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Women in Chemistry's Workforce

The Women's Laboratory at the Massachusetts Institute of Technology, 1876–1911

In the 1870s, the Massachusetts Institute of Technology (MIT) began offering educational opportunities to women scientists. Ellen Richards, the first woman to graduate from and teach at MIT, paved the way for future female students by beginning a Women's Laboratory that later transitioned into a Sanitary Science Laboratory. This paper outlines the network of women who studied in MIT's laboratories, and describes their scientific and technical research into the chemistry of water pollution and fire prevention. Beyond their laboratory work, women like Ellen Richards also engaged in the emotional labor of mentoring and network building.

Ellen Richards was the first woman to graduate from and teach at the Massachusetts Institute of Technology. Trained as a chemist, Richards broke into fields like nutritional science, mineralogy, mining engineering, water chemistry, and public health; first as a student in coeducational settings, and later as a professional in all-male settings. Richards started a Women's Laboratory at MIT as a place for women scientists like herself to train and practice chemistry. The Women's Laboratory, small and localized to MIT as it was, offers a glimpse into the type of laboratory work women did and how this work contributed to technological advances. This paper will focus on three specific areas. First, the establishment of the Women's Laboratory; second, a brief description of the women students in the laboratory, and third, a description of the type of laboratory work the women did. Underlying these three sections is the idea that "work" includes the emotional labor of mentorship and relationship-building that Richards undertook when she educated the women students in her lab. This emotional labor deserves consideration because it was the social context of women's exclusion from a majority of US scientific institutions that prompted women to network so efficiently to further their own educational and professional advancement.

Histories of women working in laboratories in the United States have received increased attention due to concerns over the lack of diversity in science, technology, engineering, and mathematics (STEM) as well as the popularity of books like Dava Sobel's "The Glass Universe" and the blockbuster film based on the book "Hidden Figures".[1] There are still many historians who do not know, though, about the kind of work women did in laboratories and how this training benefitted them as scientists. Scholars of women in science such as Londa Schiebinger have characterized the scientific opportunities available to women as ebbs and flows, never totally exclusionary but never completely inclusive, either. Historically, across one lifetime, the scientific "landscape was a varied one, rolling with peaks of

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1 Ellen Swallow Richards, 1842–1911.

opportunity and valleys of disappointment".[2] Schiebinger, along with Sandra Harding and Margaret Rossiter, have asked whether feminism and women's presence in the sciences has changed science. They also ask why women's opportunities within STEM fields have not been equal to men's. Part of the answer to these questions is the Women's Laboratory at MIT and its intrepid champion Ellen Richards.

Ellen Richards' role in establishing the Women's Laboratory

After the Civil War, which kept Ellen Swallow at home, she enrolled in Vassar College, an all-female school in Poughkeepsie, NY, at the age of 26. Upon graduating two years later, Ellen decided that chemistry was the scientific study for her. She unsuccessfully attempted to find employment as a chemist, and eventually applied to MIT, which, after months of deliberation, admitted Ellen Swallow as a "special student" in 1870. Special student status, though, was not much of an honor, as MIT used it as a convenient rhetorical device to prevent male students from becoming upset that MIT admitted a woman. At first, Ellen felt like a second-class citizen. As Robert Richards, her future husband remembered, "she was treated for some time as a dangerous person".[3]

Richards' approach to navigating her special student status was to earn mentorships and professional opportunities with her male colleagues. She was not confrontational or radical. Her strategy was to insert herself casually into her male colleagues' good graces by anticipating their research needs and then dazzlingly prove her abilities as a skilled scientist and dedicated student. Beyond research, Richards attempted to assist her male colleagues with tasks considered "feminine", such as cleaning, sewing, and care-taking. She wrote: "Perhaps the fact that I am not a radical, and that I do not scorn womanly duties, but deem it a privilege to clean up and supervise the room, and sew things, is winning me stronger allies than anything else". By dusting the tables, organizing papers, and bandaging a sore finger, Ellen Swallow coopted a space of her own in the laboratories. One professor even asked her to mend his suspenders. Taking this cue, she kept "needles, thread, pins, scissors, and the like around". To her friend she triumphantly confided, "So, you see, I am useful in a general way, and they can't say study spoils me for everything else". Envisioning those female students who would follow her, she believed her success was "winning a way which others will keep open".[4] This emotional labor was above and beyond what was required of the male students. The sociologist Arlie Hochschild uses the term "emotional labor" to understand work where "the emotional style of offering the service is part of the service itself". One facet of emotional labor, which can be performed by people of all genders, is that workers are required to elicit an emotional state in another person. In order to prove herself in the all-male setting of MIT laboratory, Richards had to not only perform her scientific research with great acumen, but also to emphasize those considered innate emotional traits of women: care-taking, nurturing, tidiness, agreeability, etc. This emotional labor was never fully articulated as such, nor written into the requirements for admission but existed in the background of Richards' approach to acceptance at MIT. As in Richards' case, it was something she recognized as a strategy for inclusion and extra labor she performed not only for herself, but for those women who would follow her at MIT.[5]

In 1873, Ellen Richards began offering lectures in chemistry under the auspices of the Boston Women's Educational Association (WEA), organized in 1872 to support women's "better education". This was the first time Ellen taught chemistry to a room full of women students and it served as a useful model for the organization of the Women's Laboratory at MIT. In 1875, she approached the Women's Educational Association and asked for money to support the purchase of chemical instruments for a year-round laboratory with textbooks and scholarships to fund women's studies. Richards had to also convince the board of MIT that educating women on its campus would be beneficial to MIT's image and budget. Richards convinced MIT to provide space on its campus and serve as an institutional umbrella, provided the WEA would agree to fund the construction of the Women's Laboratory Building and purchase the lab equipment.

The deal was made when the board voted on May 10, 1876 to authorize the Women's Laboratory, following which the WEA "promptly" produced the funds. The WEA appealed to its members for money by sending around circulars in the spring of 1876. Three weeks later, the members had raised USD 2000.[6] Expressing relief that "all has prospered" beyond her expectations, Richards planned to extend her summer European travels to include purchasing equipment for the Women's Laboratory in Jena, Germany.[7] After returning from Jena with her laboratory equipment in the late summer of 1876, Richards set up shop in the Women's Laboratory, "one little room with earnest workers therein".[8]

Whether women's education was beneficial to women was a controversial question in the mid-1870s. In

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2 The MIT Annex that housed the Women's Laboratory, built with WEA funds.

3 Interior of the MIT Women's Laboratory, c. 1879.

1875, Harvard Medical School Professor Edward H. Clarke published his book "Sex in Education: Or, a Fair Chance for Girls". Clarke postulated that the reason for "numberless pale, weak, neuralgic, dyspeptic...girls and women" was the over-taxation of their nervous systems. Clarke's message was that college study endangered a woman's ability to reproduce.[9] Despite Clarke's warnings, the MIT Women's Lab opened in an annex building off of the main MIT building and enrolled 23 students with a future enrollment of 15 the following term.

The women students at MIT

MIT Professor John M. Ordway was the official head of the Laboratory, but Richards managed the day-to-day instruction and operation. At first, the Lab experienced minor setbacks, as some students were unable to attend due to a lack of funds or a change of plans. The fear that students would not be able to pay plagued Richards as she sought to negotiate with the WEA for more funds. She knew some WEA members feared for "the success of the enterprise" – not only that there were no "women who do really want this kind of opportunity", but also that the venture would not be an economic success:

"Of the 23 only 5 (as far as I am able to judge) have been in a condition to pay the fee without sacrifice and self-denial. This makes the number who spend much time in the Laboratory quite small. They study as much as possible outside and gain as much as they can in an afternoon. While this increases the usefulness of the Laboratory it materially lessens its income."[10]

The issue of women paying for the laboratory education frustrated Richards: "It is a well known fact...a woman does not receive the same pay as a man. Ought she therefore to pay the same for her education[?]" To help women offset the costs, Ellen Richards solicited scholarship money from women's clubs and scientific circles, and she put up her own money to fund as many as three students per year. Of the women who enrolled in the first year, most were science teachers or hoping to be so following their training. Two women were "engaged in original research" and three others had "no definite aim for the immediate future" and only worked for "their own minds". Four married women enrolled in the Laboratory, three of whom had families with children. Richards felt a special bond with her married students and took great pleasure "in opening the treasures of our store-house". One of the married women studied mineralogy diligently. The other married woman hoped to be a physician and, like Richards, had a supportive husband who encouraged her professional and intellectual development.[11]

Throughout the late 1870s, women continued to enroll in the lab even if they were unsure of how they might pay. Richards wrote to her friend Anna Mineah: "I am more than pleased to see the success of the Laboratory. Now my next work is to look up professional work for some of the students".[12] By 1877, though, MIT's President Runkle lauded the Women's Laboratory "in all respects a gratifying success, due to the high attainments of its students".[13]

Ironically, the equal education Richards sought for the women of MIT put her out of employment. The Women's Laboratory closed in 1883 when MIT began accepting women students on equal status as men. Feeling that everything was "unsettled", Richards mourned that she would not have "anything to do or anywhere to work". She could not help but feel like "a woman whose children are all about to be married and leave her alone, so that she is to move into a smaller house and a new neighborhood [...] though I knew it was coming, I cannot at once fit all the corners".[14] She would not be without a teaching responsibility for long.

In 1884, Richards became Instructor of Sanitary Science when MIT began the first Sanitary Science program in the country, one year after the Women's Laboratory closed. In the first year in her new role, there were seven men in her class and no women. Soon, the sanitary science laboratory did have women enrolled and Richards acted as an informal Dean of Women to the female students under-taking coeducation. While all remembered her to be caring, they also recalled that she was exact and expected much from her students. One female student recalled the sanitary chemistry laboratory having "an atmosphere of its own". Located up a "long flight of stairs", affectionately dubbed "those Judgment Stairs, since Mrs. Richards declared that she did not wish any girl to come to her for training who could not take them easily", her office was in a corner where "she would be found, fenced in by books and charts and papers". With a sharp eye and a "keen glance" Richards might say "I thought you would be dropping in before long", and the conversation would get down to business. One student nostalgically expressed difficulty in explaining "the charm and inspiration of those conversations". Overall, Richards' female students found her to be a generous mentor who looked out for "my girls" by using her connections to find them employment, even at times housing them in her own home.[15] She helped place one student, Isabel Bevier, at the University of Illinois in Urbana-Champagne. In 1888, Bevier pursued advanced sanitary science studies with Richards and would later become well known in the field of home economics through her work in nutrition, sanitary science, and chemistry.

Other women of note who studied in Richards' laboratory at MIT include Jennie Maria Arms Sheldon, who did not graduate from the Women's Laboratory, but spent two years there. She became an entomologist, author and museum curator, and worked at the Boston Society of Natural History with zoologist Alpheus Hyatt and later on at the Memorial Hall Museum as curator.[16] Florence M. Cushing was a student of Richards as early as 1873 and was one of the first women to travel on a field school to Nova Scotia in a coeducational summer trip. She worked closely with Richards and helped run a club for college-educated women called the Association of Collegiate Alumnae, which later became the American Association of University Women.[17] Marcella O'Grady Boveri was the first woman to graduate from MIT in biology and taught first at Bryn Mawr and then Vassar. In the 1890s, she was admitted to study science at the University of Würzburg in Germany where she met and fell in love with her soon to be husband Theodor Boveri, who incidentally initially opposed women working in science. The Boveris would continue to work together in science; however, Marcella's husband's name received the credit for their collaborative work.[18]

Anna Billings Gallup, class of 1901, became curator at the Brooklyn Children's Museum at the Brooklyn Institute of Arts and Sciences where she argued for the museum as a key player in children's education and formative years.[19] Anna's sister, Harriet Gallup De Lancey, class of 1894, worked at Eastman Kodak Company before her marriage.[20] Elizabeth Spaulding Mason studied at MIT in the late 1890s under Richards' tutelage. She published a journal article detailing the effect of heat on gluten, based on experiments conducted with Richards. Mason became Associate Professor of Chemistry for over thirty years at Smith College.[21] Isabel Hyams, graduated from MIT in 1888, worked to begin "penny lunch" programs based on her work in public health where she argued that underfed children were more susceptible to anemia, which led to tuberculo-

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4 Ellen Richards with MIT Faculty, c. 1908.

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sis. She became a leading figure in the Boston Tuberculosis Association and trustee of the Boston Sanatorium. She also co-founded a settlement house called the Louisa May Alcott Club in Boston's South End.[22] Susan Minns, class of 1881, made many botanical discoveries, some of which were included in Harvard botanist Asa Gray's publication "Manual of the Botany of the Northern United States". Minns also wrote a book on silk-worms and the culture of silk in North America.[23] Marion Talbot, class of 1888, became a dear friend of Ellen Richards and the two would travel on their own together to the White Mountains of New Hampshire. Talbot became Professor at the University of Chicago in the Sanitary Science department. This is just a brief sample of the 599 women students in seven different departments who studied at MIT during Richards' life.

Women's Laboratory work and MIT

Scholars Annette B. Vogt and Renate Tobies have found that once women became affiliated with academic research institutions, it was common for female scientists to have "close relationships between industrial laboratories and academic research institutions".[24] The scenario at MIT as early as the 1870s proves this thesis to be true, especially for Richards and her female students. Professor John Ordway served as the official head of the Women's Laboratory and he passed along connections and laboratory work to Richards and her female students, both during the time of the Women's Lab and after. One example is when Richards became the chemist for the Manufacturers' Mutual Fire Insurance Company. She worked to devise "thermal reducing coverings" for steam pipes. Prior to the widespread usage of asbestos, researchers throughout the United States tested various chemical materials to find the best solution. The standard method for insulating pipes was with the highly combustible materials of hair felt, blocks of wood, wool fabric, or cork. In addition to posing a fire hazard, these materials produced an unpleasant odor when scalded. Ordway, Richards, and students at MIT's labs tested fifty-one insulation possibilities, including diatomaceous earth, burlap, flour, cotton canvas, rice chaff, sphagnum moss, and various types of papers and pastes.[25]

Richards also conducted research on the combustibility of wool oils. Underwriters, such as the Mutual Fire Insurance Company, found that wool mills were much more likely to be destroyed by fire than cotton mills. The reason for this, they believed, was the particular oil that wool fibers produced. Richards researched how to remove the wool oils from the fibers without damaging the color or quality of the raw material. She developed a process for treating wool using petroleum naphtha, increasingly used as a cleaning agent, which dried out the wool. In the lab, the students worked to devise a method for adding oils to enrich the dried-out wool. A method of this type was never expanded upon, nor put into commercial use by the MIT lab workers, but this work with the Mutual Fire Insurance Company offered her a legitimate post in industrial chemistry and she was the first female chemist to serve as a paid consultant to an American commercial firm. Through Richards' and Ordway's connections at the Mutual Fire Insurance Company, a fire safety lab was set up at MIT, and students in both the industrial chemistry lab and the Women's Laboratory (until 1883) conducted experiments in fire safety. The MIT tests remained the best in the industry until after the turn of the century.[26]

Water quality testing for the State Board of Health was another example of MIT women student's work. In a report to the Board of Health on the water supply and inland waters of Massachusetts, MIT Professor Thomas Drown, who organized the Board of Health work, acknowledged the role of the MIT students and Richards. He thanked the students who worked on the project by name, listing eleven male students and four female students who served as assistants. The women students were Clara P. Ames, Isabel F. Hyams, Sarah L. Day, and Adelaide Sherman.[27] Lilly Miller Kendall, class of 1892, also worked with Richards and Drown from 1892–1899 as an assistant for the State Department.[28]

The water chemistry work required "scrupulous care" given the exact method for collecting water samples from all over the state. Richards and her assistants shipped out one-gallon glass bottles of water, fifteen inches high and five and a half inches in circumference, weighing approximately three pounds, to individuals throughout the state who were willing to collect samples. All bottles had an envelope attached with a certificate inside. Collectors would receive two bottles, one for tap water and another for "stream, pond or reservoir" water. After filling the bottles and completing the questions on the certificate indicating if the weather conditions had recently been rainy, drought, or normal, collectors were to immediately ship the bottles back to Boston. Collectors were also to note if any plant material surrounded the non-tap water collection area. The bottles were shipped to collectors intermittently so that the lab was not overwhelmed with too many bottles on any one day.

Once the samples arrived, laboratory assistants got to work cataloguing and testing the water. The bottles had "State Board of Health" engraved on them with a unique number that assisted in cataloguing the results. When the laboratory received the bottles, the certificate was taken out of the envelope, and the serial number written on both the certificate and the envelope. Then, lab assistants recorded the serial number and the date and time the lab received the water in a logbook. Lab assistants noted the physical description of the water, describing its turbidity, odor, viscosity, etc. Next, they began chemical analysis of the water to determine its mineral content, especially the ammonia and nitrogen levels. All work had to be done within 24 hours of receiving the bottles, and precise records were vital.[29]

Richards and her water-testing assistants, through meticulous data and record-keeping, created a detailed chlorine map depicting the water quality at various times of the year throughout the state. Known as the Normal Chlorine Map, Richards filled in the map after testing the water by indicating how chlorinated the water body was where the sample had come from. Levels of chlorination were thought to indicate levels of pollution. Using isochlors – lines drawn on the map connecting places that have chlorine – Richards found that lines ran parallel to the shore in the same volume across the map. This indicated to Richards that the chlorination of the water depended on how far away it was from the shore; it was fairly consistent from place to place and could be viewed as a normal level of chlorination. Identifying this phenomenon meant that once water authorities and scientists accounted for the level of chlorination that naturally occurred away from the shore, they could then begin to determine the level of man-made water pollution.[30]

Richards performed the majority of her chemical consulting work in the lab at MIT. This practice involved both her female and male students in the government sponsored and private industry work. Many, like Isabel Bevier, found future jobs thanks to the skills learned in Richards' lab, as well as the connections made with leaders in industry. In this way, the "dangerous person" who started MIT as a special student in 1870 helped to grow the reputation of MIT in both the academic and the private business world. Richards had fulfilled both her goals at MIT, to further the cause of women in science and to bring positive recognition to MIT itself. She used her position to network for professional careers for her students, as well as practice her lifelong passion of chemistry. At the end of her life, her students were spread throughout America in industries and universities from Maine to California, as well as internationally from Constantinople to Paris. Much like Virginia Woolf's 1929 assertion that the female author should have "money and a room of her own if she is to write fiction", Richards early on came to recognize that women needed time in the laboratory and powerful connections in order to achieve scientific success comparable to their male counterparts.[31] Because of the Women's Laboratory and Richards' work in sustaining women's education at MIT, a number of women scientists found the space to study and the professional networks to grow. ■

Related article in the Ferrum archives:
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Annotations

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1–4 Courtesy of MIT Museum