Pioneers of Science Education

Peter E. Childs

Emeritus Senior Lecturer, Dept. Of Chemical Sciences, University of Limerick, Limerick, Ireland
peter.childs@ul.ie

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.

2. Rev. Richard Dawes (13/4/1793-10/3/1867) 'The science of common things'

Introduction

It is important to realise that science as a university subject and as a school subject is less that 200 years old and it was only in the second half of the 19th century that science took its place in the curriculum, after a hard-fought fight for recognition. It is interesting that the initial inroads of science into the curriculum took place in elementary (primary) schools, up to age 14, rather than in secondary schools. Layton (1973) describes the history of this in England, where there were a number of independent educational innovators, like Charles and Elizabeth Mayo (object lessons) and Richard Dawes. Dawes, an Anglican clergyman, successfully introduced the 'science of common things' to the rural poor in his parish of King's Somborne. This was an early example of context-based learning. Science not only had to fight for a place in the school curriculum, at all levels, but there was also a battle for the type of science education that would be taught. The United Kingdom in the 19th century, which included Ireland, was a class-ridden society, with massive differences between rich and poor, and education of any sort was largely the preserve of the middle and upper classes.

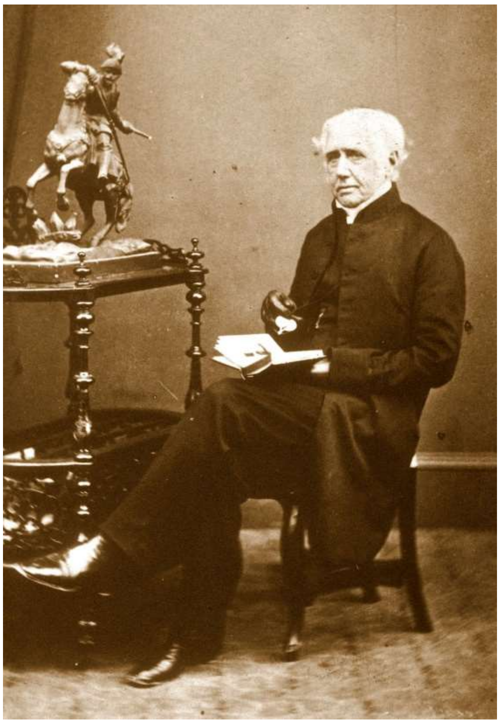


Figure 1: Dean Dawes in later life at Hereford
By courtesy of the Dean and Chapter of Hereford Cathedral

One of the unsung pioneers of elementary (primary) science education in England was the Rev. Richard Dawes (1793-1867), an Anglican clergyman. He was born in N. Yorkshire in 1793 and part of his education was with the blind mathematician Mr Gough at Kendal, in Cumbria, who also taught John Dalton. William Whewell (later well-known as a philosopher of science) was a pupil at the same time. Dawes entered Trinity College, Cambridge and graduated in Mathematics in 1817. He was elected a Fellow of Downing College in 1818 as a tutor in Mathematics and College Bursar. In 1836 he was a candidate for the Mastership (head of the college) but his liberal views on the admission of dissenters to the University (non-Anglicans) meant he was blackballed. It was an indication of his radical social views. He did no original scientific research but in Cambridge he associated with scientists and mathematicians, such as Henslow, Sedgwick, Romilly and Whewell. Dawes had been ordained in 1818, in common with most Oxford and Cambridge graduates of the day. He married Mary Helen Gordon in 1836 and after his rejection for the Mastership, left Cambridge to go into the parish ministry, first in Tadlow, Bedfordshire and then as Rector of King's Somborne in Hampshire. Cambridge's loss was the great gain of the children of his parish in King's Somborne and the cause of science education for all.

Educational initiatives

King's Somborne was a poor rural parish of around 1,100 people but with no elementary (primary) school. With great energy Dawes set about providing a school and an education suitable for the masses, although he had no prior interest or expertise in elementary education, as far as we know. In October 1842 he established a school for local children, investing £500 of his own money in the building, which still stands today as the local Church of England Primary school (see Figure 2). However, one of his aims was to make the school self-sufficient on the basis of pupil fees and later also government grants, so it was not a drain on the parish. His model of education was so successful that the local people, both labourers and farmers, were willing to pay the fees and buy school books, because of the value they saw for their children. He aimed to educate all the children of the parish and at first there was resistance from the farmers to having their children taught with the children of the labouring class. Dawes convinced them of the benefits of his school and that it would save them money to send their children there. The school was a great success in all respects and later the building was extended with the provision of a room equipped as a laboratory, one of the first in an English school.

Figure 2: King’s Somborne primary school today (http://www.King’ssomborne.hants.sch.uk/)

Richard Dawes’ curriculum on the ‘Science of Common Things’ (1842-1862) is an interesting example of a failed educational experiment. In the first half of the 19th century there were several small-scale, local and private attempts to introduce science into the elementary schools for the working classes. At this time education was largely the preserve of the middle and upper classes, with a traditional model of education based on the classics and mathematics, with didactic teaching and rote learning. The most successful experiment to bring science to the masses was that of the Rev. Richard Dawes in his rural parish of King’s Somborne (Ball, 1964; Layton, 1972; Layton, 1973; Hodson, 1987). He introduced a science teaching scheme focusing on the pupils’ everyday lives, which he called ‘The Science of Common Things.’ This was ‘science in context’ over a century before the context-based science projects of the 1980s. The scheme was holistic, including all aspects of the person (ears, eyes, hands, minds and hearts) but was destroyed by its own success and was effectively stopped in 1862, when science was effectively eliminated from English elementary schools until 1882. Dawes used secular science reading books sourced from the Commission of National Education in Ireland, and drew inspiration from the pupils’ everyday lives and occupations. The course involved them in scientific experimentation, as well as watching demonstrations. Dawes *“..provided a rich variety of illustrations of scientific knowledge applied in situations which were meaningful and relevant to them. His pupils were required to act on physical materials and participate in experimental inquiries in an environment which provided opportunities for discussion between children and teacher. In short, many of the conditions which modern research would suggest are necessary for the successful acquisition of abstract scientific knowledge by children were being fulfilled.”* (Layton, 1973, p. 171)

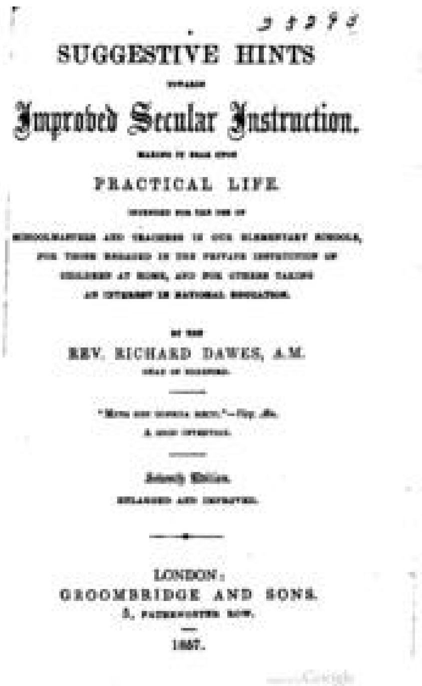
His views on education sound very modern and enlightened.
“The declared goals of the Science of Common Things were the general intellectual development of children, the improvement of reading skills, the acquisition of scientific

knowledge related to the child's immediate environment, and the provision of experience for the exercise of reason, speculation and imagination." (Hodson, 1987, p. 165)

Richard Dawes described his work in King's Somborne in several books, particularly *Suggestive Hints for Improved Secular Instruction* (1847), which went through 7 editions in 10 years (Figure 3). This alone must have had a lasting effect on the way science was taught, as it was full of useful ideas. From the introduction to the 7th edition Dawes gives a plea for improved scientific knowledge for the lower classes, his rationale for an improved form of secular education:

"Hitherto all classes seem to have taken for granted, that the labouring part of the community had no business with anything where the mind is concerned ; but why should not the miner, whose life may have been saved over and over again by the safety-lamp of Sir Humphrey Davy, know something of the principle to which he owes his safety, and of the philosophy of it—many of the accidents which occur from mere carelessness would be avoided by it ; or the plumber, whose business it is to make a pump, be taught, however much the sense of sight may mislead him, that air and gaseous substances, which he cannot see, have weight, and that these and fluid substances press equally in all directions, and he will then understand why his mechanism succeeds, and the water rises, which, without some knowledge of this kind, must appear to him a kind of witchcraft ; or why should not the labouring classes have it shown to them during their education at school, that the burning of charcoal, or of chalk and lime- stone into lime, &c., gives rise to a kind of substance which they cannot see, but when breathed into the lungs is fatal to animal life, and its being heavier than common air makes the burning of charcoal in small rooms a very dangerous thing. From a want of a knowledge of this, many lives have been lost."

(Dawes, 1857, p.xviii)


SUGGESTIVE HINTS

Improved Secular Instruction.

PRACTICAL LIFE.

REV. RICHARD DAWES, A.M.

LONDON:
GROOMBRIDGE AND SONS.

1857.

Figure 3: Title page of Suggestive Hints for Improved Secular Instruction (3rd edition available online at: https://ia601203.us.archive.org/19/items/suggestivehintst00dawe/suggestivehintst00dawe.pdf)

Richard Dawes' aims were explained as follows:

"…what may be called the philosophy of common things of everyday life. They were shown how much there is that is interesting, and which it is advantageous for them to know, in

connection with the natural objects with which they are familiar; they had explained to them, and were made acquainted with, the principles of a variety of natural phenomena, as well as the principles and construction of various instruments of a useful kind. A practical turn was given to everything the uses and fruits of the knowledge they were acquiring were never lost sight of."

"It may surprise some who read carefully the above list that such subjects should have been taught to the children of a rural elementary school. But it is an undeniable fact that they were taught in King's Somborne School, and so successfully that the children were both interested and benefited by the teaching. Mr. Dawes, in answer to the objection that such subjects are above the comprehension of the young, said:—

'The distinguishing mark of Nature's laws is their extreme simplicity. It may doubtless require intellect of a high order to make the discovery of these laws; yet, once evolved, they are within the capacity of a child,—in short, the principles of natural philosophy are the principles of common sense, and if taught in a simple and common-sense way, they will be speedily understood and eagerly attended to by children; and it will be found that with pupils of even from ten to twelve years of age much may be done towards forming habits of observation and inquiry.' Such a fact, I think, suggests some valuable practical lessons for those who have the responsibility of deciding what subjects to include in an educational system for children."

Quoted in http://thecommonroomblog.com/2015/02/early-science-lessons-the-charlotte-mason-way.html

The content of what he taught can be seen in Box 1 and this represents an ambitious science curriculum.

Later career

Richard Dawes became well-known because of his educational activities and this led to him being appointed as Dean of Hereford Cathedral in 1850, where he remained to the end of his life in 1867. He continued his educational interests in Hereford, working with the Blue Coat Schools and Ledbury national schools. When he revisited King's Somborne several years after he had left, he was welcomed back by the whole village, some of the farmers who had initially opposed his school, as they didn't want their children educated with those of their labourers, and expressed their views that the school had been of great value to the community.

In 1864 he was appointed Vice-President of the British Association for their meeting in Bath. While at King's Somborne he became friends with Edward Franklin and John Tyndall, who were teaching at the nearby Queenwood School, and who both went on to become distinguished scientists and Professors at the Royal Institution in London. Dawes kept up his friendship with them until his death. He is buried in Hereford Cathedral in an impressive tomb (Figure 4).


**Figure 4: Detail of Richard Dawes' effigy in Hereford Cathedral.
By courtesy of the Dean and Chapter of Hereford Cathedral**

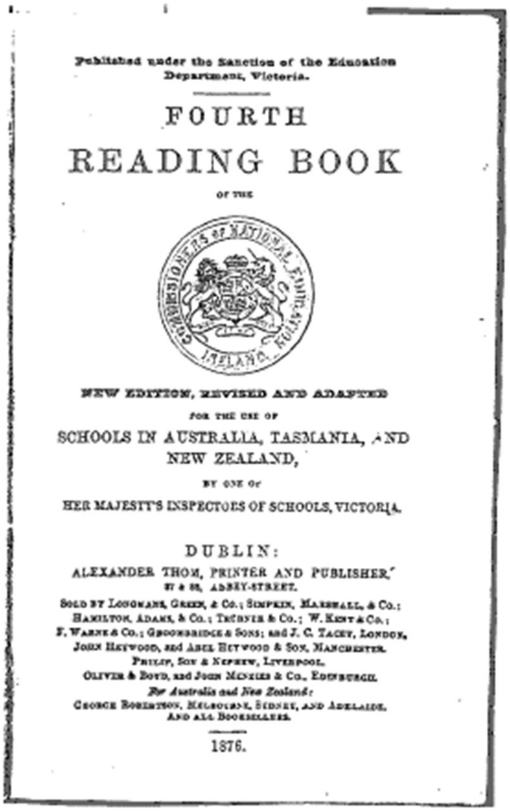
The Irish connection

Until Dawes, elementary education, Protestant and Catholic, was firmly based on the ability to read the Bible and be grounded in religious truths. Richard Dawes broke this tradition by emphasising secular education, including science, technology, history and geography, as well as reading and arithmetic, without neglecting a study of the Scriptures. He used secular reading books and he found the most suitable ones were those produced by the Irish Commissioners for National Education and printed in Ireland. Hundreds of thousands of these were sold and used in elementary schools because of the influence of Dawes and the support of Henry Moseley. They were also adapted and used in Australia and New Zealand (Figure 4).

Layton (1993) has an interesting description of the use and content of these reading books. *"In the first four books, the science content was largely confined to descriptive natural history, although this is precise and frequently quantitative. For example, the account of the blackbird in Book 2 stated that the male "is in length about eleven inches and weighs about four ounces". Its song is "delightful in the woods" but is "rather too strong for a room". It "feeds on insects and caterpillars, and is very fond of fruit". In addition to twenty-two similar natural history readings in Book 3, this volume also contained a series of six lessons on manufactures of glass, silk, flax and hemp, paper, salt and pins. By Book 5, the major part of the contents (212 pages out of 354) was given over to scientific matter, organised in sections headed physical geography and geology; physiology, vegetable and animal; and natural philosophy including astronomy, hydrostatics, pneumatics, optics, electricity and chemistry. The Irish reading lesson books were frequently reprinted and in use throughout most of the century, though with little attempt to incorporate advances in scientific knowledge. The account of caloric in a copy of the Fifth Book dated 1859 stated that "The nature of caloric is not yet well understood, it still being doubtful whether it is a material substance, or a mere property of matter. It is generally regarded, however, as a fluid of great tenuity which pervades the whole system of nature." Untouched by the work of scientists like Rumford and Joule, an identical expression of doubt about caloric's nature is found, word for word, in a copy dated 1872."*

"Some of the properties of air, explaining how its pressure enables them to pump up water, to amuse themselves with squirts and popguns, to suck up water through a straw; explaining also the principles and construction of a barometer, the common pump, the diving-bell, a pair of bellows. That air expands by heat, shown by placing a half-blown bladder near the fire, when the wrinkles disappear. Why the chimney-smoke sometimes rises easily in the air, sometimes not. Why there is a draught up the chimney, and under the door, and towards the fire. Air as a vehicle of sound, and why the flash of a distant gun fired is seen before the report is heard; how to calculate the distance of a thunderstorm; the difference in the speeds at which different materials conduct sound. Water and its properties, its solid, fluid, and vaporous state; why water-pipes are burst by frost; why ice forms and floats on the surface of ponds, and not at the bottom; why the kettle-lid jumps up when the water is boiling on the fire; the uses to which the power of steam is applied; the gradual evolution of the steam engine, shown by models and diagrams; how their clothes are dried, and why they feel cold sitting in damp clothes; why a damp bed is so dangerous; why one body floats in water, and another sinks; the different densities of sea and fresh water; why, on going into the school on a cold morning, they sometimes see a quantity of water sitting on the glass, and why on the inside and not on the outside; why, on a frosty day, their breathe is visible as vapour; the substances water holds in solution, and how their drinking water is affected by the kind of soil through which it has passed. Dew, its value, and the conditions necessary for its formation; placing equal portions of dry wool on gravel, glass, and the grass and weighing them the next morning. Heat and its properties; how it is that the blacksmith can fit iron hoops so firmly on the wheels of carts and barrows; what precautions have to be taken in laying the iron rails of railways and in building iron bridges, &c., what materials are good, and what bad, conductors of heat; why at the same temperature some feel colder to our touch than others; why a glass sometimes breaks when hot water is poured into it, and whether thick or thin glass would be more liable to crack; why water can be made to boil in a paper kettle or an eggshell without their being burned. The metals, their sources, properties, and uses; mode of separating from the ores. Light and its properties, illustrated by prisms, &c.; adaptation of the eye; causes of long and short-sightedness. The mechanical principles of the tools more commonly used, the spade, the plough, the axe, the lever, &c. The animals, wild and domesticated, of their district, their structure, habits, covering, manner of feeding and moving and of rising from the ground, which ruminants and which not, and the differences in their jaws and teeth of feeders on animal and vegetable food. The birds of the district, their shape and size and habits; times of migrating and return; kind of food they live on; the air cells in their bones so beautifully adapted to the purposes of flight; how their feathering serves for maintaining warmth and life; the differences in the feet of water-birds and of those that roost. Plants and flowers brought to the school and examined; the names of the different parts and the function which each part performs; the nature of the root, whether bulbous, fibrous, or tap-rooted; the uniformity in number of the petals, stamens, pistils, &c., running through the same class of plants; shapes of the leaves; soils and situations most favourable. The trees and the differences in their external appearance, leaves, bark, texture of the wood, value and uses as timber; which deciduous and which evergreen. The materials used in building and furnishing their houses, whence obtained and how prepared. Their clothing and its materials, which vegetable, which animal; the comparative value and suitableness of different materials for different purposes, specimens of each being shown. Articles of food, whence obtained, how prepared; their dietetic properties and values; the history of a cottage-loaf. A barometer and thermometer were hung up, and readings regularly taken by the children, the weekly and monthly averages being made an exercise of their arithmetic. The structure of the solar system; the different movements of the earth and their effects; whether a body at the equator would weigh less or more than at the poles; why the lark soaring in the sky does not find the field in which she has placed her nest moved from under her by the rotation of the earth on its axis; they were taught to notice the points of the compass where the sun rises and sets at different parts of the year, and the varying lengths of shadows cast at noon according to its altitude; the reason of the increase and decrease in the length of days; the divisions of time, which natural, which conventional. A geological map was hung in the room from which they learned which were agricultural, which mineral districts, and how the relative number of towns and population and the character of the industries are thereby affected."

Box 1 The content of Richard Dawes' science scheme



Published under the Sanction of the Education Department, Victoria.

FOURTH
READING BOOK
OF THE

NEW EDITION, REVISED AND ADAPTED
FOR THE USE OF
SCHOOLS IN AUSTRALIA, TASMANIA, AND NEW ZEALAND,
BY ONE OF
HER MAJESTY'S INSPECTORS OF SCHOOLS, VICTORIA.

DUBLIN:
ALEXANDER THOM, PRINTER AND PUBLISHER,
87 & 88, ABBEY-STREET.

1876.

Figure 4: Title page of one of the Irish Reading Books.

In addition Dawes made a trip to Ireland to visit National Schools in 1846 and recorded his observations in his book *Hints on an improved and self-paying system of National Education* (Dawes, 1847, p. 51ff). His comments give an interesting picture of the state of primary education in Ireland at that time. He reports on a visit to the school in Sligo (Dawes, 1847, p. 66-67).

"I had some conversation with the master of the school on the subjects taught, and the manner of teaching them. He was clearly well trained and took great interest in his work. He had various specimens of the rocks and minerals in the county and neighbourhood, and knew how to take advantage of local circumstances in order to interest his school. This it is in a teacher which ensures success, and it cannot be too much impressed upon our school masters to talk to the children of the nature of things about them in the animals, vegetables, minerals, and in fact, to interest them in that part of the creation which is rubbing against them at every step."

The Irish National Board of Education gave a copy of Dawes' book *Suggestive Hints towards improved Secular Education making it bear upon Practical Life* (first edition 1847) to all its trainee teachers (Ball, 1964, p. 65), an indication of their valuation of its worth.

Why was the science of common things abandoned?

The 'Science of Common Things' was widely applauded and approved as a successful scheme of elementary education in the 1840s, especially by the Schools Inspector, the Rev. Henry Moseley, but it failed to be widely adopted. Richard Dawes' approach in 'The 'Science of Common Things' for the rural working class was so effective and so successful as a means of teaching science that it posed a threat to the social order. There was a real possibility, seen then as a danger and a threat, that the lower orders would be better educated

in science than the ruling classes, which could never be allowed to happen. Lord Wrottesley wrote in 1860:
"It would be an unwholesome and vicious state of society in which those comparatively unblessed with nature's gifts should be generally superior in intellectual attainments to those above them in status." (Wrottesley, 1860)

The 'Science of Common Things' was science for citizens and not science for scientists, and it was science for the lower classes not for the ruling classes. This successful experiment was stopped due to outside pressures. Despite the success by Dawes and Moseley in promoting science in elementary schools over two decades, in 1862 science became an optional subject in English elementary schools and was effectively dropped from the elementary curriculum. When it was reintroduced in 1882 it was replaced by a watered-down version of 'pure laboratory science', which was then starting to be taught to the middle and upper classes in grammar and public (private) schools. The academic approach had triumphed over the utilitarian and pedagogic approaches, the pure over the applied, science for the elite over science for the masses, and science for the future scientists over science for the citizen.

The 'Science of Common Things' did not fail but was abandoned because it was too successful. Its two champions, Richard Dawes and Henry Moseley, a government inspector, were both moved to senior appointments in the church, as they were both clergymen, and their expertise and advocacy of 'Science of Common Things' was lost. Political considerations then ensured that science was first sidelined and then removed from the elementary school curriculum. In retrospect one must feel that this was a lost opportunity to provide a relevant science education for all, as a foundation for later study (for those able to avail of it) and a contribution to what later would be called scientific literacy.

Layton (1972, p. 56-57) sums the appeal of Dawes' approach. *"On the other hand science, if not 'culture free', could at least be related to a culture which was familiar to them. It offered rich opportunities for the exercise of reason and speculation whilst drawing upon experiences, or simple experiments, which were within their everyday experience, Furthermore, the study of science involved a fruitful reciprocity between 'thinking' and 'doing', one outcome of which was a potential for 'making', i.e. applying the results of scientific inquiry to the improvement of man's estate. The development of this quality of 'the maker' in the child – what today might be called technological creativity – was seen as one of the prime objectives of the physical sciences in elementary education."*

In hindsight we would say that 'The science of common things' ticked most of the boxes as an appropriate way of teaching science in elementary schools, but it failed to tick the box of political and social correctness. Although Richard Dawes spent only a few years in King's Somborne, he is remembered now most for his educational innovations there rather than for his work as college bursar in Cambridge or his tenure as Dean of Hereford Cathedral. Stewart & McCann (1967, p. 124) sum up his achievement in King's Somborne thus:
"King's Somborne was simply an attempt at educational progress made by an original man in conditions that were daunting in the extreme. It was the first rural school seriously to attempt to raise educational standards above the acquisition of mere literacy, and the first to make a breach in the custom that different classes of the community should be educated in separate schools. These achievements of Dawes were effected in the face of an almost total initial opposition to education by the local farmers. That Dawes overcame this and other difficulties, was almost entirely due to the quality of the education he provided at the school, to the freshness and originality of his methods, and to the way he was able to integrate learning into the life of the local community."
A fitting epitaph for a pioneer in science education for all.

References

Ball, N. (1964). Richard Dawes and the Teaching of Common Things. *Educational Review*. 17(1) 59-68

Dawes, R. (1847) *Hints on an improved and self-paying system of National Education.* London: Groombridge and Sons

Dawes, R. (1857). *Suggestive hints on secular instruction.* 7th edition London: Groombridge & Sons

Hodson, D. (1987). Science curriculum change in Victorian England: a case study of the Science of Common Things. Ch. 6 in *International Perspectives in Curriculum History*, edited by Ivor Goodson. London: Croom Helm, pp 139-178

Layton, D. (1972). Science in the Schools: the first wave – a study of the influence of Richard Dawes (1793-1867). *British J. of Educational Studies.* 20(1), 38-57

Layton, D. (1973). *Science for the People.* London: George Allen & Unwin.

Layton, D. (1993). Reading science: images of science in some nineteenth century reading lesson books. *Paradigm,* **1**(10)
Available online at: http://faculty.education.illinois.edu/westbury/paradigm/Layton.html

Wrottesley, J. (1860) *Thoughts on government and legislation*. London: John Murray, quoted in Hodson, 1987, p. 167

Stewart, W.A.C. & McCann, W.P. (1967). *The Educational Innovators 1750-1880.* London Macmillan