

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. PoSE #4 looked at J.M. Wilson, who served on a Royal Commission with Thomas Huxley (PoSE #5), who also promoted technical education as did Br. James Dominic Burke did in Cork (PoSE #6), who also used inquiry in science teaching as did Henry Armstrong (PoSE #7). Armstrong's ideas were brought to Ireland by William Mayhowe Heller (PoSE #8), one of his early disciples. In England Christ's Hospital school was important as a test-bed in putting Armstrong's ideas into practice, and through the work of Gordon von Praagh (PoSE#9) learning by discovery found its way into the Nuffield chemistry courses.

#9 Gordon Van Praagh (13/3/1909-30/9/2003): Christ's Hospital's role in transmitting heurism

Introduction

Anyone who has heard of the Nuffield science projects in the 1960s will have heard of Gordon Van Praagh. He was a member of the chemistry team which produced the Nuffield O-level Chemistry course, and later the A-level course, and as such was influential in ensuring that Henry Armstrong's heuristic ideas were resurrected as the underlying philosophy of the new course (see PoSE #7). Armstrong's ideas were most fully worked out and implemented with large classes at secondary level in Christ's Hospital School, Horsham, of which Armstrong was a member of the Council of Almoners for forty years. This was first through his disciple Charles Browne, whose work was continued by John Bradley and then pre-eminently by Gordon Van Praagh. Through example and their writings, these chemistry teachers kept the flame of heurism burning, even when it fallen out of fashion and even into disrepute. The embers of heurism burst into flame again in the Nuffield science projects and continue to burn brightly in the 21st century in the emphasis on inquiry-based science education (IBSE).

Edgar Jenkins wrote about the wide-ranging influence of Christ's Hospital (Van Praagh, 2003, p. 34). *"The influence of the approach to science teaching associated with Armstrong, Browne and Christ's Hospital was not confined to England and Wales. In Armstrong's own time heuristic ideas were taken up in Japan and, a century later, all contemporary world-wide attempts at school science curriculum reform take it as given that pupils must spend some time in investigative work as an integral component of their school science education. If the heuristic intention is frequently frustrated, not least where resources are scarce or non-existent, the commitment to 'finding out' in school science remains strong. That perhaps is*

the enduring legacy of the work that Charles Browne and his successors promoted at Christ's Hospital."

In this article I will look mainly at the work and legacy of Gordon Van Praagh, but I will also touch on the contributions of Charles Browne and John Bradley and the role of Christ's Hospital.

In his obituary of Van Praagh in *The Guardian*, Martyn Berry wrote: "*It is unusual for anyone to remain enthusiastically and vigorously active in their chosen field for 70 years, but the teacher and chemist Gordon Van Praagh was signing copies of his latest book about science education just ten days before his death, at the age of 94.*" (Berry, 2003)

Not many teachers, let alone science teachers, warrant obituaries in national newspapers like *The Guardian* and *The Times*, but Gordon Van Praagh did, and that he did is a measure of his influence and standing in the world of science education.

Armstrong's heurism at Christ's Hospital

Henry Armstrong (PoSE #7) looked for a test-bed for his educational ideas in schools, which he had already tried out in his own college. They were tried out in St Dunstan's College, Catford but particularly in Christ's Hospital School. Christ's Hospital School was a fee-paying private school initially located in London but later moving in 1902 to a custom-built campus in Horsham, Sussex. Armstrong became involved with the school when he was asked to join the Council of Almoners (the school's governing body) in 1891, representing the Royal Society. From the start he served on the Education Committee and he was later its Chairman. He was to remain in this role for over 40 years until his death. Christ's Hospital is still proud of its long science teaching tradition (see <https://www.christs-hospital.org.uk/about-ch/ch-pioneering-science-education/>). Armstrong, with Charles Browne, had a major input into the design of the science school at the new site when the school moved from London to Horsham. When these opened in 1902 they were the best science teaching facilities of any school in England.

Charles Browne (1865-1961) took an external degree in science at the Birkbeck College, University of London in 1893 at the age of 28, after being an unqualified teacher from the age of 15, and Armstrong was his chief examiner. He later in 1897 went to be a research student under Armstrong at the Central Technical College for a year, from where he went to teach Robert Gordon College, Aberdeen in 1898. He was dissatisfied by the didactic approach taken there, having seen Armstrong's ideas in practice in London. Armstrong was influential in recruiting Browne as science master at Christ's Hospital in 1899, where he stayed until his retirement in 1926, and it was Browne who introduced Armstrong's ideas into the teaching of science into Christ's Hospital. (Browne, 1966; Van Praagh, 2003)

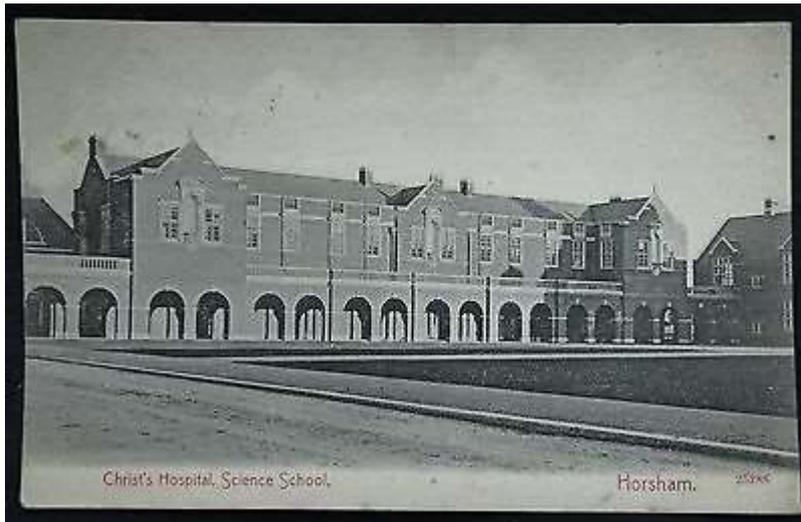


Figure 1: An early picture of Christ's Hospital, Horsham

William Fyfe was headmaster from 1919 and he coined the term '*Virus heuristicum Armstrongii*' to describe the effect of Armstrong's ideas in the school, which spread beyond science into technology, art and the humanities. He said of Browne: "*Browne organised the teaching of science, trained his assistant masters and inspired his pupils at Christ's Hospital for twenty-seven years. His appointment was one of Armstrong's most notable services to the school.*" (Browne, 1966, p. xi) Armstrong had tried out his ideas at home with his children and Browne was invited to see what they were doing. Later he said: "*The work of Armstrong's three children made a great impression on me. It was rational and simple, it appealed to them as important and worthwhile, with a well-defined purpose. It illustrated very well the possibilities of training in scientific methods from the earliest stages as well as the proper function and attitude of the teacher. Then and there I decided to adopt the scheme for the preliminary science course at Christ's Hospital in London, modifying it to meet the very different and more difficult circumstances of working under ordinary school conditions with large classes of some thirty boys.*" (Browne, 1966, p. 13)



Figure 2: An early heuristic science lesson at Christ's Hospital (Source: Christ's Hospital)

In his notebooks Browne describes his approach in more detail (Van Praagh, 2003, p. 9). *“The courses he envisages are based on practical work by the boys, not formal lessons; work benches, not class rooms. The boys must have a reason for doing something, based on curiosity to solve by experiment a problem, clearly understood and simple enough to require very little experience and no elaborate apparatus. The teacher is to afford guidance and suggestion mainly by questions – no telling – and should adopt the attitude of a co-enquirer, not an authority... These and similar notes ... reveal a man with a faith in his mission and determination to succeed ... There is no doubt that the heuristic approach makes greater demands on the forethought and patience of the teacher than the formal, didactic method aptly termed chalk and talk’.*”

Where did Browne get his pedagogy from? He was exposed to Armstrong’s teaching methods at the Central Technical College and during his visits to see Armstrong’s children, and his few months teaching in Aberdeen, where he saw the poverty of teaching based only on cramming facts.

On retirement in 1926 at the age of 60 he went to be a tutor at the London Day Training College (now the London University Institute of Education) where he taught from 1926 to 1935. Gordon Van Praagh trained to be a chemistry teacher in 1931-32 under Browne where Van Praagh imbibed his heuristic ideas. In 1933 Van Praagh was appointed to teach science at Christ’s Hospital and remained there until 1964, minus a period from 1943 to 1946 when he did scientific war work. In a real sense Armstrong passed on the torch of discovery learning to Browne, who in turn passed it on to Van Praagh.

John Bradley (1908-1967) also taught at the school after Browne from 1935 to 1938, overlapping with Gordon Van Praagh (1933 to 1964) and he also adopted the heuristic method enthusiastically. Bradley wrote a series of articles in the *School Science Review* from 1933 to 1967, in which he explained how a heuristic approach could be incorporated into a chemistry course at school, using what he called ‘heuristic patches.’ He later went on from 1945 to become a science education tutor at the University of Hull, but he seems to have largely vanished from the history of science teaching. Bradley attacked the new Nuffield science courses as not being heuristic enough!

Edgar Jenkins (Van Praagh, 2003, p. 32) gives an assessment of Browne’s influence. *“He was as seminal influence on all those whom he taught, whether pupil or student, and he helped to promote the view that any science teaching worthy of the name must allow pupils to spend at least some of their time in investigative work appropriate to their age and abilities.”*

Gordon Van Praagh’s career

Table 1 gives the main dates in Van Praagh’s life. He was active in science education from 1933 when he moved to Christ’s Hospital until his death in 2003. He was educated at University College School, London and then did a BSc in Chemistry at University College in 3 years. After a year’s research there he moved to Cambridge to complete a PhD with Sir Eric Rideal. He decided he wanted to be a teacher and so he enrolled at the London Day Training College, where his chemistry tutor was Charles Browne. After a short time at Perse School Cambridge he moved to Christ’s Hospital, Horsham in 1933 where he remained (on and off) until 1964. He was absent on war duties from 1943 to 1946. From 1961 he was seconded to the Nuffield Foundation Science Teaching Projects, fulltime from 1964 to 1967. He made a major contribution to the O-level Chemistry course (Figure 3), much of stage 1 coming from

his influential book *Chemistry by Discovery*, and also contributed to the A-level Chemistry course.

Table 1: Chronology of Gordon Van Praagh's life (*books in italics*)

1909	Born 13 th March
1925-29	BSc, University College, London
1930-31	PhD, Cambridge
1932	London Day Training College
1933	<i>An introduction to the calculus</i>
1933-64	Christ's Hospital (less war service 1943-46)
1950	<i>Physical Chemistry, Experimental and Theoretical</i>
1949 (1960)	<i>Chemistry by Discovery</i>
1961-67	Nuffield Science Teaching Project
1967	Nuffield O level Chemistry books
1967-97	Worked overseas for CREDO then CEDO
1969	<i>The Experimental Basis of Physical Chemistry</i>
1973	<i>H.E. Armstrong and Science Education: Selections</i>
1976-80	Senior Lecturer in Education, University of Penang, Malaysia
1988	<i>Seeing it Through</i>
2001	<i>Encounters with stuff</i>
2003	<i>A fire to be kindled</i>
2003	Died 30 th September

Van Praagh was encouraged to write a book describing the chemistry course at Christ's Hospital and this became the influential *Chemistry by Discovery*, first published in 1949, much of which reappeared in the Nuffield chemistry course. In the book Van Praagh said: "*The course has been evolved from the heuristic method of teaching science, according to which the pupils were not to be taught from textbooks or from the blackboard but were to be allowed to discover science for themselves by the wayside and in the laboratory. A wholehearted adherence to such a method is not practicable today, even if it were desirable, but the heuristic method embodied certain ideas which have widely influence the teaching of science for good, and this course attempts to recapture these and adapt them to present circumstances.*" (Van Praagh, 1960, Preface)

In 1954 Van Praagh spoke about the legacy of Armstrong and Browne at Christ's Hospital (Van Praagh, 2003, p. 13).

"A frequent theme of many of Her Majesty's Inspectors is that pupils should learn science at first hand in the laboratory, not only from text-books, and this emphasis permeates the vacation course they run for science teachers. However, it would be wrong to give the impression that the heuristic approach is practised today as Charles Browne practised it earlier in the century. It is an attitude that has survived, a manner of approach to science teaching – the realisation of the importance of allowing the pupils to take part in a quest. The emotion aroused by some little discovery makes memory effortless and releases energy which carries the explorer on to fresh fields of investigation."

The evidence of the success of science teaching in Christ's Hospital is shown by the large number of Oxbridge scholarships won by pupils, but more so by the large number of successful scientists, engineers and doctors produced by the school, of whom Barnes Wallis

(of the bouncing bomb) is a good example. Many examples are given in the book *A fire to be kindled* (Van Praagh, 2003).

Nuffield Science Projects

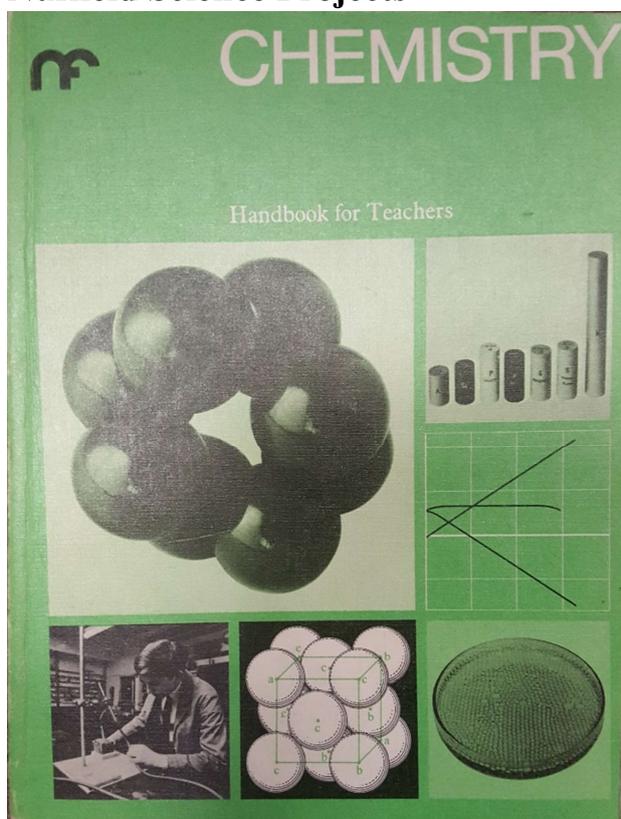


Figure 3: Cover of the Nuffield Chemistry Teacher's Handbook

The Nuffield Foundation science projects, which started in the early 1960s, have had a disproportionate influence on the way science is taught in UK schools and around the world. Starting in 1962 the Nuffield Foundation has funded the development of 27 science courses (see <https://www.nuffieldfoundation.org/curriculum-projects#Science>). The first courses to be developed were O-level (age 11-16) Biology, Chemistry and Physics. IN 1962 the Nuffield Foundation agreed to fund the development of new courses in science, based on requests from the Science Master's Association (forerunner of the Association for Science Education) and distinguished academics like Lord Todd. They agreed to give £250,000 (in the end spending £1.5 million, £30 million in today's money). This allows the creation of fulltime teams in each subject from 1963 and Gordon Van Praagh retired from Christ's Hospital to join the chemistry team. His book, *Chemistry by Discovery*, first published in 1949, had a major influence on Stage 1 of the chemistry course. The course consisted of a number of publications, but not a conventional text book, and two films 'Chemistry by investigation' and 'Exploring chemistry'. The materials were trialled in 67 schools and then revised, and were finally published in 1967. New examinations were devised in spirit with the new courses. Courses were run for teachers to introduce them to the new course and the discovery approach. The teams developed new experiments and also designed new pieces of apparatus to teach the new course, for example, top pan balances and gas syringes. The course was revised 11 years later. The approach taken with the Nuffield science projects is a good illustration of how curriculum development in science should be done. The publications

included *The Sample Scheme*, *Laboratory Investigation Sheets*, a *Teacher's Handbook*, *Background Readers* on chemical topics and a *Data Book*.



Figure 4: In 2002 Dr Van Praagh returned to Christ's Hospital to teach a 1950s science lesson (Photo Christ's Hospital)

In his appreciation of the Nuffield science projects Jonathan Osborne (Osborne, 2012, p. 6) says this about the influence of Van Praagh.

"[Nuffield] have supported the idea that there has to be a better argument for the goal and purpose of science education. In short that there has to be more to science than content. You see this in the writings of Gordon Van Praagh, an early Nuffield pioneer, who in describing a lesson on the oxidation of copper says that he begins his lesson not by stating the bare facts – something which is so mind numbing to young students – but by asking a question – why does copper go black when it is heated? What could this be and why?"

Starting with a question rather than a statement is the essence of inquiry, as in the TEMI project, and this emphasis on guided discovery popularised through the Nuffield projects, went on to inspire curriculum development in many countries e.g. in East Africa (see below). Robin Millar (Millar, 2004) gave this assessment of the Nuffield projects and guided discovery.

"In the UK, the idea of 'the pupil as scientist' underpinned the influential Nuffield Science Projects in the 1960s, which initiated a period of science curriculum innovation and reform that has continued to the present day. Though less prominent in subsequent developments, it has remained an influential notion in the UK and elsewhere. It is not difficult to see why it is attractive to science educators. Encouraging students to pursue their own enquiries taps into their natural curiosity. Finding things out for yourself, through your own efforts, seems natural and developmental, rather than coercive, and may also help you to remember them better. It seems to offer a way of holding up evidence, rather than authority, as the grounds for accepting knowledge. It is enabling, rather than dismissive, of the individual's ability, and right, to pursue knowledge and understanding for her/himself. Indeed one of the great

cultural claims of science is its potential as a liberating force – that the individual can and may, though his or her own interaction with the natural world, challenge established tradition or prejudice, by confronting it with evidence. An enquiry-based approach may also encourage students to be more independent and self-reliant. In this way it supports general educational goals such as the development of individuals' capacity for purposeful, autonomous action in the world."

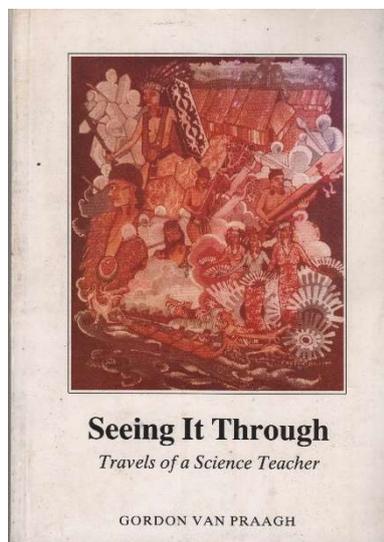


Figure 5: Cover of Van Praagh's autobiographical book, *Seeing it through* (1988)

Overseas work

When Van Praagh finished working for the Nuffield Foundation in 1967 he was encouraged to apply for a job with the Curriculum Renewal and Educational Development Overseas (CREDO), later called the Centre for Educational Development Overseas (CEDO). This led him to work for many years in science curriculum development overseas, from East Africa to East Asia. His first project was in East Africa from 1967 in the East African School Science Project (EASSP), which produced an O-level science project in chemistry, biology and physics modelled on the Nuffield courses but designed for the East African countries – Kenya, Uganda and Tanzania, which at that time were in a federation and had a common examination system. I worked in Uganda at that time at Makerere University, Kampala in the Chemistry Department, and I met many of the teachers involved in this project, although I can't remember meeting Van Praagh. A new A-level chemistry syllabus was also introduced in 1971 and this led to my involvement in school chemical education, producing a teacher's newsletter (*A Modern Approach to Chemistry*), the precursor of *Chemistry in Action!*, and setting A level chemistry papers for a couple of years.

In his books *A Fire to be Kindled* (Van Praagh, 2003) and *Seeing it Through* (Van Praagh, 1988) Van Praagh describes his overseas adventures. In Malaysia his work was recognised by the award of the equivalent of a knighthood. He also wrote a popular science book *Encounters with Stuff* (2001), where he discusses the importance of various types of stuff (his word for chemicals), from paper to glass, diamonds to copper. It is sprinkled with his limericks including this one:

We live in a world full of stuff

*I have chosen some bits – just enough
Which I'll use to display
In a light-hearted way
That Chemistry's fun – and not tough.*

Conclusion

In his appreciation of Van Praagh in *School Science Review*, Mike Nott called him a 'Firestarter Extraordinaire' from Plutarch's quote "A child's mind is not a vessel to be filled but a fire to be kindled". In it Nott says (Nott, 2003, p. 125); "*He taught chemistry and developed, preached and disseminated worthwhile chemistry education from the 1930s to the end of his life through his teaching, his textbooks, the Nuffield Science Teaching Projects, his overseas work, and not least his constant correspondence with a worldwide network of friends, acquaintances and colleagues in science education.*"

His educational philosophy was described *Adventures with Stuff* (Van Praagh, 2001, p. 168) in advice to prospective science teachers:

"Your job is to do all you can to help your pupils to learn, to stimulate their interest, encourage them to want to know and understand more, provide them with the facilities to do it, and be there to encourage, explain and help, and finally give tests to enable them to identify their weak points."

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