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Audrey Davis
Trinity University

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Where Did All This STEM From?: Investigating the Support of STEM Fields for High School Girls in the 2010s

When Dr. Sally Ride became the first American woman to fly in outer space in 1983, one question plagued the minds of the media: What makeup was she planning to take with her? In an interview with second-wave feminist and founder of *Ms. Magazine* Gloria Steinem, Ride described how the media “[…] didn’t care about how well-prepared I was to operate the arm or deploy communication satellites” instead fixating on the operations of a woman’s daily life in space.¹ For their part, the National Aeronautics and Space Administration (NASA) had effectively incorporated Ride and the first class of female astronauts into their training protocols without significant issue, but ultimately failed to consider how integrating women into the program would require steps beyond simply creating space for their employment. The flight kit construction list included shaving equipment and Old Spice deodorant, but was not adjusted to include tampons until the female astronauts made the suggestion.² This oversight was further highlighted when Steinem asked Ride if NASA had prepared her for handling the “press and pressure.”³ Ride explained: “Unfortunately, no, they don’t. You know, in my case, they took a graduate student in physics who had spent her life in the basement of a physics department with oscilloscopes and

³ Sally Ride, interview by Gloria Steinem.
suddenly put me in front of the press.” In the interview, the women laugh off the oversights and the superficial line of questioning in the face of Ride’s accomplished background, but Ride’s story is indicative of the greater issues of women moving into science, technology, engineering, and mathematics (STEM)-related fields.

Rapidly changing expectations in STEM fields towards women and girls throughout the mid-twentieth century preceded the media and NASA’s differing reception of Sally Ride in 1983. These decadal evolutions produced a culture in which the first American woman in space could exist, but the decades following 1983 continued to shape the experience of the female scientist, now that her foot was in the door. While the struggles of female scientists have been documented through the decades, the historical progression at the turn of the twenty-first century that created an environment in which female scientists were sought after rather than tolerated has yet to be investigated. As historian Kim Tolley suggests in her book *The Science Education of American Girls: A Historical Perspective*, “perhaps it is because few individuals interested in gender and science undertake historical research, and few historians of education interest themselves in science and mathematics” that has led to an under-examination of this intersection.

While women and girls are actively experiencing the impacts of this evolution that now calls for growing ranks of female scientists, the contemporaneity of the matter causes a lack of available records from recent years on the issue. By examining the well-documented trajectory of women in science throughout the latter half of the twentieth century and supplementing information about the last twenty years with what primary sources are currently available, a preliminary understanding can be constructed about the history leading to today’s conditions. While governmental initiatives in the latter half of the twentieth century created funding and

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4 Sally Ride, interview by Gloria Steinem.
opportunities for women and girls to move into STEM secondary education programs and eventual careers, the second-wave feminist movement and growing systems of female scientists advocated for creating sociocultural changes to improve the conditions of women in scientific careers. These dual efforts sought to evolve the STEM world, from education to career to culture, into one that growing ranks of twenty-first century women would seek to join.

Women’s interest in science is not a recent phenomenon. During the early twentieth century, when boys’ education centered around classical studies, men pursued science as a hobby rather than for primary employment. As such, the sciences were considered an appropriate avenue for girls’ education during the nineteenth and early twentieth centuries, as they were not allowed in the same classical studies as boys. Of the middle and upper class white American girls educated at these times, studying natural philosophy, chemistry, and astronomy was common. These studies were not intended to create career-oriented scientists, but utilized to develop mentally and culturally refined young women without a classics education. However, as teaching was a socially acceptable role for women to assume, the number of female teachers and science educators grew in the late nineteenth and early twentieth centuries. When men shifted out of classics and into science and mathematics during the turn of the twentieth century, the fields permissible for women to study changed as well, causing a significant shift in women from the sciences to liberal arts. Tolley theorizes that this instance, coupled with backlash against female teachers and the state of girls education, reduced the science educations of American girls and lead to a dearth of female scientists by the mid-twentieth century.

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7 Tolley, “Science Education,” 211.
8 Tolley, “Science Education”, 214.
9 Tolley, “Science Education”, 214.
The women’s suffrage and early feminist movements also contributed to reducing the scientific educations of girls by prioritizing fields where women could gain the most social and economic mobility, based on the jobs available at the time.\textsuperscript{10} Those who believed that women’s realm of influence should remain in the home further enforced this, uniting in the notion that girls should be educated in the skills that would be most useful for the societal positions they were most likely to hold as mothers and homemakers.\textsuperscript{11} In doing so, they reinforced existing gender divisions and embraced notions of gender fitness for certain positions. These constructions of social and cultural conditions had similar consequences to racial and class differences in education and eventually careers for women.

Based on her research of historical science education of American girls, Tolley argues that attraction to scientific subjects or otherwise is not biologically determined, but rather a product of cultural and social conditions, dictating what is appropriate for women based on the fields occupied by and limited to men at a given time.\textsuperscript{12} Biologists have debated the role of cognitive differences between men and women in relation to the gender disparity in science occupations, with some like biologist Dr. Martha McClintock suggesting that biological differences supersede social constructions and will prevent many professions from becoming equal.\textsuperscript{13} However, the American Psychologic Association supports the research of psychologist Dr. Janet Shibley Hyde, whose work and has shown that while cognitive differences may exist, they are negligible when accompanied with cultural and environmental influences that favor the greater exposure and

\begin{itemize}
\item \textsuperscript{10} Tolley, “Science Education”, 217.
\item \textsuperscript{11} Tolley, “Science Education”, 213.
\item \textsuperscript{12} Tolley, “Science Education”, 223-224.
\end{itemize}
education of young boys in science and math subjects than girls. With this understanding of the early history of girls’ science education and the vitality of cultural and social influences over biologic on science education, examining the history of the mid-twentieth century onward can now be accomplished.

The American wartime economies of World War II and the Cold War demanded man, industrial, and technologic powers that made it advantageous for the government to incorporate women and girls into the science and technology workforce. While women briefly broke into male-dominated fields during World War II, the conclusion of the war created environmental and economic factors that swiftly returned them to societally-determined careers as homemakers for the late 1940s and early 1950s. By 1957, a new war was shaping the engagement of women and girls in science. After the Soviet Union launched Sputnik in 1957, the Cold War panic reached a fever pitch, causing the United States to reassess national education for wartime response. In the hearings before Congress on Science and Education for National Defense in 1958, then-president of Purdue University Dr. Frederick Hovde outlined the vitality of American science education in Cold War competition:

I believe ways and means must be found to select, motivate, and educate every individual who possesses the natural inborne talent to contribute to the advancement of knowledge[…] Our present output [of doctors of philosophy in science and engineering] gives us less than one new doctor of philosophy per industrial research laboratory. In my judgement, this is the greatest deficiency in our educational structure insofar as national defense is concerned.

Hovde’s equation of science education with national defense, accompanied by those of many other scientists and educators, resonated among the Cold War fervor. By calling for the education of “every individual who possesses the natural inborne talent,” the participation of women in science, technology, engineering, and mathematics became an offensive means of counteracting the Soviet Union in the eyes of the American government. When Congress passed the National Defense Education Act later in 1958, it provided funds for a space program (NASA), growing science education programs nationwide, increasing identification and education of gifted youth, and bolstering science clubs and fairs for boys and girls.17 Westinghouse Science Talent Search (STS), which consolidated existing science fairs across the nation after the outbreak of World War II, served to increase the interest of students and the general public to foster scientific interests in youth for the advancements of American science and technology.18 STS shared Hovde’s belief that a national emergency like the threat of communism required the training of all potential scientific talent. STS encouraged the participation of boys and girls in the National Science Fair, especially as girls “were not subject to the draft and most of them are too young to be accepted for uniformed service women’s organizations, they have gone on with their college courses.”19 This example highlights a pervasive trend in the next several decades wherein participation of girls and women in science was sanctioned by government efforts not for feminist-oriented motivations of equality, but rather to support U.S. technological and scientific skill.

Girls’ participation in science fairs bolstered the scientific minds of the future, aided in the rebranding of scientists as unattractive and “eggheads,” and contrasted with the Soviet Union in

19 Ibid, 4.
terms of voluntary, democratic scientific participation.\textsuperscript{20} In the postwar era, the public perception of scientists was sullied by the contributions of physicists to the atomic bombs of World War II, followed by the portrayal of evil scientists in the media.\textsuperscript{21} Girls who won the STS fairs were used as marketing tools to reorient science in the minds of the public and attract young men to sciences. In one STS promotional photo, the 1957 male and female finalists are pictured sharing a milkshake.\textsuperscript{22} Promotional materials such as these suggested the potential for romantic connection with the science girls to boys potentially interested in science. In exchange for such marketing, winning the fairs offered opportunities for advancement in the sciences not as readily available to their female peers.\textsuperscript{23} Efforts to include girls in science-oriented careers supported the United States’ ideological and technological efforts in the Cold War both by introducing a female work force and making the field more appealing to male students as well.

The youth magazine \textit{Science World}, which sought to encourage more women into scientific fields, highlighted how women must maintain multiple duties including being physically attractive, the primary caretaker of children and the home, and rigorous and talented scientific researchers.\textsuperscript{24} In doing so, however, education historian Sevan Terizan theorizes that the magazine set unrealistic expectations for its readers about the experience of women in science fields and ultimately deterred young girls from science.\textsuperscript{25} Furthermore, some of the featured scientists explained in other interviews outside the magazine that women work harder to prove themselves as compared to men, must survive in male dominated fields, and reinforced scientific work available to women as

\begin{itemize}
\item \textsuperscript{20} Adams and Beatty, “Scientific Womanpower,” 6.
\item \textsuperscript{21} Tolley, “Science Education”, 215.
\item \textsuperscript{22} Society for Science, STS 1957 Finalists sharing a milkshake, 1957, photograph, Flickr, https://www.flickr.com/photos/societyforscience/4974514838/in/set-72157624917196884
\item \textsuperscript{23} Adams and Beatty, “Scientific Womanpower,” 9.
\item \textsuperscript{25} Ibid, 81.
\end{itemize}
rigorous and tedious.26 This interfered with the self-concept of female high school students; the
duality of homemaker and scientist seemed inaccessible and unachievable. Terzian argued that
greater representation in the magazine did not serve to address existing structural discrimination
against women in that “Even the political urgency of the post-Sputnik years could not revise the
cultural conviction that professional women must not abandon their domestic obligations and
feminine qualities.”27 Despite the ingrained social, cultural, and economic constraints that
inhibited women from entering scientific fields with ease, the number of female scientists was
growing. For the first time, the American Men of Science, which chronicled scientists and
engineers who made significant contributions to American science, was published as American
Men and Women of Science, even with small percentages being women.28

While the second-wave feminist movement was very engaged in advocating for legislation
addressing discrimination, some female scientists at the time felt disconnected from the influences
of feminism. The second-wave feminist movement contended with workplace discrimination,
unequal pay, sexual harassment, a lack of family services, and more, hoping to address these issues
through advocacy and legislation.29 Two key pieces of legislature from the 1960s and 1970s laid
the groundwork for the expansion of women’s opportunities in the scientific work force. Title VII
of the Civil Rights Act of 1964 protects employment discrimination on the basis of race, religion,
sex, and more, which aided women in obtaining and maintaining employment.30 Nearly a decade

27 Ibid, 99.
29 “The untold side of second wave feminism: A multinational, politically diverse movement,” Liberation Media,
later, Title IX of the Education Amendments of 1972 prohibited exclusion from federally-funded education programs or activities on the basis of sex.\textsuperscript{31} While female scientists benefitted from the legislature the second-wave feminists prompted, the efforts felt disconnected, as many female scientists were happy to be employed at all, and didn’t want to incite conflict. Dr. Nancy Hopkins, then an undergraduate biology student, said that, “I fled from [feminists]. They were the kiss of death professionally. They were so angry, so unseemly.”\textsuperscript{32} Despite the governmental incentivization to partake in the sciences, completing undergraduate and graduate degrees in science as a woman in the 1960s was wrought with obstacles, and partaking in feminism as a scientist only created another.

The tenants of feminism, while rarely directed at STEM fields of the era, were helping to critically evaluate scientific professions both in the unequal treatment of employees and the in what was studied. Hopkins’ views on feminism evolved upon arriving at Massachusetts Institute of Technology as an assistant professor of biology in 1973, where the competitive environment highlighted discrepancies between the treatment of male and female staff. While Hopkins had believed that “science would be the great equalizer,” it soon became clear that even as a scientist, the advocacy of feminism was needed.\textsuperscript{33} Simultaneously, as feminism was working to challenge existing employment issues, college-aged women were challenging the content of academic fields with scholarship that originated in the feminist movement. Dr. Ruth Hubbard, a biologist at Harvard, described how “Women and nonwhite, working-class and poor men have largely been outside the process of science-making[…] We have not formulated the questions scientists ask,

\textsuperscript{33} Zernike, “Reluctant Feminist.”
nor have we answered them. This undoubtedly has affected the content of science, but it has also affected the social context and the ambience in which science is done.”

The integration of women into historically male-dominated fields challenged the existing notions of how science operated in those fields, especially those related to biology and health, where the male body had been studied as the standard and the female body was understood through that lens.

Female scientists, who had once been content to have a job whatsoever, began to challenge their universities to address sex-based inequalities. In the hearing for the Women in Science and Technology Equal Opportunity Act in 1979, Dr. Ann Briscoe testified as a “card-carrying feminist” in her support of the proposed funding of education and research initiatives that would address sex discrimination in STEM. Many female scientists, like Briscoe, were finally coming to terms with the role feminism could play in the scientific fields they sought to break into. Dually, feminists began engaging with female scientists more directly. In January 1983, Sally Ride was featured on the cover of Ms. Magazine, a feminist magazine focused on issues pertaining to women. The article explored her experience astronaut training as a woman, but instead of focusing on details like if she would wear a bra in space, detailed the experience of breaking into a profession that had previously consisted only of men.

As the government became increasingly aware of the vitality of including women and minorities into science, technology, engineering, and mathematics fields, funding was increasingly allocated to create opportunities for marginalized populations to obtain educations necessary to

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35 Zernike, “Reluctant Feminist.”
enter these fields. The 1983 Education for Economic Security Act provided funding to the National Science Foundation to improve STEM curriculum and teacher training at all educational levels to bolster the state of science education in the United States. The report identified the folly of excluding women and minorities from the STEM workforce, in that “To do so would be to ignore their potential contributions to our nation’s defense capabilities, economic well-being and social stability.” However, these economic pushes to incorporate women into the fields did little to address the persisting issues facing women in these fields of study. Instead, increasing ranks of women, using feminist ideology, began to shape the STEM landscape as more welcoming to future women in a way government bills and funding did not address and could not enforce.

From girlhood to employment, women were facing the “leaky pipeline” of STEM, where each increasing level of education and professionalism created additional factors that caused the number of women in STEM to decline despite their interest and ability to succeed. In elementary school, the attitudes of teachers towards STEM can shape that of their female students. At the high school-college nexus, college admissions and declaring a major can further divert women away from STEM. In employment, women face a variety of challenges from the consequences of starting a family to less available funding to biases in recommendations and recognitions. A piece featuring nurses in a 1993 edition of Ms. focused on one story that was representative of many: “Delva is married with two children; her husband is an out-of-work accountant, which, she

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says, makes her ‘father and mother.’”\textsuperscript{41} Other women had sacrificed family for career altogether. Male scientists were married and having children at the same rate as the national average, while female scientists were below.\textsuperscript{42} High pressures and expectations of both scientists and women, like those portrayed in \textit{Science World}, had made it difficult to retain women in STEM fields, even if increasing numbers were joining. The cultural reception of women in science began to intersect more with the efforts of late second-wave and early third-wave feminism, identifying that “Feminists have tended to make a distinction between getting women into science and changing knowledge. Getting women in is generally considered the easier of the two tasks.”\textsuperscript{43}

Influenced by the evolving feminist movement, growing structures of female scientists, and the conclusion of the Cold War, the U.S. government made new attempts to address issues specific to women in STEM. The Women and Minorities in Science and Mathematics Act of 1991 was the first governmental report to recognize that “A major cause of this underrepresentation is a differential treatment of women and minorities at all levels of our educational system[...]. The entire educational pipeline is flawed in this regard.”\textsuperscript{44} Therefore, the Act funded grants for school, college, and graduate programs to develop programs that would encourage women and minorities to enter STEM fields, and include provisions to assist teachers with midcareer training to improve retention.\textsuperscript{45} However, increasing funding once more without specific understanding of the issues at hand prevented the retention numbers from increasing. To begin impactfully addressing the leaky pipeline issues would instead:

\begin{itemize}
\item \textsuperscript{41} Kate Rounds, “Report from the Ward,” \textit{Ms.}, January/February 1993, 36.
\item \textsuperscript{42} Zernike, “Reluctant Feminist.”
\item \textsuperscript{44} U.S. Congress, House of Representatives, \textit{The Women and Minorities in Science and Mathematics Act of 1991}, 102\textsuperscript{nd} Cong., 1\textsuperscript{st} sess., 1991, 1496-1498.
\item \textsuperscript{45} U.S. Congress, House, \textit{Women and Minorities}, 1498.
\end{itemize}
“[…] require difficult battles and a complex process of political and social change. Science departments cannot solve the problems themselves because the problems are deeply cultural… Change must occur in many areas: conceptions of knowledge and research priorities, domestic relations, attitudes in schools, university structures, classroom practices, the relationship between home life and the professions, and the relationships between different nations and cultures.”

By the end of the decade, Congress had created the Commission on the Advancement of Women in Science, Engineering, and Technology, which sought to study the barriers, practices, and policies that were influencing the gain and retention of women in STEM fields. In the initial proposal of the commission by Representative Constance Morella, she emphasized the importance of breaking down roadblocks for equality as a catalyst for the report, taking a more feminist angle, but the report emphasized the importance of the matter in terms of industrial development.

Directed to then-President Bill Clinton and Congress, the report from the Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development entitled *Land of Plenty* analyzed the issues facing women, underrepresented minorities, and disabled people throughout the science, engineering, and technology (SET) pipeline, spanning from early education to industry and academia. In the opening of the report, the Commission outlined that “To sustain America’s preeminence we must take drastic steps to change the way we develop our workforce[…] If we are to compete effectively in the global marketplace, we must advance the full and equitable participation of all Americans in science, engineering, and technology fields[…] Our high-tech, scientific, and engineering

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40 Schiebinger, “Feminism,” 1174.
industries will benefit from their diverse viewpoints and approaches, as well as their skills." The goal of the Commission was to make recommendations on systemic changes that would increase diversity in SET fields for the growth of the U.S. labor force and technological superiority in the global marketplace. In doing so, they identified precollege education as the most vital and consistently lacking stage in the STEM pipeline, with changes needed as early as preschool to intercept the self-concept issues that social and cultural scripts imparted on children. With this knowledge, the start of the twenty-first century brought the movement to elementary schools across the country.

Retention of girls in science, long term, clearly began in childhood. The *Land of Plenty* report outlined key issues and initiatives to deliberately address the preK-12 phase of the science pipeline in order to increase girls’ interest in STEM. Societal messaging towards young girls had not yet caught up with the Commissions’ efforts, however. In a back-to-school edition of Martha Stewart’s *Kids* magazine, advertisements for young boys included scientific ambitions to learn about local wildlife. Meanwhile, young girls were implied to have a dislike towards school with an advertisement from Barbie that read, “How to make school fun for us? Wearing pleather on the bus!” To improve the overall state of education and address elementary gender education disparities in society, the America COMPETES Act of 2007 reiterated the need for diversity in STEM to increase American competitiveness and began funding summer educational programs with specific support of girls and minority children. Feminist efforts of the twenty-first century

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49 Ibid, 13.
50 Ibid, 15.
51 Ibid, 16.
and governmental motives aligned in working to improve education and equity to diversify scientific fields.

The rapidly evolving STEM education culture was beginning to be reflected in the extracurriculars and entertainment available to girls. Across the country, summer camps for girls interested in science began to pop up, supported by “interests from educators and political leaders.” The camps were hosted in partnership with local schools and a variety of women’s organizations, like the Women in Science and Engineering (WiSE), and those with vested governmental or industrial incentives in education, like the Air Force and Lockheed Martin. Playing on girls’ interest in STEM became profitable. The Public Broadcasting Service (PBS) Kids network began running a show in 2010 called “SciGirls,” that served as entertainment and outreach by portraying real tween girls engaging in a variety of scientific pursuits with the assistance of an animated friend. Barbie, which ten years prior had advertised pleather instead of science to young girls, swept the 2010s with a variety of STEM occupation dolls, ranging from computer engineer (2010) to paleontologist (2012) to astrophysicist (2019). In 2018, General Electric, Google, IBM, Microsoft, and Verizon partnered to produce the “She Can STEM” ad campaign aimed at 11-15 year old girls, as the promotion of future computer scientists and engineers was a profitable investment for all involved.
twenty years relate to news and media reporting rather than governmental documents and peer-reviewed publications, the emphasis on preK-12 education in non-media sources from the turn of the century support the trajectory of investing in precollege education for future STEM success. Likely, there do or will exist reports from internal systems accessible in the future on the overhauling of the public education system and the impacts to the STEM pipeline for women. In the meantime, the investments made by governmental agencies, those that associate with them, and major technology companies in changing education, media, and toys for girls reflect the undertones of the country’s approach in the last twenty years.

The growing trend in the 2010s advocating for girls to pursue STEM careers has resulted in women earning over 50% of Bachelor’s degrees, 46% of Master’s, and 41% of Doctoral degrees in science and engineering (S&E) from 2011-2021.\(^5\) However, when STEM professions are divided by occupation type, women made up only 28% of S&E occupations.\(^6\) Gender inequalities within professional STEM fields persist despite near-equal STEM degrees awarded to women and men, highlighting the continued existence of the “leaky pipeline” for women, plagued by issues of sexual discrimination, harassment, and unequal pay and policy. Tolley argues that the lack of equitable female representation in science, even today, continues the trends of the past where cultural constructions and social systems served to prevent women from entering STEM fields, or made it difficult to maintain or obtain status in them.\(^6\) In 2020, the Emmy-nominated documentary *Picture a Scientist* exposed the personal experiences of three female scientists of different generations, races, and disciplines and the gender discrimination they have faced throughout their


\(^6\) National Center for Science and Engineering Statistics Directorate for Social, Behavioral and Economic Sciences and National Science Foundation, “*Diversity and STEM. *”

\(^6\) Tolley, “Science Education”, 224.
generationally careers. Focusing on the anecdotal experiences of the lives of biologist Nancy Hopkins, chemist Raychelle Burks, and geologist Jane Willenbring, but complimented by statistics and legal cases, they explore the sexual harassment, physical harassment, unequal pay, and higher expectations that female scientists must endure to maintain their careers. As a geologist doing field work in Antarctica, Willenbring was physically attacked and sexually harassed by her research advisor. For Burks, a black woman, her discrimination was further complicated by racism in scientific professions. Growing the number of women in STEM and improving retention across the board is an issue that continues to plague modern feminist scientists, and requires continually challenging and addressing the societal and cultural constructions that have been gradually broken down in the last several decades.

The education of American children has been shaped by governmental efforts to guide them into the STEM pipeline to support U.S. industrial and economic preeminence. For girls, the influences of feminism coupled with these governmental efforts have created a complex environment to navigate through the late twentieth and early twenty-first centuries. At every stage of education and professionalism, girls and women face unique issues based on the way that they were historically integrated into the fields by wartime and global competition efforts. In understanding the historical trajectory of this trend, it becomes clear that the modern day culture of encouraging high school girls into STEM fields could have occurred without the dual influence of government and feminism. The elements go hand-in-hand in that the funding and legislature of the U.S. government created spaces for women in STEM, but the ideologies of the feminist movements worked (and are continuing to work) to evolve them into spaces for women, as the

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63 Picture a Scientist.
64 Picture a Scientist.
difference there creates different levels of sustainability and retention for women in STEM. These trends continue to evolve today and into the future, and are worth watching, as they can explain trends in education, college, and career pursuits of women, and how history has been shaped to create spaces for women to work.
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