

Problems in Evaluating Student Engagement in Science: England, 1750-1850

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Engagement, defined in terms of the percentage of Australian school students studying Year Twelve science subjects, fell heavily during 1976-2007. This paper raises for discussion questions about the history of science teaching which the author seeks to answer; presuming that the search itself, and its possible findings, might contribute to today's debate about declining student engagement in science. Examples of schools and their science curricula which will be researched include Quaker schools, 'dissenting' academies, notable 'science' schools and the practices of small home schools in the late eighteenth and early nineteenth centuries.

Background

Ainley, Kos & Nicholas (2008) in their comprehensive ACER Monograph reviewed Australian students' participation at Year 12 level in Science, Mathematics and Technology subjects over the period, 1976 – 2007. Their Table 3.2 (p. 16) shows that in 1976 55.3 percent of all students were enrolled in Year 12 Biology but by 2007 the percentage had dropped to 24.7. The change for Chemistry was 28.6 to 18.0 percent; for Physics 27.5 to 14.6 percent; for Geology and Earth Sciences 4.8 to 0.8 percent; all other Sciences increased from zero in 1976 to 8.3 percent in 2007. National administrators could read these figures as threatening defence potential and national development; science teachers as threatening the quality of their profession; science education lecturers as making their work more difficult because fewer coming forward to be science teachers will have attained high levels in school or university science.

Ainley's trend graphs for science students as percentages of total Year 12 enrolments suggest that the percentage shares for Biology and Chemistry students had an inflexion point in 2002 and Physics students in 2006 which considerably eased their rates of fall and moved the graphs into something of a plateau. By marketing analogy innovation is now needed for these three 'markets' to rise. Where will the innovation come from? Ainley *et al* p. 82-83 list ideas that might resolve their 'sense that school science is not sufficiently connected to recent developments in science.' Underlying all moves to increase student engagement in science the fundamental and

not new issue of education versus examinations remains; teachers have difficulty in accepting or applying new ideas when their minds are on high marks for their students: tension between the present system and the aims of pedagogy continues.

Definitions of Engagement

The author seeks to engage the audience to discuss criteria by which to evaluate student engagement in school science during 1750-1850 when science was taught in a few schools led by headmasters with their own opinions about teaching aims and methods and/or were stimulated by the philosophical, religious or political views of particular groups or in private schools run for profit which provided an education more appropriate for the commercial and managerial requirements of a rapidly developing industrial society.

The everyday sense of 'engagement' is to be committed to a venture, as in 'engaged in a business enterprise' or committed to a conflict, as in 'the armies engaged at sunrise' or 'engaged to be married'. These are strong ideas, carrying a sense of passionate motivation. They call to mind the feelings and subsequent actions of the scientist, Edward Frankland who, about 1835, at the age of ten made equipment to produce an electrostatic spark. He later, wrote, "Never shall I forget the supreme happiness of that moment." (Russell, 1986) Joseph Banks IV, so well identified to Australians by his botanical investigations during James Cook's first voyage (1768-71) later in life, according to Cameron (1958) and Lyte (1980) recalled how in 1758, at age fifteen, he turned from an indifferent scholar to a passionate researcher after a transcendental experience with the sight of flowers in the light of a summer evening. Banks went on to become an international trade researcher, a considerable contributor to England's economy, President of the Royal Society for forty-three years and a Privy Counsellor. Oliver Sacks (Sacks, 2002), neurologist and author, recalls that in 1943, by the age of ten he was interested in prime numbers and then became fascinated with chemistry, its practice and the histories of famous chemists. These three examples illustrate that famous people may discover early in their lives great passion for scientific investigation which opens great new worlds in their minds. Their experiences had in common: access to books of science, the stimulus of other scientific persons and methods which were of investigation before or accompanied by theory. They were not taught theory in classrooms and then, perhaps, given the opportunity to illustrate theory through experiment. From the biographies and autobiographies of such whose achievements lead us to apply the term, 'great', we may consider how their self-discovered paths to knowledge do or could contribute to today's science teaching methods. Their personal experiences bring to mind the terms, 'passionate' and 'engagement' and that their process of discovery started before or by adolescence. The important implication for our primary and secondary school science syllabuses is to provide opportunity for students, as young as possible, to discover if they, too, have some degree of passion for discovery in science.

In a small study (Bottomley, 2006) of thirty-four men and women who between 1946 and 2006 had attended one provincial school the term 'passion' frequently entered the discussions of those who were at school before about 1970, but it was used to describe a quality they wanted from their science teachers and for the most part had not received. Using a simple rating scale to describe their enjoyment of

school science they rated most other subjects higher than science; only mathematics they rated lower. My questions today are how Australian school principals, teachers and education authorities are evaluating students' engagement in science, and in other subjects, and how in examining the early days of science teaching may I best evaluate when school science was a new subject whether students were more or less engaged than science students today? Formally expressed, my research question is what lessons from secondary science education history might point to innovations that would arrest the current decline in Australian students' declining engagement in science subjects?

Methodology of investigation

My first area of investigation is in the strategies used to engage students in science when formal school science teaching in England and Wales was new, in the 1750-1850 period. Sometimes, the strategy in early 'science schools' was clear, learning through practical application. Sometimes, only the fact might be known that a particular school included science in its curriculum and historical clues about its teaching strategy or tactics might be hard to find. My investigation is thus directed to strategies - where known - and outcomes that might be measured or inferred. My methodology will be case history and documentary. Through case histories of headmasters, their assistant teachers and their schools I look to discover the spirit of men, perhaps, also, of women, who pioneered science teaching; their purposes, equipment, methods, successes and failures. For documentary information about the spirit and circumstances of their times I shall look for biographies and autobiographies of participants; school records such as enrolments, minutes of Council meetings or of affiliated or associated groups, documents surviving in appropriate libraries or archives, census records of the time, rate and tax records and reports of school activities and advertisements for students or staff published in local periodicals or the Times Educational Supplement. To understand the science, education and philosophical knowledge of the participants' times I shall look at their society memberships, journals and newspapers they might have read and the company they kept or might have kept with other school masters and scientists of their times.

Education of the time

In contrast to the students at schools teaching science, few children had any education during 1750-1850, a period in which their numbers increased considerably. The population of England (excluding Wales, Ireland and Scotland) was estimated as 5.74 million in 1750. In 1801, the first Government census recorded 8.3 million and in 1851, the sixth census recorded 16.8 million. In 1836 Fredric Hill published his two-volume review of the state of education in England, Wales, Scotland and Ireland and comparisons with some other countries. Hill's writing was based on his own observations, such official statistics as were available - in some cases adjusted with the help of the Manchester Statistical Society - and answers to questionnaires he sent to many schools and organisations.

Frederic Hill considered that 'Education, though much improved in this country, is still very defective, even where it exists in the best state.' He attributed the

improvement to the Sunday School movements and the development of day schools conducted along the lines of Bell and Lancaster at which children paid a penny or a threepence, a week. Of the former, he wrote, 'Fifty years ago, and the infant poor of this country were wandering about on the Sunday, idle, dirty, ignorant, and immoral. The great mass of them are now received into (Sunday) schools, where at least some amount of regular occupation is found, and some instruction is given.' The 1831 census indicated the population of England and Wales was approaching 15 million. Hill suggested there were 1,135,000 children aged eight to twelve in England and Wales, or about 7.6 percent of the population. He thought that possibly 800,000 to 900,000 had some contact with Sunday schools. Hill was aware there was '... much difficulty in obtaining an accurate statement of the number of children receiving education ... (and less) hope of obtaining any accurate account of the kind of education given.'

Hill considered that the monitorial day schools 'conducted on the plans of Bell and Lancaster ... must be considered as forming the chief medium of direct education in this country (and, although many private schools offered better education) we think the schools in question are the most efficient.' Hill estimated such schools had about 250,000 pupils or about 22 percent of children aged eight to twelve, but figures were vague for the number of days or years for which students attended those schools. Twenty-two years after Frederic Hill published 'National Education', James Augustus St. John (1858) indicated that education had improved little for the mass of people.

Field of study

Much is already known about leading characters in my historical drama, for that is how I see my project: *Headmasters*: Joseph Priestley (1733-1804), Johann Heinrich Pestalozzi (1746-1827), Thomas Wright Hill (1763-1851), Robert Owen (1771-1858), Richard Dawes (1793-1867), Thomas Arnold (1795-1842), John Stevens Henslow (1796-1861), George Edmondson (1798-1863), Rowland Hill (1795-1879), John Percival (1834-1918), Frederick Sanderson (1857-1922). The two latter are outside the time span of these notes. Findlay (1914) reproduced a letter from Thomas Arnold to a local paper in which Arnold argued against science in his classical curriculum at Rugby School but supported it in schools educating students for commercial and professional careers. All the others mentioned strongly supported the place of science in their schools' curriculum.

Scientists: Priestley, Dawes, Henslow, Percival and Sanderson were scientists and/or mathematicians. Two others, Edward Frankland and John Tyndall, were associated with Edmondson's third and most famous school.

Schools and affiliations: The Society of Friends, commonly known as Quakers, developed in the mid-17th century from George Fox's preaching. The Quaker beliefs and observances which subsequently developed in Quakers' search for a purer form of Christianity proved challenging to the national Church of England, and to authoritarian government. Quakers required no intermediaries in their search for God. In their Meetings they listened, mostly in silence to their 'Inner Light'. They had no ministers; their elected Clerks attended to organisational and spiritual matters. They were pacifists, and took no oaths. In such ways they upset conservative thought. They sought to establish schools for their children and Cantor (2005) indicates that

'by 1691 at least fifteen such schools existed under the auspices of the (Quakers') Quarterly Meetings.' (Cantor, 2005, pp. 46-7) Cantor cites Lloyd (1944) who listed 'some fifty (Quaker) schools that existed before 1695, some of which were very short-lived.' They were not necessarily reporting to Quarterly Meetings. Two Quaker schools founded about a hundred years or so later, continue to this day. Each included science in its foundation curriculum. Each enrolled boys and girls, a forward step for the times. Ackworth School, near Pontefract, in Yorkshire which opened in 1779, taught horticulture. Bootham School in York, which opened in 1823 on the site of a former Quaker boys' school, became distinguished for its students' studies in Natural History, its herbarium, and by 1853 its observatory for astronomical studies. Joseph Priestley (1733-1804) who was a Unitarian minister developed his first school in 1755 in which, according to Watts (1994) he taught 'practical science and modern history to both boys and girls'. In 1758 when Priestley moved to Nantwich, in Cheshire, he opened his second school. Schofield (1966) cites Priestley's Memoirs '... my school soon enabled me to purchase a few books, and some philosophical instruments, as a small air pump, an electrical machine, &c. These I taught my scholars in the highest class to keep in order...' In 1761, Priestley joined the staff of the Warrington Academy, on the humanities side, the science position being already occupied. There he further developed his views on education and teaching methods.

Thomas Wright Hill, a member of Priestley's Birmingham congregation, opened Hill Top School, near Birmingham, in 1803. Science was included in its curriculum; so much so that later, when his son, Rowland Hill, was headmaster parents revolted when it was planned to extend science lessons to twelve hours a week!

Before the end of the 18th century there were other home schools like Priestley's catering for middle-class families. For example, Joseph Kendall (2008) in his biography of Peter Mark Roget (1779-1869) of Thesaurus fame notes that the young Roget attended David Chauvet's home school where the curriculum included, 'Latin and Greek, modern languages, and all branches of science.' His biographer notes that before Roget was fourteen and became a medical student at Edinburgh University, Roget spent the equivalent of six years under Chauvet's instruction.

Many schools were teaching science during 1750-1850; some well-known, others not. Together, they provide a wide, interesting, and possibly rewarding field for curriculum study.

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