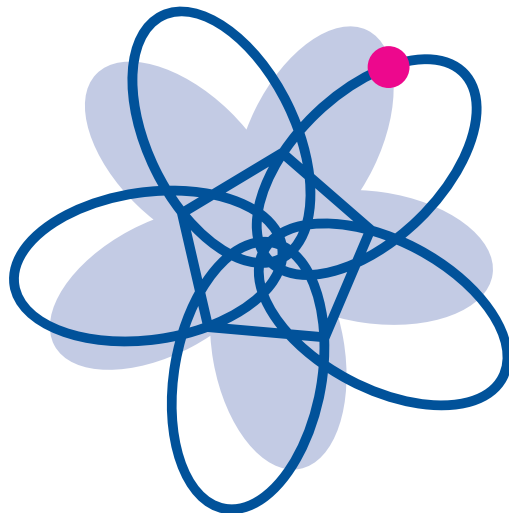


RePoSS #36:

**Women's limited role in science
conditioned by historical and
cultural factors — with a focus on
Marie Curie and her career in
natural science**

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**Women's limited role in science
conditioned by historical and cultural factors**

- with a focus on Marie Curie and her career in natural science



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Bachelor's Project

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Abstract

This paper has been aimed on mapping the historical and cultural factors, which have contributed to women's limited role in science. The paper focuses on Marie Curie and the time she lived to perform a career in natural science. Curie is in many ways a counterexample to her time. A time that didn't traditionally let women pursue intellectual careers in line with men.

Throughout history women has been perceived to have less of an intellectual capacity than men. This view has acted as a basis for women's exclusion from academia until the 19th century, where different developments in society serves to slowly alter the traditional perception of women. Curie is born early in this stage, which conditions her successful scientific career. Curie experiences special treatment from friends and family, which helps her in a professional life filled with obstacles, mainly because of her gender. Marie Curie acts as a role model for girls and women, who want to enter science, both in her time and today.

Resumé

Denne opgave har haft som mål at kortlægge hvilke historiske og kulturelle faktorer, der har bidraget til kvinders lille rolle i (natur-)videnskaben. Opgaven koncentrerer sig om Marie Curie og den tid, hun levede i. Curie er valgt som fokus, da hun illustrerer en kvinde i naturvidenskab på en tid, der ikke traditionelt set tillod kvinder at gøre den slags karriere.

Gennem hele historien har man betragtet kvinder som havende mindre intellektuel kapacitet end mænd. Dette har været en implementeret del af samfundet, og kvinder har alle steder været underlagt en mands bestemmelse. Der har været forskellige forsøg på at forklare denne opfattelse. Det viser sig, at omkring det 19. århundrede sker der flere forskellige udviklinger i samfundet, som så småt også åbner op for tanken om at kvinder kan studere på lige fod med mænd. Feminister og Blåstrømper er med til at bane vejen for kvinders deltagelse og medbestemmelse i samfundet og i videnskaben. Marie Curie lever på denne tid og bliver optaget på et fransk universitet tidligt i denne proces. Hun oplever særlig behandling af flere grunde gennem sin karriere. En karriere, der viser sig at være spækket med udfordringer, hovedsageligt på grund af Curies køn og talent. Marie Curie er et modeksempel på den tid hun levede. Dette gør hende til en solstrålehistorie i et tidligt stadie for kvinders optagelse på universiteter og i den videnskabelige verden. Hun er på mange måder også et forbillede for kvinder i alle dele og lag af samfundet. Tilmed i dag, hvor piger i stor grad fravælger visse felter i naturvidenskaben.

Preface

This paper was decided upon in a very chaotic decision making phase of my academic life.

I am a student of physics myself, but I have decided to do my minor in English Studies, which is very abnormal for a natural scientist. However, I thrive from my decision and I thought, when I'm already making my own mixed bachelors degree why not do the main project in something slightly different from the traditional too. For this reason, I looked in to The Study of Scientific History and the possibilities for a bachelor's project here, which was even listed on the Physics Department's website over available projects. So I decided to pursue my wish for an out of the ordinary bachelor's project and fell in love with a very meta-filled case of women in science throughout history.

I hope you enjoy.

Jeanette

Introduction

This paper seeks to highlight how historical, social and cultural factors have contributed to the limited female participation in the scientific society throughout the 19th and 20th centuries. The factors will be illustrated using Marie Curie as a (counter)example.

As a female student of physics I find it interesting why women have been underrepresented in the sciences throughout history. Is this due to some social and cultural norms acting as obstacles for women? Where and why did these obstacles emerge? Or have women never had any interest in the natural sciences, which are the primary focus in this paper?

Some cultural and historical factors have made it difficult for women to lead professional scientific lives. Especially the perception of the female intellect being inferior to the male has acted as a basis for obstacles for women. However, in the late 19th century it became possible for women to enter universities and pursue an academic career. Which changes enabled women to do so? How and why did these changes occur? Which problems did the early women scientists experience, if any?

Furthermore, an outline of Marie Curie's life will help initiate a discussion of obstacles and advantages in her scientific life. More specifically, culturally determined norms and traditions she was struggling with as a successful female scientist. It will be mapped how Marie Curie succeeded in physics and chemistry so early during this development. Curie evolved to be a role model, both in her own time and today. Why do many people perceive her as this role model? Does the perception have any political advantages?

Today there still seem to be a lack of women in the natural sciences. Why is that? Do young females experience some restrictions or is the problem a result of lack of interest?

These and other questions will be attempted answered shortly.

1. Historical and cultural circumstances leading the way for women in science

Throughout history academia has been characterized by male dominance up until late 20th century. What norms and viewpoints in society have contributed to this domination? Were men treated differently than women? Why? Have there been any scientific attempts to justify this view? And with what events and changes did women finally enter science? If we travel back in time and start in antiquity, we initiate the investigation by addressing how and why men and women have been perceived differently, one better than the other, to try and explain why women weren't allowed to study in universities until late in modern history.

1.1 Women biologically inferior to men

Four elements were perceived to make up all things in antiquity. A mix of these elements resulted in femininity and masculinity, which had nothing to do with the sexual nature of men and women. Women were essentially seen as imperfect men, and were not allowed to pursue intellectual studies. This view of men and women was dominating until the Renaissance. Along with Descartes and Locke, the Early Modern Feminism arose. The new views on mankind served to wipe the slate clean and the perception of female intellect was also reevaluated. Feminists of the time used biblical references to argue women and men's equal intellect. (Schiebinger, 160-168) However, this idea never implemented the 17th century, and men continued to be viewed as superior creatures and were the only ones able to enter the universities.

Later in the 17th century, a female natural philosopher made an important point, which seemed to be applicable in the scientific community centuries later. Margaret Cavendish acknowledged women's access to science in the 17th century, provided cultural constraints allowed an intellectual pursuit. Only women from the aristocracy had time and opportunity to pursue such intellectual efforts. However, she believed that women could only enter academic knowledge through men. As well as women were under the protection of their husbands, female scientists were under the supervision of male mentors. By means of marrying well, Cavendish herself ensured her academic future. Moreover, Cavendish accepted the ancient view of men being superior to women and she used this view to explain women's lack of contributions to natural philosophy. (Schiebinger, 47-49)

The Scientific Revolution began in the wake of the Renaissance and continued throughout the 18th century. With all the new views of the world, feminists hoped that a new perception of the genders would emerge. This was not the case. But there was, in fact, a shift in the perception of the differences between the genders. Sexuality was to become the subject of investigation in order to study these gender differences. A mapping of the skeleton was a sort of starting point. To be able to determine if sexuality could reside in the bones, anatomists needed a male and a female skeleton for comparison. It was clear that the female skeleton was characterized by narrow ribs and wide hips. Therefore, it seemed, the concept of sexuality was also embedded in the bones. By now the anatomists were mapping the physical differences among males and females to heighten the contrast of the two sexes, which were still arranged hieratically. An interesting argument for women's inferiority was the comparison to children. Anatomists realized that women's skulls were larger in relation to their body than in the case of a man. This might suggest a larger brain and therefore a superior intellect, but the anatomists used the occasion to emphasize how this was also the case with a child. This strengthened the perception of women as imperfect men. (Schiebinger, 188-202)

1.2 Cultural developments

To be able to understand why women were perceived inferior to men, and the difficulties emerging from this view, we need to address not only attempts to map the physical differences between the genders, but also the social gender norms and cultural developments within (western) society, as women made their way to the academic scene.

With the Industrial Revolution two other developments took place. The privatization of the family and the professionalization of the public sphere. This had a huge impact on 18th and 19th century society. The public arena was populated mainly by men and was firmly separated from the female domain; the household. For the female scientists it meant they only had one choice. A pursuit of trying to enter science (the public sphere) was doomed to fail in the 18th and 19th century, since women were still not allowed in universities. They could continue in the private sphere and be 'assistants' to their brother, father or husband while they provided for the home. In spite of this, a few women managed to enter academia, probably because of their social status. However, the next step was also difficult, because these women needed the public certification that a university

degree offered in order to use their knowledge professionally. This was not given to any woman. Society was used to the traditional female norms, which involved women working in certain convenient fields, either in the home or in appropriate new industrial areas, but no academic fields were traditionally open to women in the 18th and early 19th century. (Schiebinger, 245-247) More so, upon marriage the woman was expected to devote herself totally to the home and her children no matter if and where she had previously worked. (Pycior, 199)

1.3 Marie Curie and women entering science

Marie Curie is in many ways a good and out of the ordinary example of a woman in science around the year 1900. She was faced with decisions of choosing between a domestic life and a professional life several times. However, circumstances helped her to pursue her life in science without neglecting her family. (Pycior, 213) To illustrate how Marie Curie is a counterexample to her time, the literature often mentions an incident in 1910. At this time Marie Curie was almost invited to join the well recognized Académie des Sciences in France. She was the first women ever to have won a Nobel Prize (1903) and was even to become a double Nobel laureate (in 1911). However, she was kept out of the prestigious society, seemingly only because of her gender. (Rossiter, 122). I will return to the case of Marie Curie in more depth later. Even though some progress had been made in women's benefit, the French society was not able to fully acknowledge a women scientist at this time. However, Curie did have a rather successful scientific career. But which dynamics and changing cultural norms enabled Curie to enter and pursue her talents in natural science?

In 1802 the very first steps were taken to overcome the difficulties for women in science. Amalia Holst opened 'Higher Education for Women' in order to lead the way for female scientists. (Schiebinger, 266) The development happened gradually over more than a century and was justified by men thinking women needed some personal/intellectual fulfillment in order to become better wives and mothers. (Rossiter, 51) With this educational success, women faced another problem. Society seemed to have much greater resistance against women hosting the same jobs as men, than women getting the same degrees as men. Most jobs were traditionally labeled either men or women. As a reaction to this paradox of women finally being able to educate but not able to work, a separate market for the sexes evolved in the sciences in the late 19th century. (Rossiter, 51). Several factors helped provide an opportunity for women, who wanted to enter science these

years. In the wake of the industrialization the rise of large budgets in the scientific community were enabled. The large budgets could pay for a staff of assistants – traditionally women. Another factor was the growing social problems, which needed to be faced. This created some new hybrid fields that called for female employment, because these were considered specifically suited for women. (Rossiter, 53) However, a tendency emerged. It seemed women were only allowed to attend those jobs, which men wouldn't take, because they were either too low ranking or poorly paid. Also jobs involving women or children were generally devoted to women. (Partly because they also were poorly paid.) Then something interesting happened too. Articles concerning women and their place in science started to appear. The question on what and where women should contribute to science was quickly communicated to the growing middleclass through the new magazines in the end of the 19th century. These articles were trying to channel the newly available working women into appropriate callings. The magazines felt the need for a true success story in order to prove their point. This they found in a female astronomer, named Williamina Fleming, who was initially introduced to the field as an assistant. She started out doing mostly copying and computing, but was later introduced to more central parts of astrophysics. The male mentor ended up hiring several female assistants, since he liked their careful and tidy skills when for instance sorting stellar spectra. (Rossiter, 53-54) Williamina Fleming was a women scientist who fit the template the popular media was trying to emphasize, as a women assisting a man in academia, and therefore in an appropriate position, that society could accept.

In more fields than astronomy women proved important, partly because of their superiority in patience, perseverance and carefulness, but also because of their intellect. Marine biology, botany and zoology were fields in the natural sciences where women outnumbered men. These fields were some of the newly emerged fields, which were introduced when the separate market for the sexes evolved. Even in spite of the female majority in some areas, the women received lower pay than men. Also, women maintained to be in subordinate positions. Perhaps because they were willing to do more tedious and difficult tasks for lower pay than men. Another aspect is that women were not facing many other choices in the sciences, so they seemed to grab whatever was offered them. An important side note to the time, was that women were often relatives of the men in charge. (Rossiter, 60). This strengthens the point made 200 years earlier by Margaret Cavendish, that women only had access to science through their male supervisors who were often

their husband, father or brother. It is remarkable how far (or little) women's position in science had improved over two centuries in this light. Women were entering science in larger numbers than ever, but were still facing restrictions. As it turned out, the largest field in the whole of academia to host women was probably 'home economics'. One of the reasons for the success of this field was perhaps the increase in population, which needed research on nutrition and demanded fast practical advice. The lack of male interest in the field made it possible for women to join. (Rossiter, 65) In the light of the above, media, male scientists and the developments in society all worked to channel women scientists into fields that were considered sufficiently feminine. Either because men thought they were low ranking or because they were poorly paid. But women were seeking more equality. The path was widening, but didn't lead to all fields in (natural) science.

1.4 Suffragism, feminism and Freud

In the beginning of the 20th century several developments in Europe and America proved to women's advantage. Especially feminism and suffragism, which grew larger in the 1910's, were major factors in women's search for equality as they developed new ideas in society as to allow women into more significant and prestigious roles. The movement; Suffragism succeeded during the 1910's and 20's were women all over the western world were allowed to vote. Feminism had a lot tougher time, since people were trying to change a whole history of perception of women and much of society. (Rossiter, 100-101). Naturally many female scientists were supporters of both movements.

Around 1900 it was, as preciously mentioned, still considered a natural norm, that women were biologically inferior to men. The literature on the subject contained studies of the skeleton of males and females. The conclusion was always the same; women were imperfect men. More so, a young student of psychology noticed that the thesis had never come to an experimental test of living individuals. This she decided to do. In an attempt to map the gender differences, Helen Thompson decided to investigate the psychological differences of the sexes. She tested 50 students, 25 females and 25 males, in the abilities in physical strength and movement, sensitivity, hearing, vision, intellectual abilities, personality traits etc. She found that men were better at some things, and women better at others. She even went one step further and claimed these differences to emerge from the different training and social environment society placed the two

sexes in. Hereby she attributed the norms in society to be responsible for creating differences within the genders – a very bold and interesting point. Thompson was at this time an exceptional female scientist, who was headed for a promising career. However, she turned out to be a true product of her time, since after she married, she decided to leave the scientific scene and devote herself to a domestic life as a mother and wife. (Rossiter, 102). Nonetheless, her experimental take on the sex issue did give rise to a new view of popular and professional interest within the field. Further studies showed great variability and overlap in both men and women's abilities. The results favored the fact, that men outnumbered women in the top percent of abilities and achievements. There was no highlighting of the fact that there were similarly more men in the lowest percentages. Women came out of this study as mediocre and the male superiority stood its ground. (Rossiter, 105).

Another factor of men's superiority in the early 20th century society was introduced with Freud's psychoanalysis. (Rossiter, 105) Freud viewed women as passive, opposing to change and suffering from 'penis envy'. The penis envy is part of the oedipal complex and explains women's urge to have (male) children. Freud was also responsible for the hysteria theory, which tried to explain many female reactions and impulses. (Cherry, web) Naturally, there were opposing theories developed in reaction to Freud's. Karen Horney questioned Freud with her own 'womb envy'. (Cherry, web) The Freudian theories gained a greater foothold than the opposing theories, and even today Freud is a commonly known name in psychology. Freud managed to dive directly into the accepted norms of men and women by illustrating men as brave creatures of action with an independent and intellectual nature and women as passive, weak subordinate humans with a tendency to let the emotions govern her life. The superiority of Freud supported the superiority of men. And vice versa.

However, as mentioned, things were tilting a little to women's favor in the 20th century. For instance, a feminist book on the issue of few women in science caused by lack of opportunity rather than lack of talent received great support from former president Roosevelt, who was not exactly known for sympathizing with women. (Rossiter, 113) This was a step in the right direction for women in America. In 1914 with the beginning of World War I, men were needed in the army, both in Europe and America. This called for women taking on contemporary war jobs, as well as filling in on work positions where men were lacking. It turned out that women were mostly fully

capable of performing the same jobs as men. So after the war it would be difficult to deny women the right to enter these more masculine arenas. Also the right to vote, would be hard to reject women, since they contributed to society on equal terms with their husbands and brothers. The war also opened up new fields in chemistry, biology and other natural sciences, that called for heavier employment. Here women were available and fully capable. (Rossiter, 116) Even though things were tilting slightly to women's favor, traditional cultural norms made the path to recognition for the few successful female scientist very difficult.

1.5 Marie Curie and her tour around the United States

By 1920 women scientists had been supported by a rapid series of social and political movements. Feminism and the suffrage movement had made so great progress in education and employment since the 1880's, that some women scientists considered the job done. Several organizations dissolved because the task of encouraging women in science was seemingly complete. This forced women scientists to look for new leaders and new strategies. (Rossiter, 122). An attempt to celebrate and strengthen the theme of women in science came from a very surprising front. The journalist Marie Meloney from New York City invited Curie to tour the United States to publicize her achievements in radioactivity and raise money to continue the pursuit in radium's medical uses. Meloney wanted to promote a women of natural science who managed to combine both career and family. She was a great master of public relations, and the tour turned out to be a triumphant tour for the 'First Lady of Science'. Everyone, it seemed, wished to see the Great Lady of Science and help her continue her work. To raise money from the public, Meloney felt science needed to undergo a transformation and become a well-known, sympathetic, still prestigious field but with personified icons. Madame Curie and Albert Einstein, who also toured the United States in 1921, became symbols of science's selflessness, which appealed to the layman and was useful in the fund-raising purpose. (Rossiter, 124-125). The Curie tour turned out to be a great personal success for Marie, but in the long term it didn't serve to open as many doors to women in science, as one might have thought. I will return to this later.

1.6 The scientific community in the wake of Marie Curie

The next two decades were characterized by a growth in science but a still channeling of women into secondary roles. There were more women than ever in science but they had to work extra hard compared with their male colleagues. Such unfair treatment upset feminists who might try to create public awareness of these conditions. However, a new strategy emerged. Feminists adapted to this new, rather conservative strategy of deliberate overqualification and personal stoicism. This strategy was named the 'Madame Curie strategy' after the modest, hardworking Curie. (Rossiter, 129)

Even though women were entering science in record numbers in the middle of the 20th century doing important work, there were still signs of restriction and discrimination (Rossiter, 159). Women rarely won any awards nor did they have an office in the major professional associations. Furthermore, women were holding subordinate positions, both in the vague visibility of the fields where women outnumbered the men, but also in the fields where men were traditionally dominating. (Rossiter, 267). The underrecognition occurred in all areas, but was especially blatant in the largest fields and societies at the highest levels. (Rossiter, 295) Some women scientists were angry at these regulations that held even the most talented women of the time from much advancement and recognition, so they continued collecting statistics and publicizing this unequal pattern of women's careers in the spirit of the former feminist strategy. Others, the majority, were less optimistic and advised a greater acceptance of the inevitable and therefore promoted the 'Madame Curie strategy'. Neither strategy seemed to produce much change in these decades, but they served to prolong women's scientific lives and also provide a chance to feel like their personal struggles might help later women to go a bit further. (Rossiter, 159).

In many ways the fight for women's equality in science came to a pause in the middle of the 20th century. Women in science had come a long way in 100 years and many thought society couldn't stretch more. But in the 60's and 70's feminists had an uprising along with the thriving economy and the growing population among other things. The feminists again addressed the inequality in workplaces, both scientific, industrial and otherwise. This seemed to initiate a new great shift from the traditional perception of men and women and their roles in society.

Today, this shift in the western society has enabled women to pursue almost any career they want. However, there are still obstacles that need to be addressed before reaching gender equality in science and in society, if that is even possible. More on this later.

2. Marie Curie – the women and the scientist

As mentioned before, Marie Curie is an extraordinary example of a women scientist in the 20th century. To help illustrate and understand her persona and her life in science I will briefly try and map her life here.

2.1 Early life

Marie Sklodowski was born on November 7th 1867 in Poland. She was the last of five children of Bronislawa and Wladyslaw Sklodowski and descended from the gentry. Her upbringing, both in school and at home, was characterized by political oppression and intimidation, because of the Russian control over Poland at the time. In spite of all this, Marie seemed to love learning new things. Her parents played a great part in this interest in school. First of all, they took their daughters' educational need just as serious as their son's. And secondly after the death of Marie's mother, her father devoted his life to taking care of his children. He tried his best to pass on his love and interest in science and literature. (Pycior, 192)

Because of the Russian influence universities were closed to women at the time, and so Marie was unable to pursue her love for natural science in her home country. The family was also not capable of providing for trips to foreign universities that did accept women. Marie then took on a job as a private tutor in Warsaw, and helped provide for her sister during her studies, as Bronia would do for Marie upon receiving her diploma. While living in Warsaw Marie joined an underground 'floating university', which provided laboratory space and equipment for her physics and chemistry related works. It was during this time in Marie's life, that she realized how she loved doing physics and chemistry. (Pycior, 194-196)

2.2 Entering academia and meeting Pierre Curie

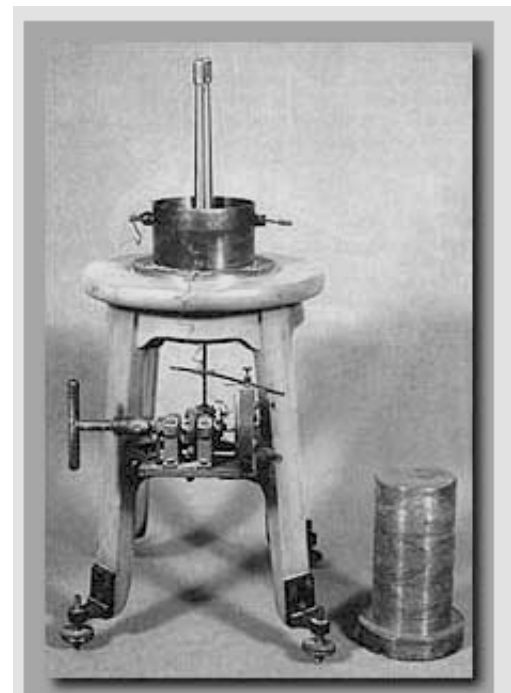
Finally, in 1891 Marie enrolled in Sorbonne University in Paris. Even though she was living off very

few means she was thriving and passed the license in physics in 1893. Then Marie decided to pursue a degree in mathematics. As early as 1894 she passed her license in mathematics and also met Pierre Curie, who was a professor at the Department of Physics and Chemistry in Sorbonne. Pierre had built a reputation of being one of the leading young French physicists at the age of 34. They met when Marie asked for space in Pierre's laboratory. The following year they married.

(Pycior,198) Their marriage was unconventional in many ways. They concentrated on essentials in life and on their professional careers, as they lived in a very small apartment. In 1897 their first daughter arrived, and this was a challenge to Marie, who tried balancing motherhood and scientific work. Marie felt guilty no matter where she was. When in the laboratory, she felt like she was neglecting her daughter and the other way around. Circumstances however drove Pierre's father to the household of the Curie's. This sort of close union of family enabled both Marie and Pierre to meet their professional obligations. With this Marie was able to keep her weekdays and some evenings dedicated to study and research without feeling guilty towards her family. (Pycior, 199)

2.3 The subject of the doctoral thesis

Marie turned to the subject of radioactivity after having studied magnetization for a year. Marie Curie first developed a way of measuring the intensity of the radiation. (Pycior, 200) The equipment used here was the Curie Electrometer. Pierre and his brother had 15 years earlier invented a new sort of electrometer for measuring very low electrical currents. (See figure on the right). Marie used the electrometer to measure the vague currents (ions) that pass through air that has been bombarded with uranium rays. (Weart, web) The installation consists of a crystal in a chamber of ionization. The chamber is made of a plate condenser whose higher plate is joined to the electrometer, while the lower plate, charged with a known potential, is covered with a layer of the examined element. (Curry, web) Marie Curie faced practical difficulties because of the humid air in the laboratory,



This device for precise electrical measurement, invented by Pierre Curie and his brother Jacques, was essential for Marie's work. (Photo ACJC)

(Electrometer. Aip.org.)

but she managed to create measurements that were reproducible. (Weart, web) Using this equipment and seeing how different elements and minerals seemed to have this same emitting property, she created the new scientific field of radioactivity. She postulated that radioactivity is an atomic property and radioactivity became the subject of her doctoral thesis. (Pycior, 201) An interesting side note to these measurements is that they confirmed Becquerel's observations that the electrical effects of certain elements were constant no matter which state the element was in and if light was shined on the sample or not. Marie Curie went one step further and proposed, as mentioned, that this effect was an atomic property. The Marie measurements contributed to a great shift in scientific understanding. At the time it was thought that the atom was the smallest indivisible unit of matter. Nonetheless the discovery of the electron and other experimental results suggested otherwise. (Weart, web)

Marie then dove into the chemical consequences of the radioactivity thesis. She examined different samples and boldly suggested having found a new element. Pierre then joined her in this stage of discovering polonium. They then discovered radium and measured its atomic weight, as Marie extracted it as a pure salt through a complex chemical process. With this addition to the periodic table, the new field of 'radioactivity' became accepted in scientific circles. The Curie's and Becquerel shared a Nobel Prize in 1903 for their 'joint researches on the radiation phenomena discovered by Becquerel'. ("Marie Curie - Facts", web) Both Pierre and Marie took part in making sure no one ignored Marie's part in the research. Here Pierre proved important. His modest and honest nature helped provide Marie with the acknowledgement she rightly deserved. However, they didn't completely oppose contemporary norms, which favored Pierre over Marie. To illustrate this, one can mention an invitation to lecture on radium at the Royal Institution, which was only directed to Pierre. Marie accompanied her husband to London, but merely sat in the audience during the lecture. (Pycior, 201-202) This illustrates the couple as fairly equal but aware of contemporary norms, that they didn't want to challenge.

2.4 New scientific opportunities and struggles

French opportunities ventured, when Genevian universities offered Pierre and Marie professorships. They both took on leading positions at the University in Sorbonne and a new department was even created for Pierre to lead. Nonetheless, to Marie's great tragedy, Pierre was killed in

1906 when trying to cross the street. (Pycior, 202) This event of course had a large impact on Marie's life, both privately and professionally. She was now a widow and a single parent, whilst also an independent female scientist. In private, she shielded her daughters from her sorrow and put on a smiling face when in their company. Professionally this meant that men scientist could no longer view Marie as a helpful wife of a successful scientist. So this called for an adjustment of the perception of Marie as a scientist among the male French academics. The French government was the first to deal with her new situation, as they offered her retirement as a widow. Marie declined this offer and expressed a desire to continue her scientific works. She managed to stay and became the first female professor in Sorbonne. She then threw herself into a life devoted to science. She studied, she researched and she taught. Not forgetting her daughters, she had organized help so she could meet all her expectations as a professional scientist. The accomplishments in her early widowhood was rewarded with another Nobel Prize in 1911 solely for her work on radium and polonium. Marie was the first scientist ever to win the Nobel Prize more than once. This second Prize recognized Marie as an outstanding independent female scientist in a field dominated by males. (Pycior, 203)

Obviously Marie Curie faced purely gender based difficulties like these, however in 1911-12 Marie was also the subject of a rather large scandal concerning her relationship with Paul Langevin, a man who had worked under Pierre and from his death continued the research on magnetism, as did Marie. (Pycior, 206) He was one of the contributors, who led the way for Marie being accepted in the scientific society as an independent scientist after Pierre's death. Many factors suggested a physical and intimate relationship between Curie and Langevin. The scandal was international and affected not only Marie's personal reputation but also her scientific reputation. Male scientists used the occasion to renew the question of whether or not women were capable of independent, creative scientific research. For the rest of Marie's life, she didn't have any close personal relationship with a man and seemed to turn a passive face towards the social world.

After the scandal had died out Curie resumed her scientific work and now took the time to go abroad for conferences and receive various honors. The honors helped her regain her self-esteem and determine her position in the scientific community. In 1918 the First World War ended and 'Laboratoire Curie' opened. She threw the majority of her energy into making sure the 'La-

boratoire Curie' was to become one of the world's leading research institutes. Marie gladly experienced that her daughter Irène would follow in her parents' footsteps in the field of radioactivity, while Eve had more of an artistic flair. (Pycior, 208)

2.5 The tour of the US

Curie needed to raise funds for her new laboratory, and in this process, she was assisted by a woman: The American journalist Marie Mattingly Meloney, as formerly mentioned. Meloney promised Curie a gram of radium worth \$100.000, if she would visit the United States to inspire female scientists and American women. She wanted Curie to be a role model of a woman who had successfully combined both family and career. In the process of fundraising Meloney founded the Marie Curie Radium Fund. The US tour became to be very important to Curie. She received several honorary degrees and experienced favorable public reception, which boosted her self-confidence. The tour was however, as mentioned, also an opportunity lost, since the overly positive atmosphere around Curie neglected the obstacles she had faced because of her gender. The tour undoubtedly provided funds for Curie's further career, but it didn't have the long term effects in the scientific community as one might have imagined. Marie Curie turned more and more to the American Radium Fund and her newly found American connections for money for radioactive materials and equipment for her laboratory. She attracted students internationally. At one time, seventeen different nations were represented in her laboratory. (Pycior, 211-213)

In 1934 Marie Curie died from the effects of many years' close work with radioactive materials only 66 years old.

3. Cultural and historical factors conditioning Marie Curie's scientific life as well as some favorable circumstances

A latently norm in western society has been dominating through out most of modern history, and was still ruling in the 19th and 20th century when Marie Curie was performing science. The norm of men having superior intellectual capabilities to women lays the basis for women having a hard

time entering academia. But in the late 19th century, a slow shift was starting to emerge in western society, which acted to women's favor. Marie Curie's scientific life was conditioned by both the traditional norms and the newly developed ones. She faced difficulties and advantages.

3.1 Marie Curie as a counterexample to her time

One of the main arguments for not letting women study in universities until late 19th century relied on a generalization of the genders. There were clear stereotypes deeply rooted in contemporary norms. It was the perception that men were like this and that, and women were like this and that and behaved in a particular way. At this time, it was a commonly accepted view, that men were more intellectually capable. There is no consideration of the differences within the genders in the literature. Except when mentioning a few astonishing counterexamples of women in science, like Marie Curie. Her life contrasted in many ways to the time she lived. (Pycior, 213) In which ways, one might wonder. First of all, it was unusual to even have women in science in the beginning of the 20th century, only certain fields had developed to house female scientists. But Marie Curie didn't work in these 'feminine fields', she took on the male dominated fields of physics and chemistry and succeeded brilliantly. Second, the acquaintance with her husband assisted her in her career and cleared some of the way for her. It was easier for the scientific society to regard Marie as a skillful spouse of a talented scientist, as had been the custom for centuries. This was however not the case. For a long time, Marie and Pierre weren't even studying the same phenomena. But the perception of Marie as an assistant was more in tune with the contemporary society. Here again proving Cavendish' point from the 17th century of women accessing science through male encounters. (Schiebinger, 47) Cavendish had seemingly hit the head of the nail, when describing women in science, as this point was applicable even centuries later. In many ways Pierre was indispensable when Marie initiated her research. He also provided practical opportunity and space for Marie to carry out her experiments, since he was in charge of a scientific laboratory on the University grounds.

But when Pierre was killed in a car accident, Marie was left alone in her work. By now Marie was already a Nobel Prize winner and her position at Sorbonne stated her as the leading expert in the new field of radioactivity. But the French academic community wasn't certain of how to handle

this independent women scientist. Suddenly, they couldn't regard Marie as Pierre's secretary. As mentioned, they decided to view Marie in the traditional light, as they offered her a widow's pension. This they did in spite of the Nobel Prize, which seemingly would oblige the scientific society to attribute her more serious independent roles. (Pycior, 203) But with the help of loyal friends in appropriate positions in Sorbonne, Marie was able to continue her research and become a professor. One of her friends was the dean of faculty in Sorbonne. This illustrates a society confused about what to do with a female scientist, once she did stand all on her own. Here extraordinary circumstances again turned out in Marie's favor and is to a large extent not a reflection of the time. Marie faced several difficulties in her career, mostly ones conditioned by the contemporary cultural norms, which questioned her intellectual talents as a woman. As mentioned, she also encountered a scandal with a male assistant, with whom she was apparently having an affair. Many male scientists used this scandal to highlight how a woman only had the strength to carry out research under a male mentor, with whom she was in love. (Pycior, 207) Here society again struggled with accepting Marie as an independent scientist. Some found that this contributed to the perception of Pierre and later Langevin having done the majority of their joint work. And this reopened the question of female scientific talent and talent in women in general. One claimed "that women could excel in science only while working under guidance and inspiration of a profoundly imaginative man ... and while she was in love with that man." (Pycior, 207) He even seemed to try and emphasize Cavendish's hypothesis, claiming that women only accessed science through male supervisors. (Schiebinger, 47) Marie handled this scandal with stoicism and a devotion to her research, and even won a Nobel Prize for this work in 1911. With this second Nobel Prize Marie Curie was seemingly finally being accepted for her independent work. There was however still tension in some paternal regions of the scientific society, even among Curie's own male colleagues. "The strained relationship with Curie was symptomatic of the general inability of male scientists to adjust quickly to independent women scientists." (Pycior, 204) When scientists met up, a male and a female, the woman was occasionally more of a hostess for the wife of her colleague than an equal to her fellow scientist. (Pycior, 205) Women were entering science in numbers larger than ever before, but men were not certain of how to handle them upon their debut in this masculine arena. Marie Curie was an extraordinarily talented scientist, and men were perhaps intimidated by her achievements.

As Marie Curie toured the United States in 1921, the public reception reached unimagined heights. The public was fascinated by this woman, who was leading such a successful scientific life in spite of traditional conventions. But this contrasted with the objections in Harvard and Yale on giving her various honorary titles. This again tells a story of a scientific community confused about how to handle women in science. Some scientists wouldn't give a doubly Nobel Prize winner an honorary degree, just because the fact that she was a woman. Harvard ended up not giving Curie an honorary degree. (Pycior, 211) The results of the tour was twofold. The tour did open doors to a slight psychological shift in the favorable direction, as Marie functioned as a role model. However, there was no long lasting effect on the position of women in science. It almost seemed that the heroic depicting of Curie minimized the difficulties she had in fact faced and that still needed to be addressed. Marie Curie was the symbol of the female success in science, but the publicity campaign created an overly positive mood, as to say to women in science, that their problems were now solved. This was not the case, since Marie Curie in many ways was a product of unusual circumstances, and even she had met obstacles because of her gender. One might think the Curie tour would open doors to more women in (natural) science. The truth was, however, that the scientific society seemingly compared female scientists to Curie, a double Nobel laureate, to justify not hiring them. This was a backfire of dimensions for the feminist core of American women scientists, and the Curie tour was perhaps a great financial success but an opportunity lost in the long term. (Rossiter, 125-128).

From this, it is obvious that Marie bore no resemblance with the stereotypical women in the 19th and beginning of the 20th century. Society expected women to, yes, work, but primarily in industrial areas such as factories, sewing or packaging something, unless their social status provided enough funds for them to live without working. Some women were primary school teachers or nurses. Marie pursued her career in physics and chemistry, which contrasted with the traditional feminine workplace. A woman was also expected to manage the household, which was in fact seen as her primary job. (Schiebinger, 245-247) Whatever a woman was doing for a living, marriage traditionally ended her career, and motherhood almost certainly did (Pycior, 199).

Marie also faced this convention upon marriage and having her first child. But with the help of her husband and father-in-law she was able to continue her research. A maid also made life easier for

the Curie's. This is one more example of how Marie's scientific career was conditioned by her familial circumstances as she led a very 'abnormal' female life.

3.2 Favorable developments

The literature on Marie Curie seems to be highlighting how she is in many ways not a product of her time. She was struggling to be accepted as a female scientist almost her entire career, but I believe some favorable changes already had been made in the academic world prior to Curie's entrance. Some dynamics in society did provide to widen the path for her. One of the key points in her career and the incitement for her success in science, was her acceptance to the University of Sorbonne in France. Without the development that opened up for women being accepted to universities, Curie wouldn't have been able to initiate her career at all. The dynamic changes in society; the Industrial Revolution, the booming economy and the vanishing class division among other things, served to initiate feminist movements such as the suffragists, who wanted to give women the right to vote and thereby participate actively in democracy. Other ideas developed and women were first accepted in universities, then to earn degrees and lastly to dominate certain scientific fields. These developments happened over approximately half a century and were conditioned by the advancements in society. The career of Marie Curie came early with respect to these progresses, but was conditioned by this major underlying norm change in society.

Also, the Nobel committee did award Marie Curie with two prizes. She shared the first prize with her husband Pierre and Henri Becquerel in 1903. That might explain why a woman was even given a prize in this early stage of admitting women in universities. Her work deserved a prize, but it was easier to give it if she shared it with male colleagues. But one cannot neglect the fact that she was given a Nobel Prize as early as 1903. The prize served to open doors for her that were normally closed to women in science. With the prize a large amount of money was also bestowed upon the winners, which was used to buy laboratory equipment and also to hiring some domestic help around the house, which favored Marie. One might attribute the Nobel Prize to Marie's raw talent but also to the Nobel Committee, who were 'bold' enough to award her with a share in a Nobel Prize. Marie Curie received her second Nobel Prize in 1911, also in the relatively early stage of women's entry in science. This prize she didn't share with anyone, which was maybe a sign of the scientific community's acceptance of her as a scientist.

3.3 Curie as a heroine

The depiction of Marie Curie in the literature is very heroic. Much of the literature rely on a novel by Eve Curie, one of the daughters of Marie and Pierre. (Pycior, 332) I believe it is fair to say, that a daughter's point of view might not be totally objective. But she is in many ways also one of those, who knew Marie the best. I think it is important to be critical when Marie's career is depicted as one huge struggle. There were some changes in society that did serve to help her, as mentioned above. There is however also some political interest in Curie's stoic and positive description. It is important to emphasize female role models when trying to engage girls to science. Marie is a good example of a woman having success in science, and she is sometimes used in campaigns directed to girls and/or campaigns based on female values today. More on this later.

In many ways Marie Curie represents a woman, who's professional path was out of the ordinary. She was of course talented but several factors turned out in Marie's favor. Curie was fortunate to live in a time where many social and cultural norms were slowly changing in women's favor. As well as the path were widening for women in science, Marie Curie is also a product of unusual circumstances surrounding her in her upbringing, marriage and later family life. She grew up in a family that embraced her dreams and talents all through her childhood in spite of her gender. Falling in love with one of the leading French physicists of the time, also served to promote her promising career. Pierre Curie made sure Marie had access to laboratory and equipment in her physics and chemistry related work. Privately the housing of Pierre's father gave Marie the opportunity and security to fulfill her obligations in the laboratory, knowing her daughters were well looked after. However, the death of her husband and later her father-in-law forced Marie to engage in the domestic life, and forced the scientific community to alter the perception of Marie, who no longer could be viewed as the helpful wife of a successful male scientist. She had to establish her position in science as a woman several times even though she had been assigned a Nobel Prize. Marie recovered and with the help of the Marie Curie Radium Fund found the means necessary to run the 'Laboratoire Marie' and turn it in to a cutting-edge laboratory. Marie Curie is an inspiring example of a successful woman in science in spite of accepted norms in western society. Her scientific life was in particular conditioned by her marital and familial circumstances. (Pycior, 213-214)

4. New waves of feminism and women in science today

Certain developments to women's favor over a century have secured women's place in academia. In spite of this, we still face a lack of women in natural science today. Especially physics, mathematics and engineering are missing girls in particular. The industrialization and the following economical and social developments have conditioned the female entry to science as a workplace. The suffragists and feminism are major factors here. After the Second World War, the so-called second wave feminism in the 60's made sure the original ideas of equality were followed up. The hope for equal pay and opportunity to advance in the workplaces were key goals for these feminists. However, the goals were not truly reached since there was a need for a third wave feminism in the 1990's. This tells a story of female advancement in science (and society as a whole) as partly conditioned by the continuing emergence of new waves of feminism. But have we reached gender equality in science? Is the lack of women in natural science still due to gender restrictions? Or do other factors play a more important role? Which factors?

4.1 Interest-based problem

Since there are no visible gender restrictions when entering natural science (since that would be illegal), it seems obvious that other factors must be responsible for the lack of women in these fields. I suggest that it is a result of a seeming lack of female interest in these subjects. It is not possible to explain in full why this is the case. But it is important to highlight that the lack of women in natural science today is based on a lack of interests, not on limitations. Of course there are some girls interested in, for instance, physics, myself included. But let's go with the generalization.

A possible explanation could be, that since men have traditionally dominated the hard natural sciences, the fields might have developed certain masculine work processes that doesn't appeal to (most) women. Certain objects of study might also not be attractive to girls. And therefore these areas do not attract the interests of young female students. This is an attempt to combine a lack of female interest with the historical developments, to show that these are not solely independent, but complexly intertwined. This also has some degree of circular reasoning. Since men dominate a field, it becomes unattractive to women, and therefore men will continue to govern this area and

so on. Also, the unavoidable gender roles, that do exist in society cannot help but influence young people. Some latent norms might suggest which interests the genders find most compelling. This effect is inevitable, since some gender roles are an implemented part of society.

Besides this, I really don't see the major issue in women deselecting some natural sciences. Men are similarly underrepresented in other natural scientific studies such as molecular medicine and biology today. As long as there are no restrictions or bans for students based on their gender, I feel the problems are minor, since everyone should be encouraged to make individual choices without fear or pressure from others.

An interesting point I would like to make, however, is that it seems women are to this day still underrepresented in the highest positions in academia. (Christiansen, web) Almost as many women as men are taking Ph.D. positions, but it seems women aren't capable of making it all the way to the professorships. An explanation to this could as well be different female interests, that doesn't match the life of a professor. Or is it a still channeling of women into, yes, prestigious roles, but not the most prestigious ones? Either way, the fact is that the majority of professors in all of academia are still male today.

4.2 Trying to engage girls to study natural science and 'Marie Curie'-organizations

There have been many actions trying to engage young girls in the natural sciences in order to balance the gender distributions in these subjects. In the future the hope is, that the perception of natural science as masculine will wash away and let women enter in larger numbers. The European Union and the Danish Government have launched campaigns to support female scientists and promote the profession as desirable for women. A Danish initiative called 'Sciencetalenter', which is trying to engage both boys and girls in science, has also designed a girl's day to try and reach out to girls in particular. (Wildside, web) The European Union has launched a campaign addressed entirely to girls. ("Science – it's ...", web) The campaign tries to engage girls to study science by clever use of feminine values. Such values are obviously maternal, caring for others and curing of diseases. This again suggests different interests that are deeply rooted in the genders in society. The campaign also makes use of female role models, which are listed on the website. There are scientists from every field in natural science trying to advocate for their fields. This campaign again highlights how the lack of women in natural science today is an issue based on interest

rather than restrictions and bans. Marie Curie is a very nice example of a woman succeeding in the early stages of even having women in science. She is also used as a role model in this particular campaign. ("Science – it's ...", web) Marie Curie also features more extensively in campaigns regarding social issues, terminal illnesses and family related problems. She lends her name to several funds, that try and make life a little easier for people who face social problems or are terminally ill with cancer. (Marie Curie Daffodil, web) The reasons for why her name is so well used in these kinds of campaigns could be her ground breaking research into radioactivity's use in the curing of cancer. The depiction of her in the literature might also explain why she is a positive association in these purposes. As formerly mentioned, she is portrayed with great selflessness and stoicism, which makes her stand out almost as a heroine. This emphasizes sympathetic values and appeal to people's care for others. When people are invited to feel sympathy with Curie, the injustice she faced is pointed out. By the use of this we start to reflect and feel the need to contribute to making other people's lives less filled with obstacles - like the life of Curie was it. However, this chosen depiction can also be problematic. First of all, it might not be true. Second, it might be true, but exaggerated to the fullest. In spite of these problems, it indeed has political advantages, when one is trying to promote young females to study natural science and/or raising funds to the less fortunate.

When viewing some of these campaigns, it is clear that the lack of women in science is a real political issue. The female underrepresentation in many areas are a still object for negotiation in politics today. Not just in science, do women face this underrepresentation, the European Union has on several occasions been discussing if gender quotas in the faculty board in universities are the way to go or not. EU also deals with making sure women receive the same pay for the same work as men perform. It has not been the case, when viewing Europe as a whole. (Newman, web) A lot of other issues are not solved, but politicians, the media and other agencies are familiar with the problems, which is the most important step in the right direction towards equality.

4.3 A quick look out

Essentially, the case of women in science is symptomatic of women's part in society in general. One is the effect of the other. Feminists have a huge part in women's success in science. And I can not help but reflect on women's continuing battle today. Some feminists seem to be striving for a

gender-free world, where there is no regard for the genders. With respect to women in science, such a society would probably mean more women in higher positions in science, than today. But it would also mean a complex change of social and cultural dynamics, that I can't even imagine. Some steps have been taken towards a gender-less society. In Sweden adults are addressing children in kindergarten with the non-bias pronoun 'hen', because some people believed the gender roles were holding children back somehow. But this is complexly problematic, since much of human identity after all is founded in the gender. The society these children are growing up in still has deep roots in the gender roles, and the children are bound to face reality at some point. As long as there exist gender roles in society, there will be basis for boys and girls to develop different interests. This is very justified, since one can not separate the person and the gender.

I believe, the key to gender equality is perhaps not to consider everyone as the same gender, but to let the sexes be equal and perfect in their differences. However, there is probably not an exact solution to absolute equality, but for the sake of modern women, modern families and modern society, one should rightly promote and not prevent women's place in (natural) science and society as a whole.

Conclusion

Throughout this paper, the aim has been to map which cultural and historical factors that have acted as conditions for women's limited role in science. The focus has been the 19th and 20th centuries, when Marie Curie unfolded her career in physics and chemistry.

It has been mapped which events and developments leading up to the 19th century that have contributed to a slow acceptance of women into academia. The Enlightenment and the Industrial Revolution were the initial steps toward viewing women as having in equal intellect with men. The development happened gradually and was conditioned by several movements. The suffragists and feminists were major factors as women were slowly entering science and advancing in western society in general. But the struggle was not easy. When women were first admitted to universities other difficulties emerged. Society struggled with women working in science, and tried to make

sure these women were holding appropriate positions. In spite of these slight progresses, some circumstances were pulling society in the traditional direction. Freud published his theories in early 20th century, which supported the conventional perception of men as more powerful and intellectually capable than women. From this, it was not an easy job the feminists had set out to do. Remember, they were trying to change a whole history of perception of women. Therefore, the men in charge, both in educational institutions, governments and in the financial businesses were not all ready to make this transition. They had a hard time accepting women in their new important positions in science and in the society as a whole. But the shift did slowly happen.

Marie Curie has been the focal point of this paper. She has in many ways been everything else but a product of her time. She was exceptionally talented, but her career was often conditioned by unusual circumstances. Her friends and family set out to save her academic career several times. Also, importantly, she lived in a time characterized by this major underlying shift in the perception of women, which served to open doors for women like never before.

Today girls are still a rare sight in some natural sciences, but initiatives have been launched to invite girls to see opportunities in these subjects. But maybe it is okay, that we experience some unequal gender distributions in some fields of science, as long as these distributions are not a result of restrictions or unfair regulations.

This paper has been focusing on historical circumstances, when women entered science and the problems surrounding this development. For further insight, one could involve statistics over women in academia, to illustrate women's entry, since this is deselected here. One could also examine other female scientists from around the year 1900, to compare and contrast the lives of these with Marie Curie. Furthermore, a wider historical spread would provide greater overview as greater detail would also contribute positively to this assignment, however, this demands more attention and is a somewhat greater task.

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