ENTRY OF WOMEN INTO STEM EDUCATION AND CAREERS: A HISTORICAL ANALYSIS OF THE INDIAN CONTEXT

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Abstract

This paper examines the historical trajectory of women's education in India, tracing its evolution from the patriarchal restrictions of the pre-colonial and colonial periods to the gradual yet contested entry of women into modern scientific and professional education. Rooted in a patri-focal family structure, women's access to education was initially justified as a means to make them better homemakers, wives, and mothers, rather than as a step toward independence. Early reform movements of the 19th century, led by Indian reformers and supported by Christian missionaries, marked the beginning of institutional efforts to educate women, although these efforts were deeply shaped by caste, class, and gender hierarchies. Nationalist debates in the late 19th and early 20th centuries further reinforced differential curricula, where "feminine" subjects such as home science were encouraged, while women's entry into mathematics, physical sciences, and engineering was systematically restricted. Despite resistance, pioneering figures such as Rashundari Debi, Pandita Ramabai, Savitribai Phule, and Begum Rokeya challenged prevailing norms, asserting women's intellectual capacities and agency. Autobiographical accounts of women from marginalized castes and communities reveal even harsher struggles for educational access, underscoring the intersectionality of gender and caste in shaping opportunities. Medicine became the first scientific discipline to open its doors to women, facilitated by societal demands for female physicians within gender-segregated spaces, leading to the establishment of dedicated women's medical colleges by the early 20th century. However, women's representation in engineering, technology, and scientific research remained minimal well into the post-independence period. The history of women's education in India thus reflects not only the enduring power of patriarchal socialization and caste exclusion but also a continuum of cultural transformation shaped by reform, resistance,

and negotiation. Ultimately, women's entry into education particularly in science was less a straightforward narrative of progress than a contested process of redefining knowledge, gender roles, and social modernity.

Introduction

The patri-focal family structure that prioritises men over women is the main characteristic of the Indian society. This system has shaped women's life in many ways, including their choices and access to education. Historically, women were invited to become educated to make more efficient homemakers, better wives and mothers. A desire to close the cultural gap between educated men and their uneducated wives provided another powerful motive for female education (Mukherji 1988, Basu 1988). Chanana (1988) describes how the spread of women's education was closely linked to the 19th century reform movements. It was primarily reform minded, middle class, urban families that initially considered educating their daughters (Mukhopadhyay and Seymour 1994). However, the traditional gender role socialisation continued to influence women's education of women and their access remained limited to the courses that did not have lucrative value and social status.

Education for women has been a very old and yet a very new question. Though education in general is not a modern concept as it has been there since the ancient times, but the access to it was limited to men in society. During the pre-colonial period in India, the fundamental religious orthodoxies of Hindu state in western India and Islamic state in north, laid down strict patriarchal order along the castes and gender lines thereby limiting the access to any kind of privileges for women. In particular, the Brahmanical patriarchy had always barred women from obtaining an education. The seriousness of the issue is demonstrated by the particular case of how the Peshwas in some regions of western India gave local officials orders to take severe punishment against those who educated their daughters and kept them unmarried after the age of nine. Only during the early nineteenth century period of social reforms in India, even while debates about sati, widowhood, polygamy, and child marriage took place, women's education did not receive the attention it deserved. However, Raja Rammohan Roy, a leading social reformist of the times wrote in 1818, as quoted by Sarkar (2008:317) "When did you ever test the intelligence of women that you can so easily designate them as foolish creatures? .....You withheld education and knowledge from them, so

how do you decide that they are incapable of learning?" According to Sarkar (2008), this was written during the early stages of efforts to provide women with access to education.

Significant progress in women's education in India was made in each of the next ten years thanks to the introduction of encouraging ideas, whether they came from missionaries in the 1820s, youthful reformers from Bengal in the 1830s, Ishwar Chand Vidyasagar or the powerful Brahmo movement in the 1840s and 1850s. Forbes (1998) describes how, after a protracted period of ignorance and stagnation, women's education history throughout the British era was a slow but steady march towards modernity. The Indian reformers along with the British missionaries, who presented a critique of their own society and its systems, articulated this period of reforms as 'golden age' which could only be possible after a long history of struggle. This was the period when earliest schools for girls along the modern lines were started in Bombay (Basu 1988). The Hindu Balika Vidyalaya, which became Bethune College, was one of the most prominent schools for females. It was founded in Calcutta in 1849 by J.E. Drinkwater Bethune, a member of the Council of Education and a legitimate member of the Governor-General's Council with an intent to attract prominent families to endorse this experiment. But he remained unsuccessful as till the year 1863 there were only 93 girls largely from the lowest class that indicated the prevalent upper caste prejudice against female education (Forbes 1998).

Nationalist Movement and the Women's Question

Nationalist discourse along with the reform movements also accelerated the resolution around the 'women's question.' Chatterjee (2008) like many other nationalist historians concluded that the nationalist movement brought women to public life thereby instilling in them the sense of 'self' and hence the 'woman's question' was largely resolved by the end of the nineteenth century. However, as noted by Rao (2007), there was a lack of consensus in the nationalist rhetoric about women's education. She clarifies that certain nationalist leaders themselves, especially radical Hindus like Bal Gangadhar Tilak and his adherents, attacked the first ever girls' high school established by Govind Ranade and Dhondo Keshaw Karve's women's university in 1884 in Poona, indicating the severe rejection to women's education even during the period of intense national liberation movement. Many such nationalist leaders argued that the course of nature would get disturbed if the women were imparted English education as they would get distracted from the work assigned by nature to them of increasing human species and they would have nothing

substantial to offer to society (Rao 2007). There was another argument put forward by these extremists for giving differential education to men and women. For example, Tilak opposed educating Hindu women the sciences, arithmetic, and English because he believed it would destroy their priceless traditional values and turn them into immoral, submissive people. Despite the continued efforts of missionaries and social reformers, the East India Company declined to take action for female education in light of these inconsistencies (Basu 1988).

Although missionaries founded the first schools for girls, the majority of their work did not contribute to significant advancements in female education until the latter part of the 1800s. It was only when government offered the financial support and coming together of urban professional elite with the reformers that the formal education for girls grew steadily. Chanana (1988) scans the debates around women's education during the pre-British period and explains that with the intense social and political awakening and enactment of various laws to prevent women from exploitation, the slogan had come to be: 'educating a girl means educating a family' by 1920s. The British Government also changed its position on the issue of women's education and showed willingness to lend support.

It is also understood that under the strict patriarchal system, Indian women got opportunities for education because the men decided that it was time for change (Forbes 1998). Basu (1988) also pointed out that it would not have been possible for women in the 19th century to obtain education without the support of men. Though, the main goal of women's education was to socialize them into becoming even more reliant and obedient than they already were. The main purpose of women's education was to prepare males. It was believed that raising a race of intellectual sons, brothers, and spouses required educated moms, sisters, and wives.

The topic of what kind of education was best for women came up next in the discussion. Many educated women began to identify their issues and write about their attempts to obtain an education before the end of the century. The life histories and memoirs of many such extra-ordinary women explain the social conditions of their education, the opposition that they faced in obtaining education and how education affected their role within the family and outside (Basu 1988, Forbes 1998). Rashundari Debi, for example, born in 1809 and an uneducated rural landlord's wife accomplished the astounding feat of teaching herself to read and write completely on her own, in complete privacy. After that, in her autobiography, *Amar Jiban*, as read by Partha Chatterjee

(2008), she describes her lifetime struggle in which she appeared as a pre-modern figure who attributed her success to a divine power all through her life for her ability to read and write. However, *Amar Jiban* was considered a modern autobiography by Sarkar (2008) as it presented Rashundari Debi as a self-asserting individual with sense of agency to transform her own destiny and put forth a new notion of self-hood.

Pandita Ramabai (1858-1922) is another example of outstanding courage and reverence. In appreciation of her extraordinary learning, she was given the appellation "Pandita." Basu (1988), while explaining her life history points out that Pandita Ramabai was an exception as she questioned the subordinate role of the women in the society and wanted to free women from tyranny of men by rejecting the submission to Shastras that called women inferior to men. According to Forbes (1998), Pandita Ramabai was in stark contrast to two educators of her era, Maharani Tapaswani and K.D. Karve, who she claimed were teaching young women from traditional homes how to be better spouses and mothers in the contemporary society. PanditaRamabai's views were unusually progressive and radical for her times. Needless to it is to say that these headstrong women were a minority and belonged to upper caste middle class urban families. Hence, the struggle stories of women belonging to lower castes and disadvantaged backgrounds largely remained unarticulated.

Caste added to the struggle of women striving to access education. Amidst the limited acceptance to women's education, women with lower caste backgrounds had even grave struggle in obtaining education. Mahatma Jyotiba Phule was a trailblazer in the field of education. He and his spouse, Savitri Bai Phule, established the first school for females in western India in 1848. However, as a result of the action he had performed, he was expelled from his parents' home (John 2008). The extremist Hindu nationalist leaders offended the idea of educating women and, more particularly, education for Dalit women did not have any significance according to them as they viewed Dalits capable and destined to do only the manual labour which did not require any education (Paik 2014).

Among a very few autobiographical accounts of Dalit women's education, Pawde's autobiographical account is a nuanced and comprehensive description of her struggle to study the most Brahmanical of subjects- Sanskrit being a Dalit (Pawde 2008). Through her autobiography named *Antasphot* (Implosion) written in 1960s, Pawde exposes the hidden nature of caste's deep structures in modern-day India. Kumud Pawde's account of the casteism she encountered among

her classmates, neighbours, government offices, and the university where she eventually returned to her position as a Sanskrit professor shocks the reader at every turn. She concludes that the caste of her maiden status remained deprived all through her life as she could get a job only when she married a high caste man (Pawde 2008). There is voluminous data available that reflects the under representation of women from lower caste backgrounds at all levels of education which gets further deteriorated with the rural and minority status attached to it. Muslim women for example have long been a minority in formal systems of education.

Forbes (1998) explains historically that Muslim women were getting traditional education during nineteenth century but traditional education meant learning to read sacred literature. The Quran and basic accounting knowledge were expected of Muslim girls, but higher class families' stringent seclusion policies prevented their daughters from attending school. Consequently, they either learned about their faith from their families or from tutors while they were at home. Even after the efforts made by British government, Muslim girls largely remained unable to gain entry into school system as they suffered deep sex segregation observed in their families which demanded separate girls' schools with female teachers exclusively (Forbes 2009).

It is said that Begum Rokeya Sakhawat Hossain (1880–1932) was the first to let Muslim girls to attend formal school. In 1909, she founded a school for Muslim girls in Bhagalpur, Bihar, where the curriculum included literacy and hands-on learning activities including gardening, home science, and handicrafts. Begum Rokeya herself published and spoke out against the immoralities of this ritual, but her school upheld the conventional curriculum and the purdah regulations for Muslim girls. Because of this, Rokeya's campaign continued to be controversial, she drew criticism, and people accused her of being pro-Christian and Europhile (Forbes 1998). However, as more young Muslim men with English-speaking backgrounds expressed interest in women's education, the idea of encouraging education among Muslim girls began to gain traction. As a result of which Female Education section was set up in Mohammadan Educational Conference in 1902 and a school for Muslim girls was set up in Aligarh in 1906 (Forbes 1998).

Chanana (1988) analyses the main arguments of these educated men who wanted their women to be educated. She finds that the dispute for "promoting education among Muslim girls was similar to that used for providing education to Hindu girls that they should be prepared for their future roles of educated wives wanted by educated men" (ibid). Importantly, it was noted at the start of

the 20th century that women's education had unforeseen and unexpected repercussions. Forbes (1998) noted that the first wave of educated women wrote on their experiences and the status of women in society. As they expressed their criticism of the established structures and the status of women as subordinates, the second generation of educated women took action. Girls who desired to learn were teased and shunned in the home, and those who went to school were stoned in the streets and made fun of in the classroom if they went to boys' schools, despite the fact that their deviant behaviour was harshly punished. If they wished to pursue their careers, they would face harassment. Notwithstanding the trends these 'new women' as was called by Forbes (1998) were becoming educated and then becoming educators who soon started to debate the rudimentary socialisation practices that limited the role of women to rearing of children at homes and doing the household chores. However, amid the debates around sex based segregation of subjects, women found it difficult to access science education.

Nationalist Discourse and the Sex Based Subject Segregation

During the late 19th century, women's education was limited to the subject areas that strengthened the traditional practices of sex role socialisation. According to Karlekar (1994), there was an understanding during the nineteenth century that excessive exposure to knowledge would undermine the unique qualities that the women had. Basic literacy and numeracy skills, hygiene, needlework, embroidery, and, in some areas, vernacular languages in addition to English were considered to be the most suitable and sufficient subjects for women. Karlekar (1994) explains the rigidity of subject segregation along gender lines that was advocated even by the leading social reformers like Keshub Chandra Sen who was active in Brahmo movement during the latter half of the nineteenth century and advocated women's education. He also asserted that women need not be educated in science and mathematics (ibid).

The Education Commission of 1882, as referred by Karlekar, also felt that a lesson that is appropriate for a boy should not be assumed to be appropriate for an Indian girl as well. (Karlekar 1988: 142). These ideas led to a significant amount of government backing for a curriculum designed specifically for girls, who saw education from a different angle than boys. Not surprisingly, even Mahatma Gandhi as quoted by Sur, also asserted differential curriculum for men and women. Sur explains what Gandhi said as, given the inherent differences between men and women, it is imperative to preserve the educational gap between the sexes. They serve different

purposes, even though they are equals in life. According to the natural order, women shouldn't have to work to support themselves. (Sur 2009:107).

Chanana (1988) also explains historically how sex role socialisation was considered 'as the primary function of education with regard to women's education' in particular, especially in the early 20th century when a great number of women were obtaining access to education. A significant group of people recommended against granting boys and girls equal access to Indian educational institutions as more young people entered them. For example, Siquira and Chiplunkar, cited by Chanana (1994), contended in the early 1900s that while men and women shared a common moral, emotional, and intellectual makeup, they differed physically and psychologically, and that this needed to be emphasised through distinct curricula. Forbes (2009) notes that Professor Chiplunkar was not alone in arguing that 'subjects like mathematics, pure chemistry, and physics should have a subordinate place,' while women were taught other sciences (botany, sociology, psychology) that could be 'applied to household needs and requirements' (Forbes 2009:10).

There was a substantial literature developed opposing 'masculinist' education for women by the year 1916, when D.D. Karve opened the first Women's University in Pune. It was argued that women who were pushed to study the same curriculum and meet the same standards as men, suffered from depression and infertility (Forbes 2009). To strengthen the dichotomized role socialisation process along the gender lines, different subjects were demanded to be taught to men and women. This demand, according to Chanana (1994), led to the emergence of 'feminine' subjects for example hygiene, home science, needlework, music and literature etc. while physics, chemistry and mathematics emerged as the 'masculine' subjects. As a result of such assertions, the All India Women's Conference demanded education for home making and lately Lady Irwin College was established in 1932 which had exclusive courses meant for effective running of the home. The ideal science was thought to be Home Science and by 1920s it had found a place in girls' high schools (Forbes 2009).

As discussed, women and science have long been considered as an unnatural relationship because of the biased socialisation practices and specified sex role expectations from both the genders. However, 'Home Science' was thought to be answering all the questions related to women's needs of acquiring scientific knowledge. According to Mary Hancock, "Home Science served a double

purpose: women who learned how to scientifically nurture the nation, and the skills necessary to work, if they needed to in food industry and social welfare" (cited from Forbes 2009: 10). Hence, the scientific element that was incorporated in the discipline of Home Science were Zoology, especially information about domestic animals and genetics, lessons from Botany on Medicine, and Psychology for understanding of child development and basic principles of Sociology. However, the Indian polity showcased a radically different view on this question of women and science. For instance, during the 1928 foundation stone laying ceremony of a college for women in Allahabad, Nehru, as cited by Sur (2009), publicly criticised the college's prospectus, which asserted that "a woman's place was in the home and that her duty was to be devoted wife, bringing up children skillfully" (Sur 2009:108).

Though in stark minority, the voices demanding equality of education started to appear. Students at all-women Bethune College started arguing initially against having a separate university for women, claiming that it would limit the competition for women and politics of sex based socialization would systematically exclude women from the science education. Henceforth, they insisted that Bethune College start offering courses towards an honours degree promptly in subjects like physics, chemistry, physiology, and zoology (Sur 2009). Also, as high schools had great difficulty finding women capable of teaching subjects like Geography, Mathematics and Science, which constituted the main syllabus for the Calcutta University entrance exam, there emerged a demand to provide support for science classes so that Indian women could get an opportunity to pursue science degrees. Sarla Ray, a women's rights activist, and her contemporaries wrote in 1909 to fulfill this demand but were never taken seriously as there was a general agreement that Women only needed to be taught subjects that were appropriate for their life at home since they had trouble understanding science (Forbes 2009). Forbes refers to the annual report of Calcutta University published in 1920 to indicate that the prevalent agreements about women's education resulted in differential access to various science sub-disciplines. For instance, those women who passed the entrance exam and entered colleges recognized by Calcutta University were allowed to opt for botany which was considered to be easier and more suitable for women than the harder and more theoretical subjects like physics (Forbes 2009).

Kumar (2009) asserts historically that while the exposure of girls to mathematics and science was disapproved of in the earlier times, colonialism in India reinforced this tendency. British government did not want Indians to be given education in science. Science, according to Kumar,

came late to India because of the biased education policy of British government that wanted Indians to resume the subordinate positions which did not require reason and logic to be learnt and taught (2009). In those days to think of science education to be given to women was virtually impossible. Some women could only receive training in physics and other basic sciences later in the beginning of the twentieth century.

Sur (2009) presents an alternative perspective to Kumar's stating that nationalist leaders had solidified the role of science and technology in producing material wealth towards the late nineteenth century. Various scientific institutions like Geological, Meteorological, Zoological and Archeological Surveys established by the British, had impacted the Indians with the supremacy of science. The Indian intellectuals placed a strong emphasis on science and technology, demanding and founding their own technical and research organisations. Indian men regarded science as the signifier of modernity but considered rationalism, the key concept in scientific thinking as inherent to human nature and not a European forte. Indian scholars quickly saw the seeds of modern progress in ancient writings, which made science a crucial component of the nationalist struggle (Kumar 2009). However, Indian nationalism, according to Sur, did not want to compromise the spiritual aspect of national culture and self-identity in the process of adopting or submitting to the western scientific model (2009). Therefore, Indian nationalism as argued by Chatterjee (2008) created gendered dichotomies to serve both the material as well as the spiritual aspects of the ideology. Resultantly, the material aspect of nationalist ideology that consisted scientific development became the public and masculine domain whereas the spiritual aspect of self-identity and preserved culture became the private and feminine domain. This view strengthened the obligation of limiting women's exposure to science which was considered to be the masculine domain and was thought to be detrimental for spiritual aspect of nationalist ideology.

In other words, women were refrained from being given science education as they were thought to be the bearer of spiritual agenda of nationalist discourse. However, the sex dichotomies, according to Sur (2009), as operated in the nationalist discourse soon got blurred with the impact of eastern philosophies that acknowledged pursuit of science or quest for knowledge as a spiritual activity than a material endeavour. It was easier for Indian women to pursue science because of this understanding—promoted by eastern philosophies—of the never-ending quest for knowledge as well as the realisation of the absurdity of the rational-emotional and objective-subject divisions. The middle and upper classes in India supported women's enrollment in more contemporary,

career-focused courses because they considered that women's education should be connected to work prospects. Women studying literature, history, chemistry, or physics didn't really matter as long as their education didn't question the patriarchal nature of the household. 'Entry of women in higher education thereby guaranteed that some women would have the chance to pursue the most improbable of disciplines' (Sur 2009).

Medicine as the First Discipline to Open its Door for Women

According to Forbes (2009), women's introduction into the scientific education was initially made possible by Hindu Mahila Vidyalaya which was established in 1873 by Annette Akroyd and prominent associates of Sadharan Brahmo Samaj. These members had a different mission of female emancipation through promotion of women in higher education and professional fields. One of the associates of Hindu Mahila Vidyalaya was a social reformer, Dwarkanath Ganguly who had been a fore runner of the idea that women had every right to the same knowledge as men (Karlekar 1994). Ganguly created alternate tracts for his students after being dissatisfied with the Bengali textbooks for geography, maths and health science (Karlekar 1994). Students at Hindu Mahila Vidyalaya were taught the subjects necessary to pass the entrance examination of Calcutta University. They continued to prepare their students for securing seats in University and soon when Bethune College was merged with Hindu Mahila Vidyalaya in 1878, Calcutta University opened its matriculation exam for women. Two of Bethune students, Kadambani Basu and Sarla Das, were the first to take and pass the Calcutta University entrance exam. Vice- Chancellor at a meeting of the Senate of the University of Calcutta in 1879, commented as quoted by Karlekar (1994), "the young lady (Kadambini), who had passed the entrance examination with great credit, she had not only obtained very high marks in Bengali, tolerable marks in history and even exact in science- a subject which is not usually considered to be congenial to the female intellect" (Karlekar 1994:64).

Chandramukhi Basu, was the initial person to earn a B.A. from Calcutta University alongside Kadambani Basu. Kadambani then made the decision to enroll at the university to study medicine. Kadambani was admitted to medical college in 1883 after failing a section of her final practical exam. Instead of earning the more prestigious MB (Bachelor of Medicine) degree, she was awarded the GBMC (Graduate of Bengal Medical College) degree in 1886. In 1888, after establishing her own private practice, she was transferred to the Lady Dufferin Women's Hospital

and paid Rs 300 a month. In a separate region of the country, Anandibai Joshi, a Marathi woman, also earned her medical degree in 1886 (Forbes 1998). She became the first Hindu woman to study medicine overseas when she graduated from Women's Medical College in Philadelphia. In a speech given to a mixed audience at the Bapist College Hall in Serampore in 1883, Anandibai, cited by Forbes, explained why she chose to study in a "foreign" country. She claimed that, as a Hindu, she faced verbal and physical threats when she ventured outside of her home alone. If she had been a Christian or a member of Brahmo Samaj, she might have found it easier to obtain an education in India (Forbes 1998:162). Forbes claims that Anandibai's husband, Gopal Vinayak Joshi, made it possible for her to follow her ambition. Joshi was adamant about giving his wife an education and had written to an American benefactor in India, pleading with him to fund Anandibai's schooling.

Among the various sub disciplines of science, medicine was the first to attract Indian women. Medicine was the first discipline with which they stepped in the world of professions, however there were already large number of women as workers in factories, mines and agriculture. As per Forbes (1998), in 1921, more than thirty percent of women were employed. There weren't many professionals among them. According to the same statistics from 1921, there were 68,000 women working as medical professionals, 30,000 women working in the domains of education and science, and 6,000 women working in law and business. Women's representation in the non-traditional professional areas that had a great social status and lucrative value attached to it but were male dominated fields like scientific research and technology, was far from satisfactory. Women started to acquire professional positions with the efforts made by women's organization in 1920s and 1930s. Women's organisations called for women to have access to healthcare and education, which required female professionals because of the sex segregation norms prevalent in the society.

Burton (2009) reports that although middle-class and upper-class Indian women saw western medicine as cutting edge and scientific, they were hesitant to use male physicians instead preferring to see female physicians. As a result, there was a greater need for female medical experts in the late 19th and early 20th century. After World War I, there was an immediate and overwhelming demand for female physicians, which led to the addition of scientific courses to the curricula of women's institutions. The Lady Harding Medical College for Women was subsequently established in 1916 in Delhi. By 1929, women were being admitted to nineteen male-

only medical colleges and schools, and four medical institutions catered solely to female students (Forbes 1998).

While Indian men long had access to western medical education, Indian women did not receive it until 1885, when Lady Dufferin, the Viceroy's wife, founded the Dufferin Fund, also known as the National Association for Supplying Female Medical Aid to the Women of India (Burton 2009). This programme, which offered financial aid to women wishing to pursue training as physicians, medical aides, nurses, or midwives, benefited Kadambani Basu (Burton 2009). It is important to note that medicine was the first profession which was opened to women in western European countries as well though after a tremendous resistance as many western women trained as doctors had difficulty in finding positions at home in England (Burton 2009).

Interestingly, as Kumar notes, female seclusion and segregation resulted in women's entry to medical education. Though, the culture of segregation discouraged women from choosing the engineering profession. It was feared that women would have to learn and work in male dominated fields. Resultantly, women's involvement in engineering was quite low until the early 1980s and the exclusive women's colleges for engineering did not develop unlike medical profession till very recently (Mukhopadhyay 1994). What is significant to observe however is that the historical instances of resistance to women's education in general and in science and technology in particular indicate that the transition from 'no education' to 'science education' is in continuum. This continuum is indicative of salient processes of cultural transformation.

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