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Mathematical women in the British Isles 1878–1940: using the Davis archive

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The Davis Historical Archive identifies the women who obtained an honours degree in mathematics in the British Isles between 1878 and 1940 and gives information on them. This note uses the Archive to pick out patterns in women's mathematical education in England and Wales, adding the necessary historical and institutional context. It pays special attention to the dominant institutions of the period, viz., the women's colleges in Cambridge and London. It also glances at the careers of the graduates.

Introduction

The Davis Historical Archive—Davis (2004)—lists the women who obtained an honours degree in mathematics in the British Isles between 1878 and 1940, a cohort that would also provide the senior female mathematicians for decades afterwards. The Archive sorts around 2500 individuals by university, year and class of degree and gives further information on many of them; it also provides aggregate figures for male graduates for comparison.¹ A mass of statistical information is presented in a form that is easy to use: Davis (2017, 255) intended it to 'be available for use in schools, as examples or exercises for students taking a statistics course' and in this spirit the present note reports some elementary exercises involving counting, summing and plotting to pick out patterns in the records of these women.²

The Davis Archive records individuals and the exercises in §§2–3 below move upwards to extract information—for England and Wales only—on national trends and about significant institutions. §§1 and 4 add context: while literature abounds on special aspects of the history of women's university education in mathematics, no general account seems to be available. There are accessible biographies for some of the women—currently around 50—in *MacTutor*, the *Oxford Dictionary of National Biography*, *Wikipedia* and elsewhere and I have drawn on these. So, who is in the Archive?

1 *Mathematical women?*

The universities of the British Isles began admitting women in the 1870s; see §2 below. What makes the women of the Davis Archive mathematical is their receiving an

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¹Davis (2017) describes the origins and scope of the project and indicates on-going research.

²A E L Davis died in November 2020—see Lawrence (2021)—and she had no opportunity to see this note or answer my queries. I hope this note serves as a memorial to her work on the Archive, itself inspired by John Fauvel who died in 2001.

honours degree in mathematics from one of those universities. This net catches nearly all of the women reading mathematics in the British Isles who were born between 1860 and 1920 and includes such recent figures as Violet Cane (1916–2008) who retired from a Manchester chair in 1981.³ Among those missed are Mary Cannell, Silvia Skan and Alicia Boole Stott who, like the earlier Ada Lovelace Byron and Florence Nightingale, had no degree, and Phyllis Nicholson, Cecilia Payne-Gaposchkin, and Frances Wood who had a degree in another subject. Alice Lee, Kirstine Smith and Rosalind Tanner (née Young) are included by virtue of a higher qualification, a doctorate: Smith and Young's first degree was awarded abroad while Lee's two first degrees were not honours class.

In this period, almost all those working in the British Isles had been educated there: thus, none of the female mathematics lecturers in the 1934 *Yearbook of the Universities of the Empire* had a foreign qualification, though soon there would be a trickle of refugees, like Olga Tausky-Todd and Hanna Neumann.⁴ Of course, some women of the British Isles worked abroad—including Charlotte Scott, Dorothy Wrinch and Jessie MacWilliams (née Collinson).

Today's career mathematician typically has a PhD, but that degree only appeared in England in the 1920s and was still unusual in 1940.⁵ Germany was the original home of the PhD, with the USA its second home, and five women in the Archive had doctorates from there: Grace Chisholm (awarded hers in 1895), Eleanor Pairman (in 1922), Marion Gray (in 1926), Mary Taylor (in 1926) and Jessie Collinson (in 1962 [*sic*]). I have found seven women who had completed British PhDs by 1940.⁶ The 1934 *Yearbook* has 17 women on the books of maths departments in English universities; three had PhDs and nine had first degrees only. Some forms of post-graduate study existed then, but are no longer significant. Cambridge was the centre of the highest mathematical learning: thus Winifred Deans, Sheila Scott and Eva Rowland took its BA after a first degree from Aberdeen, Edinburgh and Liverpool, respectively. The Cambridge degree was awarded for performance in Part I of the Mathematics Tripos but a few of the best students took Part II or Part III; in 1900 only 3 of the 19 women graduates went on to Part II.⁷ Some early Cambridge women, like Charlotte Scott, also acquired a London degree probably because a woman's certificate from Cambridge was not quite a degree.⁸

What was an honours degree in mathematics? In the Davis years mathematics changed in substance and in scope—one development was the entry of statistics towards its close—but the name did not change: in England and Wales the relevant

³All the women—apart from Cane and MacWilliams—mentioned in this paragraph and the next have *MacTutor* biographies.

⁴The *Yearbook*, first published in 1914, records the current university scene. The entries are not always as comprehensive as they might be: thus the 1934 entry for maths at Imperial College mentions, without naming, six Assistant Lecturers and two Demonstrators and so misses Rosalind Young. A referee brought this to my attention.

⁵Simpson's *The Development of the PhD Degree in Britain* (2009) is exhaustive while Aldrich (2006/10) sketches the mathematics scene.

⁶Nora Calderwood (awarded 1931) by Edinburgh, Mary Cartwright (1930) and Ida Busbridge (1938) by Oxford, Bertha Swirles (1929) and Rosa Margaret Morris (1940) by Cambridge, and Constance Mary Rigby (1930) and Florence Nightingale David (1938) by London. Calderwood and David were both established lecturers when their PhDs were awarded; David's thesis was a collection of published papers.

⁷See Jones (2009, ch 6).

⁸In Cambridge, women were not treated on equal terms to men until 1948: see McWilliams Tullberg (1998).

degree was usually Mathematics while in Scotland it was Mathematics & Natural Philosophy.⁹ Honours graduates were the elite of graduates with a first degree. The first degree—in England, a Bachelor's and in Scotland a Master's—came in two forms, the Pass/Ordinary degree and the Honours degree.¹⁰ Practice varied across universities: there might be two programmes with a Pass degree awarded for satisfactory performance on the easier programme, or a Pass degree could be awarded for poor performance on the harder (or only) programme.¹¹ Honours graduates were classified, and the Davis Archive gives the distribution for each university: thus 9.7% of women (78 out of 806) from Cambridge 1882–1940 graduated first class—were ‘wranglers’—compared to 33.6% of men (1674 out of 4977).

The next two sections base some statistical exercises on the Archive. I have not tried to replicate Davis's findings, and there do not appear to be any reviews of the Archive, but my impression is that it achieves a high level of accuracy. I have noticed some problems, however. Take the treatment of the statistician Alice Lee, mentioned above: Lee does not belong in a list of honours graduates, though she belongs in a list of doctors or of graduates with a Pass degree. It would be interesting to have such lists, at least, to gain some sense of the scale of the Pass contingent.

2 *Country totals and trends*

Davis's British Isles was neither an educational nor a political unit. Until 1922 there was a United Kingdom of Great Britain and Ireland and then two separate states, the United Kingdom of Great Britain & Northern Ireland and the Irish Free State which was reconstituted as the Republic of Ireland or Eire in 1937. Even when the Isles were politically unified, there were separate educational structures in Ireland, Scotland and England & Wales. England, the most populous unit, contributed most of the nearly 2,500 women graduates in the Archive with Scotland contributing nearly 400 and Ireland and Wales fewer than 100 each. My focus will be on English institutions and most of my statistical exercises will be for England & Wales. Similar exercises may be done for other parts of the British Isles.

In the Davis years, universities were small and few in number: in 1900 just under one percent of the age-group went to university. In England from the 1870s, new colleges for women in Cambridge, Oxford and London were doing university work; these colleges dominate the story of the Davis women and are examined in §3 below. In Oxford and Cambridge, women were taught and examined but not awarded university degrees until 1920 and 1947, respectively. Existing colleges in London and Durham and in Scotland were opened to women in 1878, 1895 and 1896, respectively, while all the new universities created after 1880 admitted women from the start.¹² The 2,500 women graduates of the Davis years may be compared to around 10,000 men—in 1935, the peak year for women, 80 graduated in England & Wales (compared to 238 men).¹³

⁹A referee points out that Davis overlooks the BSc degree, where students could also specialise in mathematics. An instance was Nora Calderwood who had a career at Birmingham University.

¹⁰An Oxbridge MA was a BA who had paid a fee and enjoyed certain university privileges.

¹¹Darwin and Galton had pass degrees from Cambridge: Darwin by design, for the easier course sufficed for his projected career in the Church; Galton by accident, when illness meant he could not manage the harder course.

¹²See Dyhouse (1995, ch 1).

¹³HETSA (2020) reports that in 2018/9 there were around 12,000 female and 21,000 male undergraduates in the ‘mathematical sciences’.

Table 1 Student numbers at selected institutions in Britain

No of full-time students	1900/1		1910/11		1920/1		1934/5	
	Men	Women	Men	Women	Men	Women	Men	Women
Manchester	738	123	881	276	1425	581	1734	634
Cambridge	2830	296	3822	396	4759	428	5328	507
Oxford	2537	239	3114	328	3663	542	3953	876
Reading	33	73	128	117	214	335	293	322
Edinburgh	2119	235	2311	580	3084	1078	2437	915
Wales	778	475	899	476	1951	798	1968	750
UCL	295	167	512	162	1064	579	1348	795

Table 1 conveys the scale of the Davis period: it shows the total number of full-time students in all subjects at six institutions in Great Britain across four academic years.¹⁴ The institutions are four of the eleven universities in England, one of the four in Scotland, the one (comprising three colleges) in Wales and a college of the University of London. Such at least was their status at the end of a period that had seen institutions form, break up and re-badge: in 1901/2 Wales was a recent foundation, Manchester part of the federal Victoria University (along with Liverpool and Leeds) and Reading a university college awarding London degrees.¹⁵

Enrolments at all the institutions grew over the period, but at greatly different rates and with very different mixes of men and women. By 1900, 16% of all British university students were women, rising to 27% by 1930, and falling to 23% by 1938 where the figure remained until the early 1970s. In the Davis period, Reading usually had fewer men than women while Cambridge had ten times as many; the ratio at the slightly smaller University of Oxford was approaching four to one at the end of the period.

Turning to mathematics, enrolments grew in the Davis period, but not uniformly across universities, and mathematics was always far from being equally represented. At the start of the period, by far the majority of mathematics degrees were awarded by Cambridge University; but, as mathematics teaching at other institutions increased, Cambridge became less dominant: in 1902 it contributed 148 graduates to the British total of 171; in 1935 it contributed 117 to a total of 353.¹⁶ Of these 117, there were 21 women corresponding to the 507 female students—undergraduate and postgraduate and of all years—in 1934/5 (Table 2).

Davis gives the number of male and female students graduating in mathematics for each year and each university. Summing across universities yields time series of new maths graduates for each year: these are represented in Plots 1 and 2. Davis takes 1878—when women were first admitted to degrees on equal terms with men at the University of London—as the beginning; but she reports earlier results from

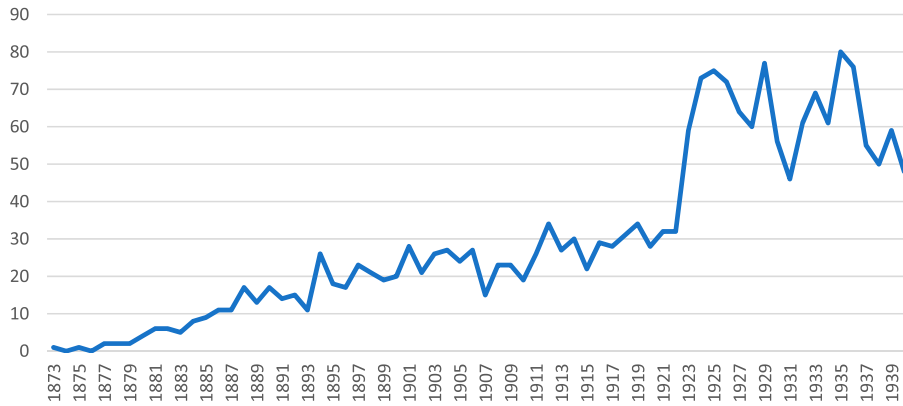
¹⁴From Dyhouse (Appendices I–II).

¹⁵In 1878 the universities of the United Kingdom of Great Britain and Ireland were (in England) Oxford, Cambridge, London, and Durham, (in Scotland) St Andrews, Glasgow, Aberdeen and Edinburgh and (in Ireland) Trinity College Dublin. In the reduced UK of 1940, England had additional universities in Manchester, Liverpool, Leeds, Birmingham, Sheffield, Bristol and Reading; Scotland saw no change, and Wales and Northern Ireland each acquired a university.

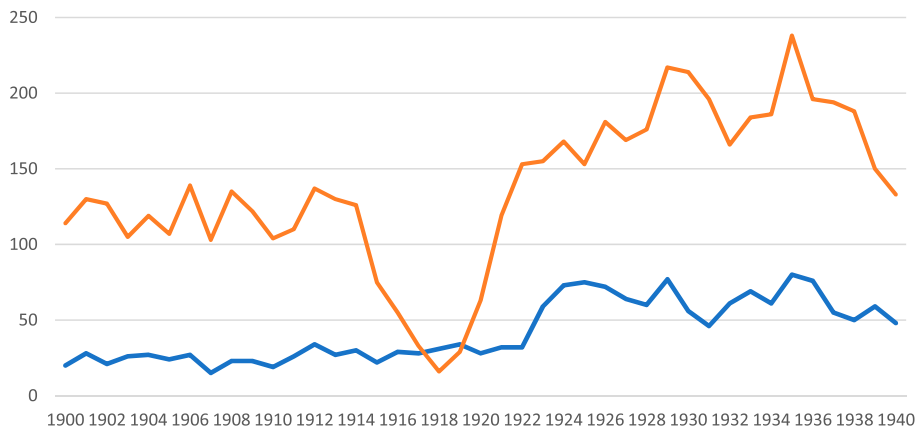
¹⁶Cambridge mathematics has received plenty of attention—see Warwick (2003) and Barrow-Green (1999, 2014) for different aspects of what was very largely a male experience.

Table 2 Numbers of female maths graduates 1890–1940 (with male figures in brackets)

Cambridge	London	Edinburgh	Glasgow	Aberdeen	Manchester	Oxford
806 (4977)	703 (1009)	123 (429)	108 (511)	86 (243)	83 (216)	80 (890)



Plot 1 Female maths graduates in England and Wales 1873–1940



Plot 2 Male and female maths graduates: England and Wales 1900–40

Cambridge, where women started to sit the exams informally, and I have started in that year, 1873.

There is considerable annual variation, but the period divides into three: from nothing to a normal that set in around 1900 of around 25 a year, rising to a new normal of around 60 a year from the mid-20s until the end of the period.

The Great War of 1914–18 affected men and women differently: men went to war instead of to university, while women went on studying.¹⁷ For the period as a whole

¹⁷Barrow-Green (2014) describes the effect of the war on Cambridge mathematics.

there were about 4 male maths graduates for every female: before the war there were about 5 to 1 and in 1925–40 it was more like 3 to 1; these ratios are similar to those for the student population as a whole. The next section examines the most important constituents of these totals.

3 *Institutions: women's colleges in England*

In the Davis period two universities—Cambridge and London—dominated mathematics education for women, together being responsible for 60% of all British graduates in mathematics. The figures are given in [Table 2](#) along with those for the next five.

For Cambridge, teaching women mathematics was a small part of a very large mathematics operation while, for London, teaching women was a large part of a much smaller operation.

Most of the mathematical education for women was provided by colleges for women: all Cambridge's women and most of London's attended them and no co-educational establishment had as many graduates as any one of the big four women's colleges: Girton and Newnham in Cambridge, Bedford and Royal Holloway in London. Of these colleges, only Newnham survives in its original form: Girton and Holloway have been fully co-educational since the 1970s while Bedford disappeared after merging with Holloway.¹⁸

The women who graduated from Cambridge in 1873–1940 came from two colleges: Newnham with 443 graduates and Girton with 384. Davis's London list reflects a much more complex situation: a woman with a London degree may have studied in London at a women's college, or at a mixed college, or outside London at a university college that awarded London degrees.¹⁹ The university colleges at Bristol and at Reading became universities during the Davis period while those at Exeter, Hull, Nottingham and Southampton made the transition later. The university colleges were mixed, but they did not produce many female maths graduates: Nottingham 21 (beginning 1924), Reading 13 (from 1914 to 1923), Exeter 10 (beginning in 1922), Bristol 8 (from 1898 to 1913), Southampton 6 (beginning in 1928) and Hull 2 (from 1933). A further possibility (indicated by a referee) that is not represented in the Archive is instantiated by the remarkable Dora Metcalf (née Greene)—see [Monro \(2021\)](#)—who gained a degree without attending a university-level institution. I have no information about the numbers of such truly external women (or men) but I suspect they were small.

The main London contribution was from internal students, with around two-thirds of graduates coming from the three women's colleges: from Bedford 202, from Royal Holloway 195 and from Westfield 61. Of the mixed colleges, East London (later Queen Mary) College contributed 92, University College 68, King's College 39 and Imperial College 2.

For a snapshot of the women's colleges, I have drawn on the Universities' *Yearbook* for 1934 relating to the academic year 1932/3. That year the two Cambridge

¹⁸The origins of the big four are described in [Jones \(2009, ch 1\)](#). [Kirk's \(2003\)](#) study of Bedford and Holloway focusses on the years 1939–69, but it has much on the years before.

¹⁹For a time, it was possible for a time to study in London and take Oxford exams: in 1884–1907 the Oxford list has more students from Royal Holloway than from Oxford's own colleges: 18 as against 11. In the same period 7 Royal Holloway students were awarded London degrees. [Bingham \(1987, 80–83\)](#) describes the arrangement.

colleges together graduated 163 BAs (16 in mathematics: Girton 8, Newnham 8) and the three London colleges 246 (18 in maths): Bedford had 147 graduates (11 in maths), Holloway had 54 (5 in maths) and Westfield had 45 (2 in maths). Bedford was the largest of the women's colleges, and had overtaken Newnham as the college producing most maths graduates.

The Cambridge and London women's colleges had different staffing policies. The Cambridge colleges were staffed by women, while the London colleges employed men as well: the principal was a woman but other senior positions mostly went to men. Bedford had its first female head of department in 1913, while the mixed UCL appointed its first female professor in 1949, the crystallographer Kathleen Lonsdale FRS. In both Cambridge and London, the organisation of the women's colleges followed the same pattern as the existing men's colleges: the London colleges had departments with professors and lecturers; the Cambridge colleges covered a narrower range of subjects each with its director of studies and lecturers. Referring again to the 1934 *Yearbook*, three of Bedford's twelve professors were women (in German, Modern History and Philosophy). Mathematics had a male Professor and Reader, a female Lecturer Enid Fowler (née Turner) and part-time Lecturer Sybil Weevers (née Jervis). Holloway had a male Professor, Senior Lecturer Ethel Rowell and Lecturer Marion Pick. Westfield mathematics was headed by a Reader, Gertrude Stanley, with Winifred Sargent as Lecturer. In the Cambridge colleges, the academic roles were director of studies and lecturer: at Girton, these were, respectively, Frances Cave-Browne-Cave and Eleanor Veitch (née Harvey); at Newnham Lorna Swain and Margaret Kennedy. Together, the five women's colleges of London and Cambridge employed 10 women, with Reader their highest rank. Elsewhere in Great Britain there were 9 women on the mathematics staff of the universities.²⁰

4 *A life in mathematics?*

What happened to the mathematical women after they graduated? For some there are biographies, some had further involvement with universities—additional qualifications and employment which are detailed in the Archive—but, for most, we do not know.

A century separates the last Davis woman retiring from the first graduating, one in which opportunities for women and the uses of mathematics both multiplied. In the first place, higher education in mathematics for women existed so that schoolgirls could be taught mathematics: the task involved not only class teachers but headmistresses, like Sophie Bryant and Helen Sheldon, school inspectors, like Louise Doris Adams, educational administrators, like Philippa Fawcett, university lecturers, like Agnes Bell Collier, and college heads, like Ellen Higgins and Emily May Larby. The great disrupter of the Davis epoch was the First World War, which improved women's opportunities generally and found new uses for mathematics: Dorothy

²⁰At Birmingham Ruby Colomb MA and Nora Calderwood MA BSc PhD, at Manchester Bertha Swirles MA PhD and Violet White MSc, at Oxford Dorothy Wrinch DSc MA, at Reading Lucy Ashcoft MA and Elsie Ternouth MA, at Southampton University College Annie Trout BA and at St Andrews Mary Simpson MA BSc.

Spiers (née Davis) became the first woman to qualify as an actuary in 1923, and in 1919 Frances Bradfield was one of several women at the Royal Aircraft Establishment; radio research also drew in women, including Alice Stickland.²¹ It is a safe bet, though, that few of the 2500 had lives in mathematics.

Mathematical men often made careers elsewhere but, for women, there was the additional matter of marriage. Most women married, and marriage usually excluded a career: middle-class married women were not expected to work, even in teaching, the career for which their degree had prepared them. A marriage bar was imposed by many employers, disappearing only after the Second World War: it ended the civil service careers of Annie Maunder and Mary Taylor; Royal Holloway had a bar and Dyhouse (161ff) relates instances of universities trying to impose one. Most of the MacTutor/ODNB subjects were unmarried, but some combined marriage and mathematics including Herthe Ayrton, Grace Chisholm Young, Sheila Scott Macintyre, Gladys Mackenzie, Phyllis Nicolson, Kathleen Ollerenshaw, Eleanor Pairman, Bertha Swirles and Dorothy Wrinch. Of these, Chisholm Young, Scott Macintyre, Pairman, Swirles and Wrinch married mathematicians.

5 *The present use of the Archive ...*

The Davis Historical Archive lists women with an honours degrees in mathematics, the colleges they attended and, for some, their subsequent careers. The present note has used this magnificent resource to construct a statistical account of female mathematics graduates in England and Wales before the Second World War; it also sketches the context for these developments. Its scope and ambitions are limited: it uses the Archive, neither re-researching it nor revising it, and is a work of description, reporting phenomena not offering explanations for them. Furthermore, it neglects entirely the Strand B of Davis's (2017) research into mathematical women: their work and publications.

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²¹Other aviation mathematicians were Mabel Cave-Browne-Cave, Muriel Glauert and Hilda Lyon. See also Royle (2017).

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