

EARLY PRACTICAL CHEMISTRY AT BRITISH PRIVATE GIRLS' SCHOOLS

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Abstract

Contrary to most accounts, experimental chemistry was a key part of the education of girls at private British girls' schools in the late 19th and early 20th centuries. Here we report detailed evidence on the teaching of practical chemistry on the basis of archival searches at many of these schools. In particular, we have found photographic evidence of numerous school chemistry laboratories and we have contextualized the laboratory experience of the times.

Introduction

In the early part of the 20th century, Angela Brazil (1868-1947) wrote a range of fictional stories of life at private British girls' schools (1). To indicate that the story was set at a forward-looking school, Brazil included in the saga the presence of a chemistry laboratory. For example, in the 1906 novel, *The Fortunes of Philippa*, reference is made to: "... we had chemistry classes in a well-fitted laboratory ..." (2). In *The School by the Sea* (1914), the school, Dower House, is a former nunnery founded in the 14th century. The headmistress, Miss Birks, muses that "Could the Grey Nuns have but returned and taken a peep into the well-equipped little chemical laboratory, they would probably have fancied themselves in the chamber of a wizard in league with the fiends of darkness, and have crossed themselves in

pious fear at the sight of the bottles and retorts; ..." (3). To have entered the realms of fiction-writing for girls, it would seem that chemistry was considered an expected part of a girl's education at such schools.

In our previous work, we showed that private (called "independent" in Britain) girls' schools were at the forefront of chemistry education in Britain in the late 19th and early 20th centuries (4). Our research went against the common perception, not only about the introduction of chemistry into British schools, but particularly the practical aspects. For example, in an account "The Teaching of Chemistry and its Development" the first practical chemistry was said to have been performed at the (boys') City of London School in 1847, while the first school to offer practical chemistry in a laboratory setting was claimed to be the (boys') Manchester Grammar School in 1868 (5). No mention is made anywhere of the teaching of chemistry at girls' schools. Even a more recent comprehensive study on the history of science education in Britain relegated the teaching of science to girls to a single chapter out of a total of eight chapters. In that chapter, the author commented on the inadequacy of, and often lack of, girls' school chemistry laboratories until the 1960s (6). Also of note, all photos of school laboratories were those of boys' schools. We have therefore further researched the issue, accessing the archives of 54 independent (private) girls' schools and uncovering additional documentation, and, in particular, photographic evidence of some of the school chemistry laboratories and of the student experiments.

Practical Chemistry at Girls' Schools

The earliest record we have discovered so far of teaching chemistry at a girls' school is that of the Newington Academy for Girls, a Quaker school in Stoke Newington, London (7). Opened in 1824, one of its founders and teachers was the Quaker scientist, William Allen (1770-1843). From the beginning, chemistry was taught and the chemistry demonstrations would probably have been the first at any school in Britain. One of the students, Louisa Stewart, later recalled: "William Allen gave the girls lessons in his own house in chemistry..." (8). In her memoirs, the social reformer Sophia Elizabeth de Morgan (1809-1892) mentioned meeting Allen sometime in the mid-to-late 1820s: "... I made the acquaintance of William Allen, who kindly allowed me to attend the lectures on chemistry which he gave, with experiments, to a class of young girls." (9). Unfortunately, the school closed in 1838.

Quaker girls' schools seem to have been at the forefront of introducing chemistry, another example being the Mount School for Girls, York, where practical chemistry was demonstrated by an Edward Grubb in the 1860s. As the school historians, Winifred Sturge and Theodora Clark commented: "To his lectures on chemistry his audience came in a mood of prophetic sympathy, awaiting the experiment: "Will it? Won't it?" It generally wouldn't! Why should it? For before the laboratory was built in 1884 there was no scientific equipment worth the name" (10).

Though the Quaker schools led the way, other independent girls' schools soon followed. Princess Helena's College (founded originally in 1820 as the "Adult Orphan Asylum" to train governesses), then located at Ealing in west London, began offering chemistry in 1890: "Mr. G. S. Newth, of South Kensington Science Department, gives the Chemistry Lectures, and makes them most interesting to his class by his numerous and beautiful experiments" (11). Newth, demonstrator and lecturer at the Royal College of Science (later Imperial College), was a prolific writer of chemistry texts, including *Chemical Lecture Experiments* (12).

The impetus for introducing chemistry was the opening of London University to women in 1878 (13), for, at the time, grade-school chemistry was a necessary prerequisite for admission. This point was made explicitly by the Headmistress of St. Leonard's School, St. Andrew's, Scotland, Miss Dove, to the Administrative Council of the School in 1880 (14):

A letter was read from Miss Dove regarding the necessity of procuring certain chemicals and chemical apparatus with a view to the preparation of pupils for the examination of the London University. It was agreed that a sum not to exceed 15 pounds might be expended for this purpose.

It is clear from subsequent Minutes that Miss Dove was in charge of decision-making (15):

The account for the chemical apparatus etc. obtained by Miss Dove amounting to £22.15.10 was laid upon the table. It was explained that every economy had been used in the purchase of the necessary materials and in the circumstances it was agreed that the full amount should be paid by the Council, although exceeding the sum formerly agreed upon.

In England, the leading girls' school for experimental chemistry was the North London Collegiate School (NLCS) (16). From its inception in 1850, the founder, Frances Mary Buss had included chemistry in the curriculum, her father, Robert Buss teaching the subject by means of demonstrations with memorable "smells and explosions" (17). Moving the school to a new building in 1885 enabled her to incorporate a custom-designed chemistry laboratory in which the girls could do hands-on experiments themselves (Figure 1). Of particular note are the individual vents over the lab benches. The laboratory was designed by the renowned architect of technical and college buildings, Edward Cookworthy Robins, the original plan for the NLCS laboratory (Figure 2) being included in his monograph *Technical School and College Building* (18).

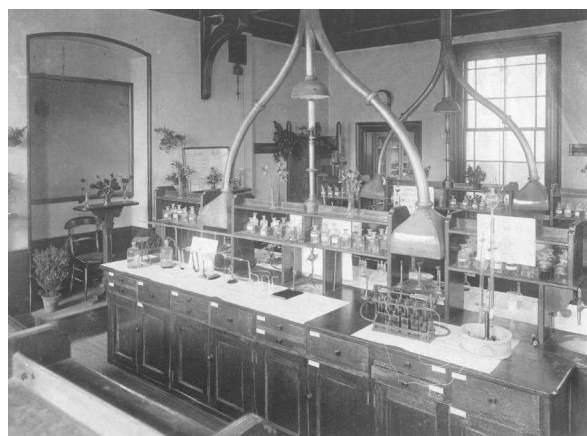


Figure 1. Chemistry laboratory at the North London Collegiate School, built in 1885, photo taken ca. 1890. Photo from North London Collegiate School Archives, by permission.

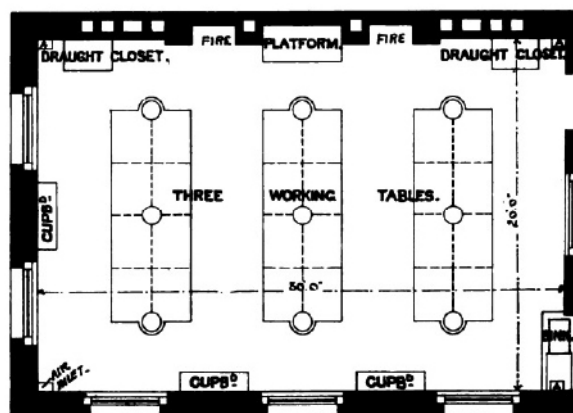


Figure 2. Plan of the chemistry laboratory at the North London Collegiate School, built in 1885. Plate 52, Ref. 18.

Schools of the Girls' Public Day School Company

The NLCS was regarded as a role model for subsequent independent girls' schools, to provide for girls an education comparable—or even superior—to that offered at the best boys' schools. In particular, the Girls' Public Day School Company (GPDSC) was inaugurated to provide a supervisory body for a network of girls' day schools (19). The first of these schools was opened in 1873 and others followed, many communities clamoring for their own GPDSC school. By 1900, there were 33 schools and a total of 7000 students. The central Council held sway in many matters, including curricula and many minutiae, including chemistry laboratories.

Though some of the GPDSC schools already incorporated a chemistry laboratory, in 1882, an edict went to all GPDSC schools that any new school building must incorporate a chemistry laboratory (20):

A chemical laboratory should be provided not less than 15 ft. wide and 16 ft. to 20 ft. long. It should be fitted with the necessary working tables and sinks. The ventilation arrangements should be similar to those in classrooms except that two shafts should be provided instead of one. One flue should be provided for ventilating the closet used for producing noxious gases.

The Council made it clear that costs were to be controlled (21):

They [the Council] recommend that in all Schools where there is practical teaching in Chemistry, a charge of not less than 5s. per Term shall be made for materials to each pupil doing Laboratory work,

and that all breakages shall be replaced by the pupil responsible.

Excellence in the teaching of chemistry was a major goal of the GPDSC as a means of establishing the academic reputation of their schools. To this end, a Conference on the Teaching of Science with Especial Reference to Chemistry (22) was organized by the Council in 1896, and chemistry teachers from all GPDSC schools were required to attend. There were two speakers, Ida Freund (23), the leading woman chemistry educator from Newnham College, Cambridge, and Henry Armstrong (24), of the Central Technical College (later part of Imperial College). Both speakers were fervent believers in the centrality of the laboratory experience for the teaching of chemistry. Armstrong proselytized his heuristic method of learning science. This form of learning through experimental work was, he contended, the only satisfactory way of truly understanding an experimental science, such as chemistry.

Following from the Conference, a detailed syllabus for the teaching of chemistry, including laboratory work, was produced by W. W. Fisher, Aldrichian Demonstrator of Chemistry in the University of Oxford (25). The complete listing of topics to be covered was circulated to all GPDSC schools. This was followed by a second conference in 1900 at which Armstrong again presented the arguments for the heuristic method of teaching chemistry (26). A further detailed syllabus for theory and laboratory work was published in 1902 and reprinted in 1912 (27).

Many schools took photographs of their new chemistry laboratories and, in some cases, photos showing students (and teachers). These photos give a fascinating insight into the facilities and into the experiments performed, even though some were clearly staged. Figure 3 shows the early chemistry laboratory at the GPDSC Shrewsbury High School for Girls. Titrations can be seen, while the teacher appears to be demonstrating gas collection. Despite the apparent enthusiasm, in 1900, the visiting GPDSC chemistry examiner at Shrewsbury, Dr. J. R. Green, was less than impressed with the one year's chemistry by the twelve girls in the 5th form class (28):

The girls, as a rule, remember the visible changes that occur in a particular reaction, but have no idea of the quantitative changes, and know practically nothing of what is actually taking place. For instance, they know that hydrogen is produced by the action of zinc on sulphuric acid, and know how to collect it, but know little about the quantity of gas produced from a given amount of zinc, and absolutely nothing as to the changes undergone by the acid or the zinc.



Figure 3. Chemistry laboratory, Shrewsbury High School for Girls, built in 1898, photo taken 1906. Photo from Shrewsbury High School Archives, by permission.

As each GPDSC school introduced laboratory work in chemistry, formal practical examinations were administered. The reports on these examinations were submitted to the Council of the GPDSC. For example, the 1886 report on chemistry examinations for Gateshead High School for Girls stated (29):

Division I. This Form took a paper on the South Kensington Advanced Course [in Chemistry]. Of the nine girls two were good, two moderately good, and the rest very weak. The same Form took a paper in Practical Chemistry. The work was, as a whole, extremely good, only two or three girls failing to find all the bases and acids set. The chief deficiency was in drawing conclusions from experiments, the results of which seemed in many cases not to warrant the conclusion arrived at.

Many GPDSC schools had already converted a classroom or other available space to a chemistry laboratory. The first chemistry laboratory at Oxford High School for Girls was a converted classroom, though it was used for a wide range of experimentation, from gravimetric and titrimetric quantitative analysis through to charcoal block and blowpipe qualitative analysis. A muffle furnace with exhaust vent is also visible (Figure 4).

By the 1900s, most GPDSC schools had a properly-equipped chemistry laboratory, but there were a few exceptions, one being the GPDSC Notting Hill and Ealing Girls' School. As shown in Figure 5, even in the 1920s, a classroom at that school was being used for practical chemistry. Along the window side-wall, it would appear that some reaction involving a drying U-tube is being employed.



Figure 4. Chemistry laboratory, Oxford High School for Girls, photo taken ca. 1900. Photo from Oxford High School Archives, by permission.



Figure 5. Chemistry class and laboratory session at Notting Hill and Ealing High School for Girls, photo taken in the 1920s. Photo from Notting Hill and Ealing High School Archives, by permission.

Practical Chemistry at Other Independent Girls' Schools

The Council of the GPDSC had clearly made practical chemistry a key part of the program at all of their schools. So did those of many other independent schools. Bedford High School for Girls was very highly-rated in 1900, having been chosen by the prestigious girls' magazine, *Girls' Realm*, to include in a series on outstanding British girls' schools. The author of the article, Christina Gowans Whyte, noted: "Two science laboratories are fully appointed for all grades. Practical work in chemistry is included in the curriculum" (30). Figure 6 shows the chemistry laboratory, constructed in 1887, with a distillation set-up in the foreground.

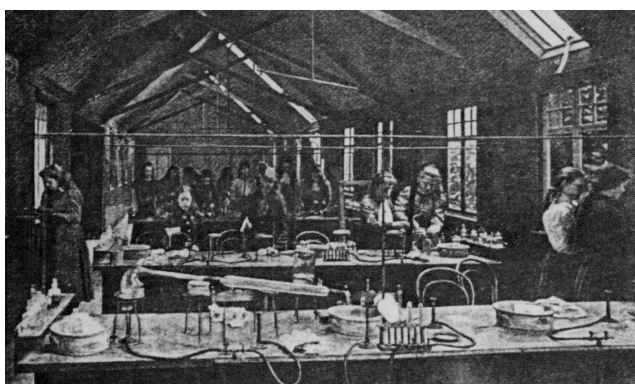


Figure 6. Chemistry laboratory, Bedford High School for Girls, built in 1887, photo taken 1902. Photo from Bedford High School Archives, by permission.

There were several books on chemistry experiments for high school students published during the 1880-1920 period. Perhaps the most authoritative version of required experimentation appeared as a series of lengthy articles in the journal, *School World*, in 1900 (31), following the syllabus necessary for the junior local examinations of Oxford and Cambridge Universities. The series starts with the distinguishing of a physical and a chemical change by heating a platinum wire, then a strip of magnesium, followed by observations of chemical changes by reacting iron and sulfur and also by heating mercury(II) oxide to give globules of mercury metal. All experiments were to be performed by the students themselves. Many of the later experiments revolve around gas collection, and Figure 7, the chemistry laboratory at Bedford's other girls' private school, the Bedford Girls' Modern School (later the Dame Alice Harpur School), shows the girls collecting and studying gases.



Figure 7. Chemistry laboratory, Bedford Girls' Modern School, photo ca. 1910. Photo from Dame Alice Harpur School Archives, by permission.

Even the smallest independent girls' school had to have a chemistry laboratory. Howell's School, Llandaff, Wales, was one example. The school authorities con-

structed a chemistry laboratory in an attic over a stable in the grounds of the school. Figure 8 shows a lonely student at Howell's School undertaking the ubiquitous acid-base titration.



Figure 8. Chemistry laboratory, Howell's School, Llandaff, Wales, photo ca. 1890. Photo from Howell's School, Llandaff, Archives, by permission.

By the 1920s, organic chemistry experiments were becoming more common and sophisticated. For example, Figure 9 shows a steam distillation in progress in 1925 at St. Leonard's School, St. Andrew's, Scotland.



Figure 9. Chemistry laboratory, St. Leonard's School, St. Andrews, Scotland, 1925. Photo from St. Leonard's School Archives, by permission.

The Decline of Practical Chemistry in Girls' Schools

Enthusiasm for practical chemistry seems to have waned by the 1930s. One cause was the concern of the significant costs versus limited benefit for most girls. Together with the tightening of finances, there was a greater emphasis on an education for girls toward the

roles of wife and mother and this demanded more time and resources for the domestic sciences (32). An additional reason was the lack of new chemistry teachers. Our research has shown that most of the chemistry teachers were born and educated in a narrow time-frame around the end of the 19th century. These pioneering women were enthusiastic about chemistry and devoted their entire adult lives to teaching chemistry. As they died, or in a few cases, married later in life, there seem to have been few in the post-suffragist era willing to see teaching chemistry as their sole future. In fact, the decline of chemistry did not happen at the same time at every school. A much better correlation can be found from the death or retirement of the chemistry teacher who had been at that particular school for decades. With the loss of these dedicated teachers, the existence of advanced chemistry courses at these schools in the early years often became forgotten.

The change in attitude can best be followed through the *Council Minutes* of the GPDSC. In a report of the Government Inspectors of 1922, it was stated that for the GPDSC Clapham High School for Girls: "Biology should be dropped in favour of more Chemistry and Physics, if the girls were to enter the Advanced Course as properly equipped as the boys." (33) Thus the focus at that period was on university-bound girls and equality with boys' schools.

By contrast, eight years later in 1930, a discussion took place among GPDSC science teachers on the teaching of biology in the GPDSC schools (34):

Miss Esdaile urged that Biology should be a compulsory subject, especially as such a small percentage of girls went on to Universities. ... Miss Haig Brown agreed that Biology was the best [science] subject for girls not going to a University. ... Miss M. E. Lewis and Miss Cossey said that Biology developed thought along interesting lines, made girls healthy and natural, and fitted them for public health work and social life.

And so this came to pass. For example, in 1931, it is noted that one of the GPDSC schools, Bromley High School, had dropped chemistry in favor of "General Elementary Science (Physics and Chemistry)," while another, Tunbridge Wells High School, was dropping chemistry for botany (35). By 1932, the general opinion of the GPDSC Education Committee was to replace the individual science courses by "General Science" (36). The change in emphasis become particularly apparent in the 1938 report for South Hampstead High School: "The only change in the curriculum this year has been the introduction of Cookery into the Lower Fifth and Sixth

Form Syllabus. This was made possible by the conversion of the old Chemistry Laboratory into a cookery-room and dining-room" (37). And, as the GPDSC schools were often the leaders, so it is likely that other girls' schools followed.

Commentary

We have shown in more detail that the teaching of chemistry, including a significant laboratory experience, flourished at British independent girls' schools between the 1880s and the 1930s. In addition to written accounts, we have collected visual evidence of the laboratories, a few examples of which have been shown here. In some photographs it is possible to deduce the type of experimentation. Reasons for the decline in chemistry teaching and, indeed, the "collective amnesia" of this era have been suggested.

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About the Authors

Marelene and Geoff Rayner-Canham have been active researchers into long-forgotten or overlooked early women chemists. Among the books they have authored are *Chemistry Was Their Life: Pioneering British Women Chemists, 1880-1949* (2008) and *Women in Chemistry: Their Changing Roles from Alchemical Times to the Mid-Twentieth Century* (1998). They were the editors for *Creating Complicated Lives: Women and Science at English-Canadian Universities, 1880-1980* (2012). Currently, they are undertaking a comprehensive study of the teaching of chemistry at pioneering British girls' schools.