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## OVERCOMING CONCEPTUAL LIMITS: WOMEN IN SCIENCE

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In the mid-19th century, black people and women did not have the same rights as white European men. Many of these inequalities were based on measurements of the skull and brain. The last half of the 19th century gained enormous value in the Theory of Social Darwinism. It asserts that the political and social order, and the people within it, evolve according to Darwin's laws of natural selection. According to this, women possess an «innate temperament», maternal, pure, pious, compassionate; by virtue of which, their fundamental roles within society are reproduction and motherhood. The discourse of sociobiology defines male aggressiveness, female passivity, dominance hierarchies, sexual roles, territoriality, racism or xenophobia as natural biological tendencies.

This approach describes the female scientist as exceptional, the woman who defies convention to claim a prominent position in an essentially male world. Many of the historiographical works on women scientists frame them as contributions within the “History of Great Men”. Biographical studies have located Marie Curie's achievements, for example, within the male world, demonstrating that women are capable of generating important contributions to science. This work aims to show that women are capable of great contributions to science and need to be included with the aim of bringing scientific production closer to the “lay female public” through information and dissemination, worrying about contributing to the visibility of female participation in the generation of knowledge.

**Keywords:** STEAM; Gender; Education, Science; Women Scientists.

## INTRODUCTION

The issue of social learning, where a false notion is perpetuated that exact sciences are not for girls. A simple example of these stimuli would be toys given to boys and girls, which would enhance different skills. For example, boys are given toys that encourage construction (building blocks and toolboxes) and outdoor activities (such as balls and cars, for example). For girls, the toys that have accompanied them since early childhood are dolls and playing house, which encourage caring for others, the use of imagination and language. These would, then, be lessons that girls would learn from childhood and that would culminate in them opting for humanities or biological courses when they reached the entrance exam. Ideas based on the works of Hippocrates, born in 460 BC and considered one of the most important figures in the history of Medicine, about how feminine nature did not combine with intellectuality crossed Antiquity and the Middle Ages, also permeating the studies of modern philosophers such as Immanuel Kant and Jean-Jacques Rousseau. In the 19th century, Charles Darwin, in the publications *The Origin of Species* (1859) and *The Descent of Man and Selection in Relation to Sex* (1871), stated that, in the human species, females were intellectually inferior. It was contrary to these ideas and the fact that the vast majority of girls were illiterate until the beginning of the 19th century that some astronomers, mathematicians, doctors, physicists and chemists marked their names in history with discoveries that contributed to the advancement of science in various areas.

In the book “L'Histoire des grands scientifiques français”, French engineer Eric Sartori tells that, in the 300s BC, a young woman from a noble family called Agnodice dressed as a man to study in Alexandria. Upon returning to Athens, she practiced

medicine hiding her identity from everyone except her patients. Soon, Agnodice became very popular and other doctors, outraged by the competitor's success, denounced her. She was sentenced to the death penalty. However, on the day of the trial, hundreds of Athenian women invaded the court protesting the sentence, which was overturned. In the article "Les intellectuelles de la Renaissance", French historian Eliane Viennot talks about how the end of the Middle Ages was a special period for intellectuals, with knowledge becoming a source of social advancement and wealth. However, access to the knowledge market was exclusive to men and this system remained until the 19th century.

In 1636, Descartes published, in French, *The Discourse on Method* and, as he rejected the scholasticism of universities, he sought disciples among people who had no contact with that philosophy. In the 1700s, ladies from the English and Swedish aristocracy studied and produced knowledge inspired by Cartesian ideas. Among them, Princess Elisabeth of Bohemia, Queen Christina of Sweden, Viscountess Anne-Finch Conway and Duchess Margareth Cavendish. In Germany, in the first decades of the 1700s, Marie Winkelmann Kirch discovered a comet and wrote important treatises working alongside her husband. However, upon his death, the Berlin Academy refused him an official position as an astronomer. Years later, the same position was offered to her son and she was then able to become his assistant.

During the Renaissance, history identifies researchers in different areas of knowledge. The article by Unicamp professor Maria Conceição da Costa highlights names such as Sophie Brahé, participating in stargazing as her brother's assistant; Reine Lepaute, mathematician and astronomer who participated in the calculation of the return of Halley's Comet in 1759; and Maria Sybilla de

Merian, who collected numerous plants and insects in Suriname, published the results of her studies and illustrated her own books.

In France, women from the upper classes began to attend private courses and meet in salons to discuss literary, philosophical and scientific issues. These salons that emerged with Cartesianism disappeared with the approach of the French Revolution. Jean-Jacques Rousseau vehemently attacked them and supported the idea of female inferiority and submission.

Under the lights of the Enlightenment, the French Revolution did not extend its ideals to the female gender. I would still prefer a simple and little-educated woman a hundred times over a cultured and pedantic woman who would come and establish in my house a literature court of which she would become president. A pedantic woman is the scourge of her husband, her children, her servants, everyone. From the sublime height of her genius, she disdains all her duties as a woman", wrote Rousseau, in the work *Emílio ou da Educação*, from 1762, in translation by teachers Nadia V. J. Kovaleski, Cíntia de Souza Batista Tortato and Marília Gomes de Carvalho, from "Universidade Tecnológica Federal do Paraná" (UTFPR).

At the beginning of the 1980s, Margaret Rossiter (1982) highlighted the situation of women in science, especially the prejudices and discrimination suffered by them, although scientific practice presents itself as universalist and asexual. Prejudices were revealed in the allocation of jobs: women were delegated tasks that were repetitive and considered 'feminine', such as those that would require 'specific qualifications', which would require greater care and attention (such as those related to the position of assistant in laboratories) and which, therefore, would leave them out of decision-making circles. In other words, activities that would make it impossible for

them to climb the career ladder following their male colleagues. Furthermore, women would have longer careers, taking longer than men at different levels, due to marriage and/or children, which would require them to work double shifts. According to Rossiter, the first fact that draws analysts' attention is the 'disappearance' of women throughout their careers, that is, the higher up the scientific career ladder goes, the smaller the number of women at each level.

In addition to analyzes of discrimination against women in science, scientific dissemination and/or popularization of science, which aims to bring scientific production closer to the 'lay public' through information and dissemination, has been concerned with contributing to the visibility of female participation in the generation of knowledge. In the most industrially advanced countries, scientific communication is old and covers the most diverse subjects. However, scientific dissemination has emerged, over the last four decades, as an important activity that popularizes and 'vulgarizes' science.

Concerned with scientific dissemination, Eric Sartori, a French engineer from the "École Supérieure de Physique et Chimie", has dedicated himself to promoting different aspects of science in books such as "L'Histoire des grands scientifiques français" and "L'Empire des sciences", "Napoléon et ses savants" and, recently, the History of women scientists. Although it is a work of dissemination and not of analysis, nor linked to currents that deal with gender relations, it has the merit of popularizing and making visible the participation of women in the history of scientific thought. History of actions and thoughts. From its origins to its institutionalization as a social practice, science has been seen as a Male niche par excellence. Although in the Middle Ages, or during the 16th and 17th centuries, science

acquired an important role in society, women's participation in it had incipient visibility.

## **HISTORY OF WOMEN'S PARTICIPATION IN SCIENCES**

Chemist Elizabeth Fulhame was the first professional researcher in the field and made three fundamental discoveries: metallic reductions, catalysis and photoreduction, the first step towards photography. At the end of the 19th century, the British Augusta Ada Byron King, Countess of Lovelace – currently known simply as Ada Lovelace – actively participated in the development of the science that would become Information Technology. Today she is recognized for having written the first algorithm processed by a machine.

Polish Marie Curie is one of the few scientists who achieved prominence and recognition during her lifetime. In 1903, she became the first woman to receive the Nobel Prize in Physics, and in 1911, she was awarded the Nobel Prize in Chemistry, becoming the first person to win the prize twice. Curie is known as the "mother of modern physics" for her pioneering research into radioactivity and for discovering and isolating isotopes of the elements polonium and radium.

Called the German Marie Curie, Lise Meitner was born in Austria, studied radioactivity and participated in the discovery of nuclear fission, having coined the term together with her nephew and collaborator Otto Hahn in a publication in the scientific journal Nature in 1939. However, in 1944, the Nobel Prize of Chemistry was given only to Hahn.

Society owes a scientist the use of Wi-Fi technology. Austrian Hedwig Eva Maria Kiesler – known as Hedy Lamarr – was an actress and also an inventor. In the 1940s, during World War II, she worked together with pianist and composer George Antheil to create a torpedo control system that did

not use radio waves. In the 1960s, Lamarr's technology was adopted to control torpedoes and communication and is currently still used in mobile networks, Bluetooth and Wi-Fi devices.

A scientist's creations ended up becoming a large cosmetics empire. Canadian Elizabeth Arden was a nursing graduate when she began creating cream formulas to treat burns. In the 1910s, she moved to New York and opened a salon where she began selling products she developed. In 1930, she already had a line of more than 600 cosmetics and Elizabeth Arden Inc. still exists today.

Archaeologists and anthropologists Isabel Ramirez, a Mexican, and Zélia Nutal, an American who lived in Mexico at the beginning of the 20th century, were marginalized by the scientific community and it was only in the 2000s that their research was recognized. The Argentine specialist in Entomology (a specialty in Biology that studies insects) Juana Miguela Petrocchi described 11 previously unknown species of mosquitoes. Despite being highly recommended by her professor, she was not accepted as a professor of Zoology at the Faculty of Exact and Natural Sciences at the University of Córdoba in 1920.

American scientist and physician Florence Rena Sabin studied the lymphatic and immune systems of the human body. She became the first woman to win a seat in the US National Academy of Sciences in 1925 and earned the title "First Lady of American Science". The Apgar Scale, an exam that evaluates newborns in the first moments of life, was created by doctor Virginia Apgar in the 1950s. An anesthesia specialist, she also discovered that some substances that were used as anesthetics during childbirth harmed babies. Biochemist Gertrude Belle Elion received the Nobel Prize for Medicine in 1988 and created medications to alleviate symptoms of leukemia, herpes and HIV/AIDS.

Chinese physicist Chien-Shiung Wu was awarded awards by scientific institutions and North American universities. Having already graduated with a degree in Physics, she went to the USA in 1936 to continue her studies. In the 1940s, she received a Ph.D. in Physics studying nuclear fission and was part of the Manhattan Project. In 1958, she became a full professor at Columbia University, and in 1976, she was elected the first female president of the American Physical Society and also received the National Medal of Science, paving the way for many other women scholars.

## **MATERIAL AND METHODS**

For this study, responses from 100 high school students at the Ayr Picanço Barbosa de Almeida State School, located in the south of São José dos Campos, were analyzed. Questions were asked about interest in science areas and the reasons that keep them away from science. A study was also carried out on the participation of students in the Prova Paulista of the 1st Bimester of 2023. The results of the Physics test of 139 students from the 3rd Year of High School were analyzed, 71 of whom were male and 68 (female).

## **RESULTS AND DISCUSSION**

The Figures below show the results of a survey with 100 students from the Ayr Picanço Barbosa de Almeida State School, where students between 15 and 18 years old responded about their interests in science areas and the reasons that lead them to choose other areas.

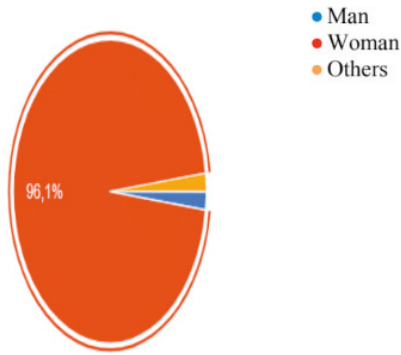


Figure 1. Student's gender.

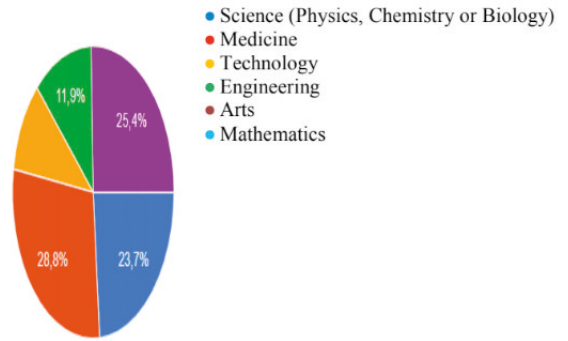


Figure 4 – Area of interest in Sciences.

Among the areas of interest in science, the vast majority chose Medicine, followed by Arts, according to Figure 4.

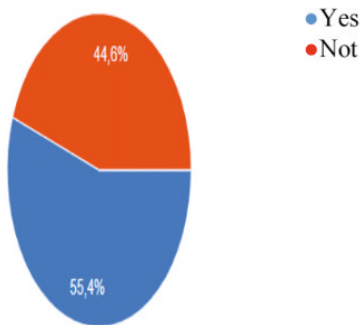


Figure 2 – Interest in a career in the field of Science.

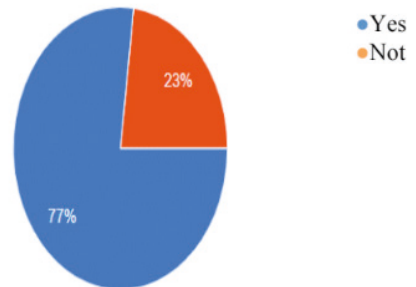


Figure 5 – Interest in building a Family.

The graph in Figure 5 makes it clear that the dream of getting married and having children still remains among teenagers aged 15 to 18.

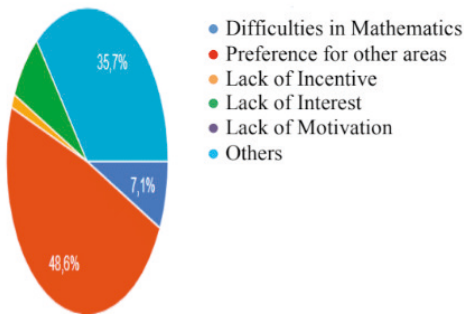


Figura 3 – Motivo que os afastam da Ciência.

Among the reasons that keep him away from the science field, his preference for other areas prevails, according to Figure 3.

Gender	<50%	>50%	100%
Male	57	14	2
Feminine	46	22	5

Table 1. Successes in the Paulista Test, Physics.

According to Table 1, women stood out in the Prova Paulista both in relation to the number of correct answers, they were the ones who obtained the most marks of 10 in the Test and the ones who obtained the least marks below 5.0. It is evident that women are not only capable of acquiring scientific knowledge but also have a higher level of knowledge compared to men of the same grade/age, which can be proven in Figures 6 and 7.

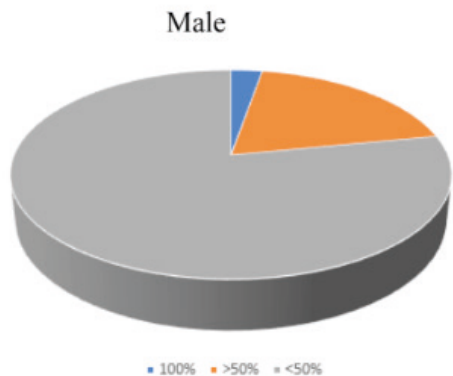


Figure 6 – Performance in the Paulista Test, Physics, male gender.

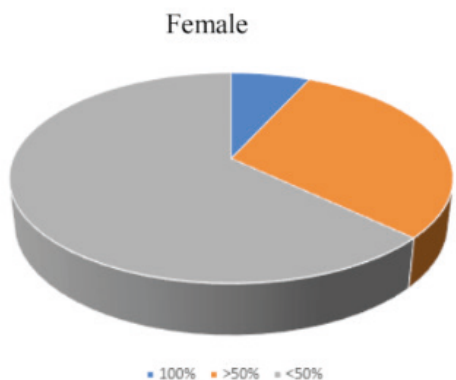


Figure 7 – Performance in the Paulista Test, Physics, female gender.

Gender	1st Year	2nd Year	3rd year
Male	11	7	6
Feminine	5	8	7

Table 2. Interest in Public School Physics Olympiads.

Despite little interest in participating in the Public-School Physics Olympiads, around 10% of students enrolled, there was a certain gender equality in the participation of students.

## CONCLUSION

Over the years and a series of transformations in society, some priorities have adapted for women. If before, they thought and/or were limited to just starting a family and being mothers, today establishing themselves professionally and gaining financial independence are also among their dreams. However, just like in the not-so-distant past, women still need to face battles, such as the triple shift (working, taking care of the family and themselves), dealing with harassment, inequality in positions and salaries and guaranteeing their rights. With the data analyzed, it is clear that the option for the STEAM area prevails among the students interviewed, however, even though there is a certain gender equality in high school, the same is not noticed years later where the male gender continues to prevail in jobs. Although there are many women of relevant prominence and scientific knowledge, there is still a lot to be done so that they are included and recognized in work where the male figure still prevails. It is clear from this work that this is a preliminary study, a bibliographical survey and classroom observations. For greater conclusions, a more detailed study would be necessary at both primary, secondary and higher education levels.

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