

Chapter 1

Getting an Education

Access to education was crucial to the advancement of women in science. These days one takes for granted that girls should have the same secondary and tertiary education as boys, but up to the last two decades of the 19th century such ideas were heretical. It is therefore crucial to our saga on the pioneering women chemists that we spend a whole chapter on the many barriers to a girl's education and the ways in which these challenges were overcome. As we shall see, certain individuals — “the agents of change” — played crucial roles.¹

Education for Girls

Even before there were any academic schools for girls, some young women yearned for an education. As Gillian Avery has noted:

A passionate desire for learning seems to have been characteristic of many of the early nineteenth-century girls ... With dedicated self-discipline many girls worked at home, teaching themselves Latin, Greek, and German, reading Dante, translating Schiller, in between the demands that their families made upon them.²

The first controversy was that of the most appropriate type of secondary education for girls: whether the educational content should involve academic subjects, or simply focus on those

activities that would make girls into better wives and mothers.³ In 1868, the antifeminist writer, Sarah Sewell, contended:

... profoundly educated women rarely make good wives or mothers. The pride of knowledge does not amalgamate well with the every-day matter of fact rearing of children, and women who have stored their minds with Latin and Greek seldom have much knowledge of pies and puddings, nor do they enjoy the hard and uninteresting work of attending to the wants of little children.⁴

Lydia Becker made the contrary case in 1869, arguing that a training in science would be particularly beneficial for girls:

Prevalent opinions and customs impose on women so much more monotonous and colourless lives, and deprive them of so much of the natural and healthy excitement enjoyed by the other sex in its free intercourse with the world ... many women might be saved from the evil of the life of intellectual vacuity, to which their present position renders them so peculiarly liable, if they had a thorough training in some branch of science, and the opportunity of carrying it on as a serious pursuit.⁵

There was no dispute about education for working-class girls. The aim was simple: to prepare them for marriage and children in the context of religious devotion. The possibility of any further aspirations was firmly dismissed in this comment of 1861:

... it is to be hoped that no desire to make girls little Newtons, little Captain Cooks, little Livingstones, little Mozarts and Handels, and little Sir Joshua Reynoldses, will ever take us too low for keeping in sight the object of teaching them to make and mend shirts, to make and mend pinafores, and darn stockings and socks.⁶

Pioneering Schools

Quaker schools initially led the way. The Quaker religious principles allowed women to play an active role in both the public and private spheres of the Religious Society of Friends.⁷ In the history of The Mount School, a Quaker school in York, Winifred Sturge and Theodora Clark comment in general on the reason why Quaker schools for girls benefited from the austere aspects of the Quaker movement:

Looking back on the [eighteen] sixties, we may feel satisfied that among girls' schools of the country, Quaker schools were indubitably in the front rank. The very narrowness of the curriculum — no music, dancing, or singing, no fine needlework — left space and time available for better grounding in history, arithmetic, and geography, and for relatively wider reading in English literature.⁸

Edward Grubb taught chemistry at the School (in addition to Latin, mathematics, and psychology), and Sturge and 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.”⁸

There were two Quaker women in particular, Priscilla Wakefield and Maria Hack, who popularised science and promoted scientific literacy in the early 19th century.⁹ Science education became accepted for both Quaker boys and girls. In Bristol, the Quaker Dr. Thomas Pole gave lectures in general science for school children and young adults, the series starting with a course on chemistry.⁷ At Susanna Corder’s Quaker School for Girls in Stoke Newington, she acquired the assistance of the scientist and political radical, William Allen.¹⁰ As one of the students, Louisa Stewart, later recalled: “William Allen gave the girls lessons in his own house in chemistry ...”¹¹; while

Jane Heath, at Sarah and Harriet Hoare's Quaker school in Frenchay, wrote in 1820 to her mother:

We rise a little before seven and study Geography till eight with dissected maps. After breakfast we make our beds and into school again by nine ... I have then to write a page of English and Natural History, lectures on Chemistry, Botany, etc., besides parsing and a slateful of exercises so that I cannot always finish before dinner.¹²

During the latter half of the 19th century, a range of academic schools for middle-class girls sprang into existence. We will describe a few of the most important of these in the following sections. Contemporary accounts of life at these schools from the 1860s to the 1920s usually paint a rosy picture; however, as Sara Delamont has uncovered, life was far from idyllic: the schools demanded total silence by the girls at all times during school hours, often including playtimes and breaks.¹³ The headmistresses and teachers at these schools met fierce opposition from several directions, as Delamont notes:

The feminist pioneers who opened academic secondary schools for young girls in the second half of the nineteenth century did so against a body of medical opinion, religious orthodoxy, and a widespread belief among their potential clientele (that is, middle- and upper-middle-class parents) that such institutions were dangerous. A pupil, or a member of staff, at an academic secondary school was held to be in physical danger (her health would suffer, she might become subfertile or die of brain fever); in moral danger (away from the control of her mother she might meet anybody) and liable to forfeit her marriage prospects for men who would not want a wife who knew algebra.¹⁴

The dedication and fearlessness of these pioneering headmistresses cannot be overemphasised. As a result of their

efforts, and the girls' schools they founded, late 19th-century girls were able to obtain an academic education and hence have the requirements to enter university.¹⁵ And it was very young shoulders who bore this burden incredibly well, as Nonita Glenday and Mary Price have noted: "Most of the headmistresses were in their early twenties, very young for the responsibilities they were carrying, and had led sheltered lives."¹⁶

In our studies, four particular schools provided models for the science education of girls: North London Collegiate and its offspring, the Girl's Public Day Schools; Cheltenham Ladies' College; King Edward VI School for Girls; and Manchester High School.

North London Collegiate School

It was Frances Mary Buss who founded the North London Collegiate School for Ladies, as it was first named, later called the North London Collegiate School for Girls (NLCS).¹⁷ Buss, born in 1827, was the daughter of Robert William Buss, an engraver and illustrator, and Frances Fleetwood. When only 14 years old, Buss started her own teaching career at the Mrs. Wyand's School on Mornington Place, the school she herself had attended. Four years later, she and her mother opened a preparatory school for young children in Kentish Town. From 1849 to 1850, she attended the night classes at Queen's College for Women, Harley Street (see Chap. 4), from which she obtained teaching certificates in French, German, and geography.

Having acquired formal qualifications, Buss opened the NLCS in 1850 as a day school for the education of daughters of the local middle-class community, often of limited means, such as the daughters of clerks or tradesmen.¹⁸ One of the students, Molly Hughes, had been delighted to move from a fashionable "snobby" school to NLCS: "Now at the North London I sensed at once a different atmosphere. No one asked where you lived, how much pocket-money you had, or what your father was — he might be a bishop or a ratcatcher."¹⁹

Buss wanted her school to give girls a very different education from that prevalent at the other girls' schools: she wanted her pupils to have equal opportunities to boys, and that included real science:

It [NLCS] also set out to offer their daughters an education quite different from anything available anywhere else. There was, for example, the inclusion of science within the curriculum. Science was not really taken seriously by most girls' schools until well into the twentieth century. Robert Buss [Frances Buss's father] made a memorable science teacher as Annie Martinelli, an early pupil later remembered: "His talents were simply wonderful. His Chemistry series was marvellous, especially for smells and explosions." He was the first of a series of outstanding science teachers at the School where learning by rote was replaced from the beginning by encouraging pupils to learn by thinking for themselves.²⁰

After Buss died in 1894, the strong science program at NLCS was continued by the second Headmistress, Sophia (Sophie) Willcock (Mrs. Bryant). Born in 1850, Willcock, daughter of Rev. W. A. Willcock (Fellow of Trinity College, Dublin), entered Bedford College in 1866. She married Dr. W. Hicks Bryant in 1869, and upon his death in 1870, Willcock obtained a teaching position at a school for ladies in Highgate. In 1875, she joined the staff at NLCS and was appointed Headmistress in 1895. During her "reign," the presence of laboratory facilities at NLCS was specifically mentioned in the girls' magazine, *Girl's Realm*: "Beyond is a chemical laboratory well fitted up and large enough for twenty-four girls to work together at one time."²¹ She was Head until 1918, dying in 1922 after becoming lost on a mountaineering holiday in the Alps.

Buss' father, Robert, had taught the science classes in the early years, with the first qualified science teacher, Grace Heath,²² being hired in 1888. Heath had been a chemistry

student with Henry Armstrong (see Chap. 2) at the Central Technical College. Unfortunately, Heath died in 1895, her position passing to Rose Stern (see Chap. 2). Stern ensured that chemistry was a prominent subject at NLCS. One of her students reported how well the NLCS lab was, compared with that of Holloway College during a school visit there in 1897: “A hasty peep into the laboratory showed that it was very much like our own school laboratory, but, as someone triumphantly remarked, much more untidy,”²³ There was a hand-written and illustrated student science magazine, *The Searchlight*, which mentioned Chemistry Club social events such as: “On Thursday, July 11th [1912], Miss Stern, Miss Drummond and the Science Sixth gave a party in the Old Laboratory. We drank tea out of beakers, and stirred it with long glass wands....”²⁴

The Girls’ Public Day Schools

NLCS became the model for the girls’ schools financed by the Girls’ Public Day School Company (GPDSC), later the Girls’ Public Day School Trust.²⁵ The formation of the GPDSC was the greatest success of the National Union for Improving the Education of Women of all Classes, widely known as the Women’s Educational Union. The funds raised by the Company were used to found independent, affordable, academically selective girls’ schools (see Table 1.1). These schools had an influence on the educational opportunities for girls far beyond their numbers, particularly in providing many of the entrants to universities.

In the early years, the Heads and Assistants of GPDSC schools were required to visit NLCS before taking command of their own school in order to study and reproduce the methods and organisation of the NLCS.²⁶ In fact, the renown of NLCS as a model was such that each term there were visitors not only from the British Isles, but also from the European countries, Canada, Australia, the United States, China, and Japan.

Table 1.1. The Girls' Public Day School Company schools opened 1873–1901.

Birkenhead High School	Notting Hill & Ealing High School
Blackheath High School	Oxford High School
Brighton & Hove High School	Paddington & Maida Vale High School ^a
Bromley High School	Portsmouth High School
Carlisle High School ^a	Putney High School
Central Newcastle High School	Royal High School, Bath
Clapham High School (merged)	Sheffield High School
Hackney (later Clapton) High School ^a	Shrewsbury High School
Croydon High School	South Hampstead High School
Dover High School	Streatham Hill High School (merged)
Dulwich High School ^a	Sutton High School
East Liverpool High School (merged)	Swansea High School ^a
Gateshead High School (merged)	Sydenham High School
Highbury and Islington High School ^a	Tunbridge Wells High School ^a
Ipswich High School	Weymouth High School ^a
Liverpool High School	Wimbledon High School
Newton Abbot High School ^a	
Nottingham High School	

^a Those schools later closed or exited the GPDSC.

The importance of Buss and the NLCS in providing the template for the GPDSC cannot be overemphasised. In 1900, there was a formal three-day Jubilee celebration of the founding of NLCS, including a service at St. Paul's Cathedral. An account of the several events in *The Magazine of the Manchester High School* ended with the following passage:

Thus was bought to a close one of the most interesting events of our time — the Jubilee of the first “High School for Girls,” the success of which has meant so much for all of us; for to Miss Buss's efforts we owe the inception of the whole movement, and were it not for her valiant struggles against much opposition, the establishment of Girls' High Schools, and the opening of the Universities to women, might have been greatly retarded.²⁷

Cheltenham Ladies' College

The Young Ladies' College, Cheltenham (CLC), was opened in 1854.²⁸ Though it, too, was to offer an excellent training in science, it was very different to NLCS; the CLC was designed as a boarding establishment catering to a socially-elite clientele. Initially, the school followed the traditional view of the education of young women as was enunciated by the first report issued by the Governors:

The school intends to provide an education based upon religious principles which, preserving the modesty and gentleness of the female character, should so far cultivate a girl's intellectual powers as to fit her for the discharge of those responsible duties which devolve upon her as a wife, mother and friend, the natural companion and helpmate for man.²⁹

Over the first 4 years, the enrolment declined. Then the Governors appointed Dorothea Beale³⁰ as the second Principal and everything changed. Beale, the daughter of Miles Beale, a surgeon, and Dorothea Complin, was initially educated by a governess, but then she was sent away to school — an experience which convinced her of the need of a radical overhaul of girls' education:

It was a school considered much above average for sound instruction; our mistresses had taken pains to arrange various schemes of knowledge: yet what miserable teaching we had in so many subjects; history was learned by committing to memory little manuals; rules of arithmetic were taught, but the principles were never explained.³¹

In 1848, Beale, like Buss, attended Queen's College for Women where she excelled, being appointed their first mathematics tutor after her graduation. However, she became dissatisfied with the College and left to become Head Teacher at Casterton

School, Cumbria. Her attempts to reform that school failed and she resigned within 1 year. During the next year, Beale wrote *A Textbook of General History*, and the success of this book contributed to her appointment as Principal of CLC. Here, at last, she was able to put her strong principles into action.

The construction of science laboratories was one of Beale's priorities. This was accomplished as noted in a description of the school in a 1900 issue of *Girl's Realm*: "in the Science Department there is a laboratory for physics and two for chemistry ..."³²; while a new Science wing was added in 1904 that was designed by Millicent Taylor, the woman chemist who linked CLC and University College, Bristol (see Chap. 5).³³

Beale of CLC and Buss of NLCS were two of the most important figures in women's education in Britain. They had met at Queen's College for Women and, from then on, their lives were intertwined. For example, in 1874, they were both instrumental in the formation of the Association of Head Mistresses, Buss being the first President while Beale was the first Chairman. Their names were even coupled in an anonymous rhyme:

Miss Buss and Miss Beale
Cupid's darts do not feel.
How different from us,
Miss Beale and Miss Buss.³⁴

The CLC differed from the other girls' high schools in that, during the early period, students could actually complete an external B.Sc (London) degree. In 1904, Sophie Bryant visited CLC and described the two alternative futures for the College as was reported by Millicent Taylor: "Mrs. Bryant expressed the view that the Cheltenham Ladies College could (1) develop as a public school sending more and more students to university or (2) become a 'great University College of the West of England; perhaps the centre of a Women's University'."³³ The issue of a "Women's University" periodically arose, usually to be rejected by the large majority of women on the grounds that men would

immediately label it as “inferior” to the male-based universities and it would serve to ghetto-ise women. Thus, CLC adopted the first course, ceasing to cater to degree students while University College, Bristol, rose in prominence as the centre for higher education in the southwest of England (see Chap. 5).

Beale remained as Principal of CLC until her death in 1906 — a “reign” of 50 years. The philosophy changed under the next Headmistress, Lilian M. Faithfull, who had been Vice-Principal at King’s College, Ladies’ Department (see Chap. 3). Academic success was no longer the prime focus. Faithfull gave her views in 1911:

In recent years there has been a widespread movement to bring the education of our girls into relation with their work as home-makers. The old “blue-stocking type, who prided herself on not knowing how to sew or mend, and who thought cooking menial and beneath her, no longer appeals to anyone ... we want our girls to grow up into sensible, methodical, practical women, able to direct intelligently and practically the manifold duties of home ...”³⁵

King Edward VI High School for Girls

In 1547, the Act of Suppression required the confiscation of all assets of religious guilds except for an amount of land with an annual income of £21 if the guild supported a school. The Guild of the Holy Cross in Birmingham had no school, but it persuaded the Earl of Northumberland (also the Lord of the Manor of Birmingham) to release land for the creation of a school. As a result, a Foundation was created in 1552 under King Edward VI for a Free Grammar School for boys. In 1883, the Charity Commissioners agreed to allow the opening of more schools under the same name, including the King Edward VI High School for Girls (KEVI).³⁶

The first Head was Edith Elizabeth Maria Creak. By the time of her arrival at KEVI at age 27, she was already a veteran,

having been appointed the first headmistress of Brighton and Hove Public Day School (a GPDSC school) before her 20th birthday. The School biographer, Winifred Vardy, noted: “To Miss Creak belongs the honour of being a pioneer in the teaching of science to girls. Though her own training [with Clough at Newnham College, Cambridge] had been mathematical and classical, she seems to have foreseen the value of scientific knowledge for women.”³⁷

Creak hired three dedicated and enthusiastic science staff, all Newnham graduates: Lizzie Davison, Alice Celia Slater, and Josephine Bingham. Another School biographer, Rachel Waterhouse, commented:

Miss Davison and Miss Slater took charge of science, each stayed for thirty-one years at the School, and to them belongs almost all the credit for the great scientific successes achieved by Edwardians during the whole of that period. King Edward’s Girls High School became the outstanding girls school for science in the country.³⁸

Vardy also quotes a former student:

Miss Davison also used to take the XIIth Class, little girls of 8 to 10, in the principal gases. “She did all the demonstrations, which according to modern ideas was bad,” writes a pupil, “but she made it so interesting that I used to be impelled to tell my small brother all about it each week, and what she taught us *sticks*.”³⁹

Some KEVI students obtained permission to attend the men’s classes of practical physiology at Mason College (later the University of Birmingham, see Chap. 5). Another former student commented:

This meant our entering the sacred medical department of the College, and one of the demonstrators, who has since become

known for his research work, announced that he would leave if those little girls from the High School came to his laboratory. He did not keep his word. The “little girls” referred to were Professor Winifred Cullis, Dr. Ida Smedley Maclean, and Hadda Hough. A year later Mary Phillip and Hadda Hough attended also the Chemistry Department of the College, both for lectures and for practical work in Organic Chemistry.⁴⁰

A new building for KEVI enabled students to complete all of their science studies within the school and, as Vardy commented: “... the Science Classes had the best laboratories of any Girl’s School in England.”³⁷ The new building was opened by Eleanor Sidgwick (see Chap. 6), Principal of Newnham College, on 18 November 1896. In her address, Sidgwick not only commented on the flow of graduates from Newnham to teach at Birmingham, but also the flow of new students in the opposite direction:

This school [KEVI] has sent up students to Newnham College every year, or almost every year, since there have been here any girls old enough to seek a university education.... I am certain that it has been an advantage of Newnham. If we were to lose it we should lose an important link with the education of the country, and we should also lose some of our best students.⁴¹

Manchester High School for Girls

In Manchester, Lydia Becker was a fervent believer that girls should be educated in science.³⁸ Becker became better known for her leadership of the Women’s Suffrage Movement, but in fact before her shift into politics she was planning a scientific career. When the Education Act (1870) created School Boards, Becker was elected to the Board for Manchester, where she led the fight for science in girls’ schools and the offering of scholarships for girls. To illustrate the effect of her initiative, in 1881, two (unnamed) girls gained first class honours in Practical

Chemistry in the science examinations in the Central (Manchester) Higher Grade Schools.⁴²

Manchester High School for Girls (MHSg) was another school to graduate several of the pioneering women chemists mentioned in this book. The first Principal, Elizabeth Day, who had also attended Queen's College with Buss and Beale, was a believer in academic education, though she "... had grave doubts as to the suitability of science teaching, especially chemistry as then taught"⁴³

However, her famous successor, Sara Burstall, swung the emphasis back towards science. In fact, the appointment of Burstall as the successor to Day was, in part, due to the desire among some of the governors that more science be taught at the school. Burstall commented that by the 1920s: "We had ... four specialist teachers on the staff, all first class honours graduates in chemistry, physics, botany and zoology, and many Old Girls were students in universities or science graduates."⁴⁴

Just as the girls at NLCS considered their chemistry laboratory to be at least equal to that at Holloway College (see above), so the girls at MHSg, visiting Cambridge in 1901, were of the opinion that theirs was superior to Newnham's laboratory: "The Newnham Chemistry Laboratory was inspected on Monday morning, but was agreed to compare very unfavourably with the Chemical Laboratory of the Manchester High School, whatever the standard of work may be."⁴⁵

The life of Burstall also illustrates the linkages amongst these powerful Headmistresses.⁴⁶ Burstall came from a poor family, but was awarded a scholarship to NLCS. From there, she proceeded to Girton College, Cambridge, then after a period as a teacher with Miss Buss at NLCS, she was offered the Headship at MHSg. Thus, MHSg, too, became modelled upon NLCS lines.

Chemistry in the Girls' Schools

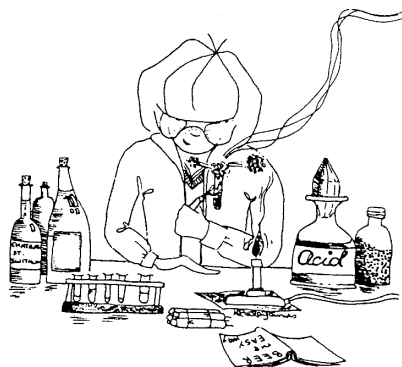
Until the last two decades of the 19th century, Jane Marcet's *Conversations on Chemistry*⁴⁷ was the key chemistry resource

for both governesses and science teachers in girls' schools. However, in that era, the girls were expected to memorise the book from cover to cover and regurgitate upon demand.⁴⁸ By the 1880s, the new progressive era had arrived with an emphasis on understanding rather than rote learning. In a definitive study of education for girls (one co-author being Beale) published in 1898, there was a chapter on *The Teaching of Chemistry* by Clare de Brereton Evans (see Chap. 4). In this chapter, de Brereton Evans argued that junior as well as senior girls needed exposure to practical chemistry:

For success in examinations it is now necessary to have a certain amount of practical knowledge of chemistry and examination classes are therefore given some practical training, but this reform still remains to be extended universally to the junior classes, which need even more than the senior ones that the teaching should be objective: a child may learn and repeat correctly a dozen times that water is composed of oxygen and hydrogen, and the thirteenth time she will assure you that its constituents are oxygen and nitrogen; but let her make the gases herself, test them and get to know them as individuals, and mistakes of this kind will become impossible.⁴⁹

As we described above, it was NLCS and KEVI that pioneered the introduction of chemistry laboratories. A few other schools followed their lead, including Redland High School, Bristol,⁵⁰ and St. Swithun's School, Winchester.⁵¹ St. Swithun's acquired a chemistry laboratory in 1895, after an open flask releasing chlorine gas was left deliberately in a classroom prior to a tour by the Administrative Committee (see Fig. 1.1). One of the students taking the chemistry practical examination in 1897 reminisced:

In those days a "don" was in charge in cap and gown. An enterprising examiner had given red phosphorus as the unknown substance. About ten minutes after we had commenced a nervous



The practical approach and independent research are introduced early in our science syllabuses...

Fig. 1.1. Pen-and-ink sketch from Bain, P. (1984). *St. Swithun's: A Centenary History*. Phillimore, Chichester, p. xvii.

candidate dropped a glowing match on the “unknown” — result, a wild flare and we all “knew”. Hardly had the invigilator extinguished this when it was discovered that a pile of dusters was on fire; this in turn was extinguished. Then suddenly the bottom came out of a medicine bottle improvised to contain sodium hydrate, devastating a varnished table and all the candidates’ papers. Warily our friend came for a third time to the rescue, remarking, “My life is insured — I only hope yours are!”⁵²

In the 1895 Bryce Commission Report on Secondary Education, it was stated that in a mixed class of 14 year olds in Oldham: “There were 20 girls and 48 boys at work at the time of my visit, all doing practical chemistry together in a splendid laboratory, fitted up with all the new improvements; uncommonly bright and happy they looked.”⁵³ In Liverpool, it was noted in the Report that all scientific subjects requiring apparatus were taught in the Central Higher Grade School, requiring the girls

to walk there and back for their science lessons. Teachers at the girls' schools planned to discontinue the arrangement. However, girls at six of the local schools petitioned to be allowed to continue with the sharing arrangement to ensure that the standard of their science education matched that of the boys.

But the fervour for science education for girls seems to have abated in the early decades of the 20th century. In 1912, the Headmistress of Sacred Heart School, Hammersmith, described how the educational reforms of the later decades of the 19th century had emphasised the teaching of natural science. She added:

So laboratories were fitted up at great expense, and teachers with university degrees were sought after. The height of the tide seemed to be reached in 1904 and 1905 ... Then disillusion seems to have set in and the tide began to ebb. It appeared that the results were small and poor in proportion to expectation and to the outlay on laboratories ... The conscientious accuracy that was to come of measuring a millimetre and weighing a milligramme was disappointing, and also the fluent readiness to give an account of observations made, the desired accuracy of expression, the caution in drawing inferences. The links between this teaching and after life did not seem to be satisfactorily established ... It begins to be whispered that even in some boys' schools the laboratory is only used under compulsion or by exceptional students, and the wave seems likely to go down as rapidly as it rose. Probably for girls the strongest argument against experimental science taught in laboratories is that it has so little connexion with after life.⁵⁴

Which Schools Produced Women Chemistry Students?

Few of the first generation of women students at university studied science, and the majority of those came from a small number of schools.⁵⁵ Janet Howarth reported on the secondary

school origins of residence women students attending either Oxford or Cambridge Colleges during the periods 1891–1893 and 1911–1913.⁵⁶ Her results showed that in the earlier period, the English secondary schools from which at least 10 women had come were (in order of decreasing numbers) North London Collegiate, Notting Hill High School (a GPDSC school), Croydon High School (a GPDSC school), Kensington High School (a GPDSC school), Cheltenham Ladies College, and Manchester High School. During the later period, the order was Cheltenham Ladies College, St. Paul’s High School, Clapham High School (a GPDSC school), St. Felix School, Wycombe Abbey, Oxford High School (a GPDSC school), King Edward VI High School, Bedford High School, and North London Collegiate.

We have collected biographical information on the 898 women chemists who became Associates or Fellows of the Royal Institute of Chemistry and/or Fellows of the Chemical Society between 1880–1949, and we were able to ascertain the secondary schools attended for 284 of them. Our analysis differs from that of Howarth’s in that we are looking at students who attended either Redbrick or Oxbridge universities and who had specifically chosen a chemistry career (Table 1.2). Nevertheless, there are strong similarities. In light of our earlier comments

Table 1.2. Most common English Schools attended by British women chemists who were Associates or Fellows of the Royal Institute of Chemistry and/or Fellows of the Chemical Society, 1880–1949.

School	Number of students
King Edward VI High School for Girls	20
North London Collegiate	11
Cheltenham Ladies College	10
Manchester High School for Girls	10
Clapham High School for Girls (GPDSC)	7
Croydon High School for Girls (GPDSC)	5
South Hampstead High School for Girls (GPDSC)	4

about the science emphasis, it is no surprise that KEVI, NLCS, CLC, and MHSG top the list. What is also interesting is that the remaining schools were members of the GPDSC, based on the North London Collegiate model.

However, one cannot generalise and say that all GPDSC schools were well equipped for chemistry. Some indeed were, such as Gateshead High School, which had a chemistry laboratory as early as 1886. On the other hand, Notting Hill High School was lacking in science facilities during the early years. Harriette Chick (see Chap. 2) recalled that: “we had no science laboratories at all and girls like myself who wanted to do Science had nothing. We learned Science almost theoretically but it was exceptionally well done.”⁵⁷ The success of some Notting Hill chemistry students (three students in our study) was more a result of the inspired teaching of Mary M. Adamson, the first B.Sc. graduate of the University of London.

It was not only the GPDSC schools that excelled in science. Malvern Girls’ College (also three students in our study) was another school proud of its science programme, as a former student, Grace Phillips, described in her biography of the Headmistress of the time, Iris Brooks:

Miss Brook’s knowledge of Science almost equalled the vacuity of her information about Physiology and Mathematics. Nevertheless, she admired wholeheartedly the work of the Science Staff. She also rejoiced when Malvern Girls’ College acquired such a reputation for achievement in scientific circles that it became the first Girls’ school to be awarded £10,000 from the Industrial Fund for the Advancement of Scientific Education in Schools.⁵⁸

What Sort of Science?

Throughout the later 19th and early 20th centuries, there was an ambivalence about the purpose of an academic education for girls.⁵⁹ Should the school topics be aimed at the majority who

were going to be wives and mothers, or the minority who were going to pursue careers? The same discourse was trying to define the more appropriate chemistry for girls: should girls study domestic science for their role as a homemaker, or academic science — including chemistry — to provide them with career options?⁶⁰

A leading exponent of domestic science for girls was Arthur Smithells, Professor of Chemistry at Leeds University (see Chap. 5). Smithells was part of the “Science for All” movement, which was concerned with the low level of scientific awareness among the general population.⁶¹ Members of the Movement contended that humanisation of science was the answer, in which scientific principles were related to people’s daily lives. Smithells saw domestic science as a means of bringing an applied aspect that would, in particular, be appropriate in the education of girls.

What was domestic science? This, in itself, was a contentious issue, and in its teaching there seemed to be two extremes, as a report of 1911 indicated:

The course may consist of little more than an ordinary course of Experimental Science ... with certain items in the Chemistry section of it, which fit in with housecraft requirements, tacked on the end; or it may consist of a course in which the housecraft bias is dominant throughout, a course consisting in fact of a kind of “Applied Science” from the outset.⁶²

Having fought hard for getting girls an academic education equal to that of boys, many women scientists opposed domestic science as a turning back of the clock, limiting girls’ aspirations and opportunities to that of domesticity. Ida Freund (see Chap. 6), Lecturer in Chemistry at Newnham College, critiqued the whole idea of domestic science in the feminist publication, *The Englishwoman*:

It was erroneous to think that through the study of the scientific processes underlying housecraft and especially cookery,

you can teach science, that is, give a valuable mental training which should enable the pupils in after life to judge whether an alleged connection between effect and cause has been established or not.⁶³

Debate continued throughout 1911 and 1912. Lucy Hall and Ida Grünbaum, Science Lecturers at Avery Hill (Teachers') Training College, Eltham, supported Smithells⁶⁴; while Hilda J. Hartle (see Chap. 13) of Homerton College, Cambridge, pointed out: "The science of cookery and of laundry work is yet in its infancy. No literature of the subject exists. Not even the most brilliant organic chemist can be said to 'know' the chemistry of foods, still less can such a subject be within the grasp of students in training."⁶⁵

Six months later, Hartle wrote a scathing attack⁶⁶ on a book of domestic science written by R. H. Jones, Head of the Chemistry Department, Harris Institute, Preston, in which he claimed that: "science can be directly and adequately taught in the kitchen and that a previous training in elementary science is not indispensable." Hartle not only attacked the book in principle, but also pointed out the many errors in science that it contained, particularly "loose phraseology" such as: "distilled water contains nothing and is quite soft; fruit contains as a rule 80% of water and this is in pure condition."⁶⁶

Though most women science educators favoured the pure classical sciences, there were a few who argued for a hybrid solution, one being Margaret Seward (Mrs. McKillop — see Chap. 3) of King's College for Women. Seward contended that pure and applied chemistry could be interwoven: "It was perfectly possible to make the outlines of the changes occurring in for example saponification clear to a class that had been trained in elementary chemistry and had further made acquaintance with some typical organic compounds."⁶⁷

Rose Stern (see Chap. 2), the science teacher at NLCS, argued that using household chemicals would enable girls to

better appreciate academic chemistry: "... every good teacher in science in a girls' school should look for examples for experiments from substances which are known to the pupils, for example, there is no reason why washing soda should not be used instead of another carbonate, and Epsom salts as a type of sulphate."⁶⁸

However, the tide was against the "domestic science as science" movement in schools. William Tilden, a strong supporter of women chemists (see Chap. 2) and long-time President of the Chemical Society, gave an address in 1911 to the Science branch of the London Section of the Assistant Mistresses in which he stated: "Applications are not easy, and there is no satisfactory book on the chemistry of common life. Hence it is doubtful whether domestic science can form a proper University faculty."⁶⁹

Faithfull concurred:

The foundations of a knowledge of chemistry and physics should be built up on a well-ordered system which must not be subordinated from the outset to the requirements of home science. The teaching of science during the school years should be such as to prove equally useful to the pupil who elects to take at a later stage a university course in science and to the pupil who enters upon the home science course.⁷⁰

There was a final bout of correspondence in 1914 — one which would resonate even today. It was initiated by Isabel C. Fortey, sister of chemist Emily C. Fortey (see Chap. 5):

The review in your August number of Mrs. White's "First Book of Experimental Science for Girls" begins with the words, "To those who have studied the problem, it has long been obvious that girls require a course in science quite different from that which it has been customary to provide for boys." Such a statement will not be allowed to pass unchallenged because Miss Freund is dead.⁷¹

Fortey then argued that a girl had to do the same science as her brother in order to compete with him at science studies in

university, or if she wanted to become a doctor. In reply, Jesse White contended that she was not in favour of teaching girls domestic science, but that science should be taught as relevant to girls' lives rather than assuming "... the only girls who really matter are the few who will go on to university."⁷²

In the end, with the antipathy of most of the women science teachers, domestic science ceased to be an acceptable alternative science subject for girls. As illustration, Sutton High School closed its domestic science department in 1916.⁵⁹ By 1918, domestic science had been relegated to a low-status nonacademic subject.⁶⁰ The high-school debate was over.

University for Women?

Looking back at the late 19th century, it is astonishing to see how quickly the battle moved from the question of the admission of girls to secondary school education to that of university education. This is due to a couple of factors. Firstly, a number of organisations sprang up across the country to proselytise where possible and badger where necessary.⁷³ There were numerous local schoolmistresses and ladies' educational associations, including the Manchester Board of Schoolmistresses, the London Association of Schoolmistresses, the Leeds Ladies' Educational Association, and the Hampshire Association for Promoting Female Education. Then there were regional organisations, such as the North of England Council, together with the national organisation, the Women's Educational Union (the organisation instrumental in the founding of the GPDSC; see above). Each of these organisations was lobbying between 1865 and 1885 for the higher education of (especially middle-class) women.

The New Girl

A second factor was the production of a more assertive generation of middle-class girls who saw wider horizons for themselves.

Sally Mitchell has contended that the introduction of the school uniform promoted among young girls a liberating sense of “girlhood”:

I wonder, however, whether late-twentieth-century school-girls’ joy in getting rid of school uniforms when they leave adolescence comes anywhere close to the turn-of-the-century girl’s dramatic liberation when she first dressed in a costume distinctly her own, which marked her as neither child nor woman, had pockets, made it possible to run and climb, and let her add a boy-style shirt and tie.⁷⁴

Victorian and Edwardian middle-class girls discovered role models through the new magazines for girls that appeared: the *Atalanta* (1887–1898), the *Girl’s Realm* (1898–1915), and the *Girl’s Own Paper* (1880–1927).⁷⁵ Though the viewpoint depended upon the editor of the time, these magazines were very forward-thinking and quite adult in their messages. The issues contained a significant proportion of intellectual material, including articles on science topics and reviews of colleges and universities for young women.

Some of the content was quite subversive. For example, an issue of the *Girl’s Realm* of 1914 carried an article, “The Woman of the Future,” which expounded at length that: “One of the greatest social crimes that has ever been committed was man’s enslavement of woman.” The author anticipated women’s future role:

Woman is taking to herself a new significance. She is discovering that she, as well as man, has another message for humanity besides that presented by wife and mother, and that henceforth she is to fulfil an entirely new mission in civilization. ... The new woman protests against having her life absorbed in ministering to man, in being exploited wholly for his benefit.⁷⁶

With the girls' magazines urging them forth, many of the young girls of the 1880s to 1920s saw it almost a duty of their generation to see a university education as their next goal.

University Women: For and Against

Many of the arguments which had been used for or against an academic secondary education for girls became re-used and expanded for the new issue of women's admission to university. There were three arguments by proponents of a university education for women, particularly a scientific education. These were that women would become better wives and mothers if they had a scientific background; that simple justice and equal opportunity should permit women to enter scientific careers; and that women could perform certain scientific work better than men as a result of their superior patience and manual dexterity.⁷⁷ Yet many women themselves questioned the role of higher education for their gender, in particular, whether greater knowledge conflicted with the ultimate goal of domesticity.⁷⁸

There was "scientific" evidence that could be used against women's advancement, especially the theory of evolution. For example, the sociologist Herbert Spencer had concluded that the difference between the sexes could best be understood in terms of "a somewhat earlier-arrest of individual evolution in women than men."⁷⁹ In fact, many scientists of the time had discovered proof in their research of women's "intellectual inadequacies"⁸⁰ and, of particular importance, Charles Darwin himself had found "scientific" evidence of female inferiority: "It is generally admitted that with women the powers of intuition, of rapid perception, and perhaps of imitation, are more strongly marked than in man; but some, at least, of these faculties are characteristic of the lower races, and therefore of a past and lower state of civilization."⁸¹

By the 1870s, the medical field had added its voice to the undesirability of advanced education for women. Edward H. Clarke,

a former professor at Harvard Medical School, had described in his book, *Sex in Education*, how the health of many girls had been severely damaged by education.⁸² In the 1880s, Henry Maudsley of University College, London, and John Thorburn, Professor of Obstetrics at Owens College, Manchester, contended that for women, the stress of education could have dire consequences.⁸³ When a woman student at Owens College (later, University of Manchester) died of tuberculosis, Thorburn publicly announced that the death was due to “overeducation.” It was not until the 1890s that data conclusively showed that there was no indication of ill health among women students as a result of university studies.

There was also a concern that, if women’s intellects were developed, it would result in their masculinisation, with women abandoning marriage and motherhood for academia and professions. Such a certain eventuality was put in verse in the pages of the magazine *Punch*:

O pedants of these later days, who go on undiscerning,
To overload a woman’s brain and cram our girls with learning,
You’ll make a woman half a man, the souls of parents vexing,
To find that all the gentle sex this process is unsexing.
Leave one or two nice girls before the sex your system smothers.
Or what on earth will poor men do for sweethearts, wives and
mothers?⁸⁴

There was the particular fear that educated women would not produce offspring — in fact, of the first generation of Girton College graduates, only 16 of the 35 married, and of these, only 7 had children.⁸⁵ It was popularly believed that such an outcome would cause the decline of civilisation. This common view was concisely expounded by Robert Lawson Tait, sometime President of the British Gynaecological Society: “To leave only the inferior women to perpetuate the species will do more to deteriorate the human race than all the individual victories at Girton will do to benefit it.”⁸⁶

At the same time, voices were raised to support women's entry. As early as 1870, the journal *Nature* expounded in an editorial on the virtue of the scientific education of women — albeit in the context of improving their homemaking talents: “Few have yet realized the enormous gain that will accrue to society from the scientific education of our women. ... What insight would a knowledge of chemistry afford into the wholesomeness or unwholesomeness of different articles of food!”⁸⁷

Eleanor Sidgwick, in a lecture in 1896, saw university education as opening career opportunities:

Women ought to have an independent career, because nothing can be more depressing or demoralising than waiting for the marriage which may never come; it is bad for them physically, intellectually, and morally; and moreover, nothing can be more apt to lead to unhappy marriages than the temptation to marry merely for the sake of a career.⁸⁸

Yet, despite the naysayers, access to university turned from a dream to a reality. Even the supporters, such as Faithfull, marvelled at the speed of change:

Perhaps it is safe to say that there is no movement which has made a more wonderful advance in the last twenty years than that which concerns the higher education of women. The very phrase twenty years ago made people shake their heads ominously, and prophesy untold evils to women's character, women's health, women's influence, to women's work in their homes and to society at large. ... Few people probably realize the courage and independence of those pioneers, who were certain to be dubbed “blue,” and looked askance at as alarmingly intellectual and “advanced.” Now-a-days all that is changed, it is hardly too much to say that throughout England college education is regarded as a desirable continuation of a girls school education.⁸⁹

Who Went to University?

To decide to go to college was a brave act in itself. It required a strong self-image, particularly if the family held to the conventional view that a well-brought-up Victorian or Edwardian girl should stay quietly at home until a suitor appeared on the horizon. And, in most countries it was an avenue open only to daughters of the expanding middle class, a rapidly growing business and professional sector of society.⁹⁰ The daughters of the poor were simply financially unable to attend university; while the daughters of the upper classes were, for the most part, given an education that would prepare them for their intended life of leisure rather than one that might promote intellectual development. Although the information is incomplete, one or both of these factors are apparent in the lives of many of the women discussed in this book. Being the eldest daughter (or particularly, an only child) also seems to have favoured the pursuit of a university education.⁹¹ Daughters of clergymen seemed to be over-represented among these early cohorts.⁹² In addition, to go to college was one of the few avenues (nursing and missionary work being among the others) for a woman to escape the family home without the necessity of marriage.⁹³

Going away to college was an exhilarating experience for this first generation. As one student remarked, she and her fellow co-eds were happy "... in the glorious conviction that at last, at last, we were afloat on a stream that had a real destination, even though we hardly knew what that destination was."⁹⁴

For the second generation, there were different factors. In particular, by the end of the First World War, with so many young men having been killed, marriage prospects were minimal. Muriel Glyn-Jones recounted her own experience:

My father decided to discuss my future with me. He said he would like to see me happily married, but after what had gone on in Flanders for the past four years that could only be doubtful. He would never be able to leave enough money for me to

live on, but he was prepared to spend any money I could use for my education. It was later decided that I should go to Royal Holloway College ...⁹⁵

As we will see in later chapters, attitudes from the men students ranged from outright hostility through amused tolerance. A student at Sheffield University in 1905 expressed her views poetically:

'Twas always said, in the long ago,
That maids to College should never go;
The very idea made the cheek grow pale
and caused the stoutest of hearts to quail
'Tis all very well for men to praise
The women of past and bygone days;
'Tis their opinion of us that's wrong
at least so think I, and end my song.⁹⁶

At co-educational facilities, women students were often constrained as to where they were allowed to go. In several institutions, women had to enter lecture rooms through a different door from men, and it was common for the lecture room itself to have a separate ladies row or section. Yet to these women students of the Victorian and Edwardian eras, the slights and insults were a small price to pay for the excitement of being in the first assault on the bastions of learning: to be in those "hallowed halls," where studying philosophy or physics was a joy, an end in itself.

By our standards, the activities of women students were severely circumscribed by the university rules, such as the need for chaperones. However, compared to the societal restrictions at home, universities were a haven of freedom for women. The historian J. F. C. Harrison described this feeling:

For middle class girls the opportunity to have a room of one's own, to be able to organize one's life free from patriarchal

dominance, to have cocoa, tea or coffee parties unsupervised, to discuss what one liked with friends, to play games of hockey, and cycle around town — all this was immensely liberating, despite many restrictions and controls imposed by the college authorities.⁹⁷

The Choice of University

For the 898 women chemists who became Associates or Fellows of the Royal Institute of Chemistry and/or Fellows of the Chemical Society between 1880–1949, we found information on the college or university attended for 841 of them.⁹⁸ The institutions where 10 or more women chemistry students obtained their undergraduate degree during that period are shown in Table 1.3.

As can be seen from Table 1.3, Bedford College, London — a small women-only college (see Chap. 4) — produced a disproportionately large number of women chemists. Royal Holloway College (RHC), too, is overrepresented for its size. For the constituent colleges of Cambridge, over 60% attended Newnham; while at Oxford, Somerville and St. Hugh's were the most popular. Queen Elizabeth College was founded as King's College, Ladies' Department, in Kensington, the graduates being awarded degrees through King's College (see Chap. 3). Likewise, the University of Newcastle was formerly a satellite college of the University of Durham; thus, women graduates from Newcastle were listed as having Durham degrees (see Chap. 5).

As students could obtain external degrees from the University of London, we find Battersea Polytechnic and Nottingham in the list, both offering London external B.Sc. (Chemistry) degrees during this time (as did Exeter, Northern Polytechnic, and others). In addition to those women chemists identifiable with a particular college, an additional 39 women had London chemistry degrees with no indication of their affiliated institution.

The total for all of the Welsh constituent university colleges (Aberystwyth, Bangor, and Cardiff; see Chap. 7) is given here.

Table 1.3. Most common universities/colleges attended for their undergraduate degree by British women chemists, 1880–1949.

University/College	Number of students
Bedford College, London	100
University College, London	57
Glasgow	48
Cambridge	45
Manchester	38
Royal Holloway College, London	36
Oxford	28
Birmingham	27
Queen Elizabeth College, London	24
Imperial College, London	23
Liverpool	22
Leeds	21
Queen Mary College, London	19
Edinburgh	19
Birkbeck College, London	15
Wales (combined)	15
Newcastle	13
Battersea Polytechnic	12
Aberdeen	10
St. Andrews	10
Nottingham	10

For Scotland (see Chap. 7), Glasgow was the overwhelming choice of women chemists. In part, this was probably due to the existence of a separate women's college, Queen Margaret College, in the early years; while the total for Edinburgh includes Heriot-Watt College (later Heriot-Watt University).

School–University Links

The most apparent link is between MHSg and the University of Manchester: nearly all MHSg graduates who became Associates or Fellows of the Royal Institute of Chemistry and/or

Fellows of the Chemical Society went to their neighbouring University; as a former MHSG student, Mary McNicol, commented in 1902:

Owens College [later, Manchester] has always seemed to me the natural place at which [Manchester] High School girls should study after having finished their school course, and, judging by the number of Old Girls there, other people think so too. No High School girl needs ever feel lonely at Owens, for she will always come across girls she has known at school. A considerable number will be found in the Arts Classes, and several in the Science Department.⁹⁹

Though the link between KEVI and Newnham College was mentioned earlier, in fact, only about 30% followed that route. Nearly all NLCS graduates entered either Bedford or RHC, with about half going to each. On the other hand, women chemistry students from South Hampstead High School for Girls all went to Bedford, according to our data set, as did a significant proportion of CLC graduates planning to follow a chemistry career.

Admission to university meant that another barrier to women had been overcome. But there was yet another one to face: admission to professional societies; and for certain societies, this proved a lengthier battle — the subject of Chap. 2.

Commentary

The advancement of women in chemistry would not have been possible without the development of academic schools for girls, particularly those emphasising a strong science component. The reader of subsequent chapters will observe that a very high proportion of the women chemists came from NLCS, CLC, KEVI, MHSG, or the GPDSC schools. Thus, it is important to give recognition to the pioneers who made it possible — particularly Buss, Beale, and Burstall — and to the forgotten

institution from which they came: Queen's College, Harley Street (see Chap. 4).

Freund and Hartle were among those who fought for girls to take mainstream (men's) chemistry rather than domestic science. This route gave academically gifted girls access to university-level studies rather than diverting them to "women's science." On the other hand, the argument of Smithells and Stern — that making chemistry relevant to girls' lives would have broadened the appeal and usefulness of the subject — is as valid today as it was then. However, the majority of the activists insisted that for the good of future generations, it was necessary to have the same secondary chemistry as that for boys to enable their most talented girls to enter university chemistry degrees.

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