1871), New Series **10**, 540.

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