How to improve the representation of women in STEM

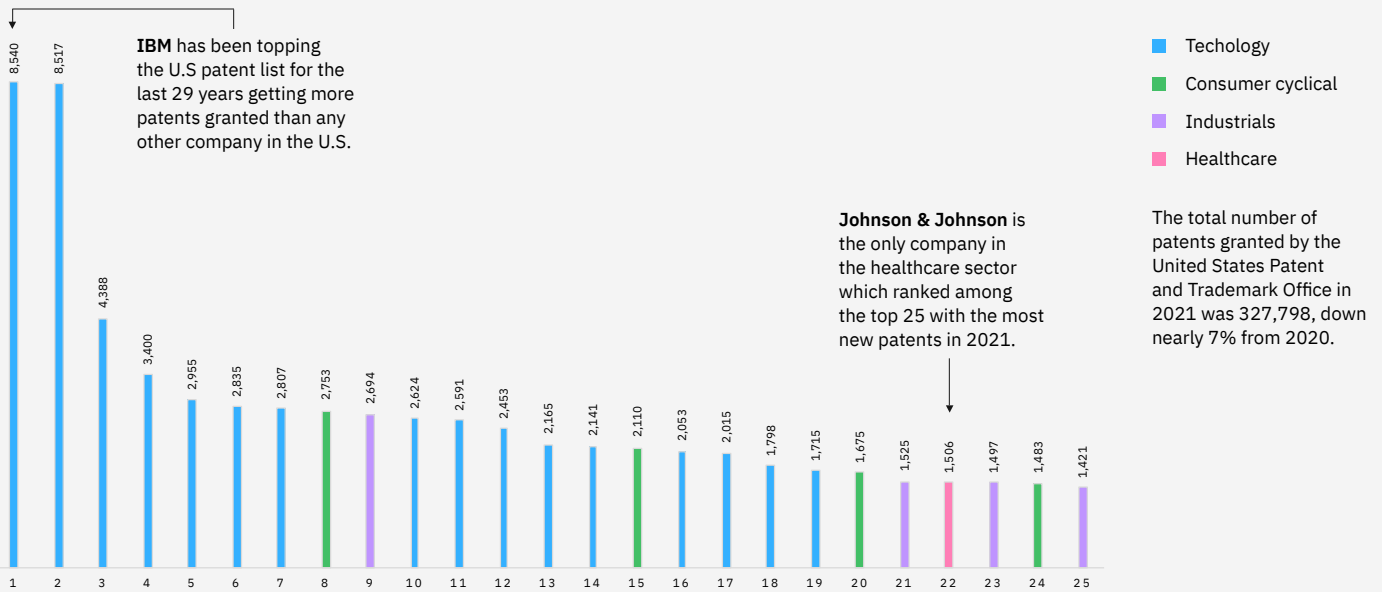A case study from IBM inventorship and patenting

IBM

In 2015, the United Nations (UN) introduced 17 Sustainable Development Goals (SDGs) that it believes will provide a better future for the world's population.[1] With 2030 as the deadline to achieve these goals, less than 10 years remain to bring about significant change.

Goal 5 of the UN's SDGs is focused on gender equality. Women and girls must have equal rights and opportunities. It's not only a basic human right, but it also affects all other development areas. In recent decades, great progress has been made in providing women and girls with access to education, but a great deal of work remains to be done. It's especially true in the STEM fields: science, technology, engineering and mathematics.

Girls and women are systematically tracked away from STEM throughout their education, limiting their access, preparation and opportunities to enter these fields as adults.[2] The gender gaps are particularly significant in the tech industry, especially in patenting and inventorship.

Top 25 companies with the most new patents in 2021

The Patent 300®, developed by Harrity Analytics, compiles the top 300 companies, organizations, and universities in the patent field every year. It s based on the quantity of U.S. Utility Patents issued each year.

IBM has been topping the U.S patent list for the last 29 years getting more patents granted than any other company in the U.S.

Johnson & Johnson is the only company in the healthcare sector which ranked among the top 25 with the most new patents in 2021.

■ Techology
■ Consumer cyclical
■ Industrials
■ Healthcare

The total number of patents granted by the United States Patent and Trademark Office in 2021 was 327,798, down nearly 7% from 2020.

Rank	Value
1	8,540
2	8,517
3	4,388
4	3,400
5	2,955
6	2,835
7	2,807
8	2,753
9	2,694
10	2,624
11	2,591
12	2,453
13	2,165
14	2,141
15	2,110
16	2,053
17	2,015
18	1,798
19	1,715
20	1,675
21	1,525
22	1,506
23	1,497
24	1,483
25	1,421

The Patent 300® by Harrity Analytics

Economic benefits of gender equality

According to the McKinsey Global Institute (MGI) report,[3] all types of inequality have economic consequences. MGI has estimated that full female participation and integration into the labour force could boost global gross domestic product (GDP) by as much as 26%.

Another study conducted by the National Center for Women & Information Technology (NCWIT) of the United States found that information technology (IT) patents with mixed-gender teams are cited more often than those with single-gender teams in later patent applications.[4] This study suggests that greater diversity on teams may lead to the development of patents that are more useful and successful.

Patenting is a valuable aspect of IBM's scientific and innovation contributions to the economy. The diversity & inclusion (D&I) dimension offers a new competitive advantage in patenting and inventorship for IBM. IBM generates approximately USD 1 billion in income annually from the licensing and sale of intellectual property, and has been at the top of the US patent list for the last 29 years.[5]

IBM case study: Inventorship and patenting from a gender perspective

A case study from IBM on inventorship and patenting was recently published. IBM partnered with IVADO and Makila AI to analyze granted patents filed by IBM from a gender perspective, and map to what extent these patenting activities are inclusive for women.[6]

This study exploited the power of machine learning to conduct descriptive and predictive analysis to examine unconscious bias in IBM patents.

– The descriptive analysis was used to identify the explicit bias, the univariant, and implicit bias, the multivariate; correlations between variables.

As part of our descriptive analysis, we investigated multiple factors, such as groups' gender composition, attorney gender, examiner gender, processing time, number of figures and others. From there we noticed one interesting aspect related to the way inventors form groups for patents. Once we started analyzing groups' composition, we observed that female participation was largely in mixed teams, while males largely favoured homogeneous groups. One positive trend we saw during our study was that, even though the majority of the inventorship is currently produced by men-only groups, we see this trend beginning to reverse in favour of mixed groups.

– The predictive analysis was used to estimate how the bias will evolve and behave in the future, and determine which social actions need to take place to avoid future degradation and strive for amelioration.
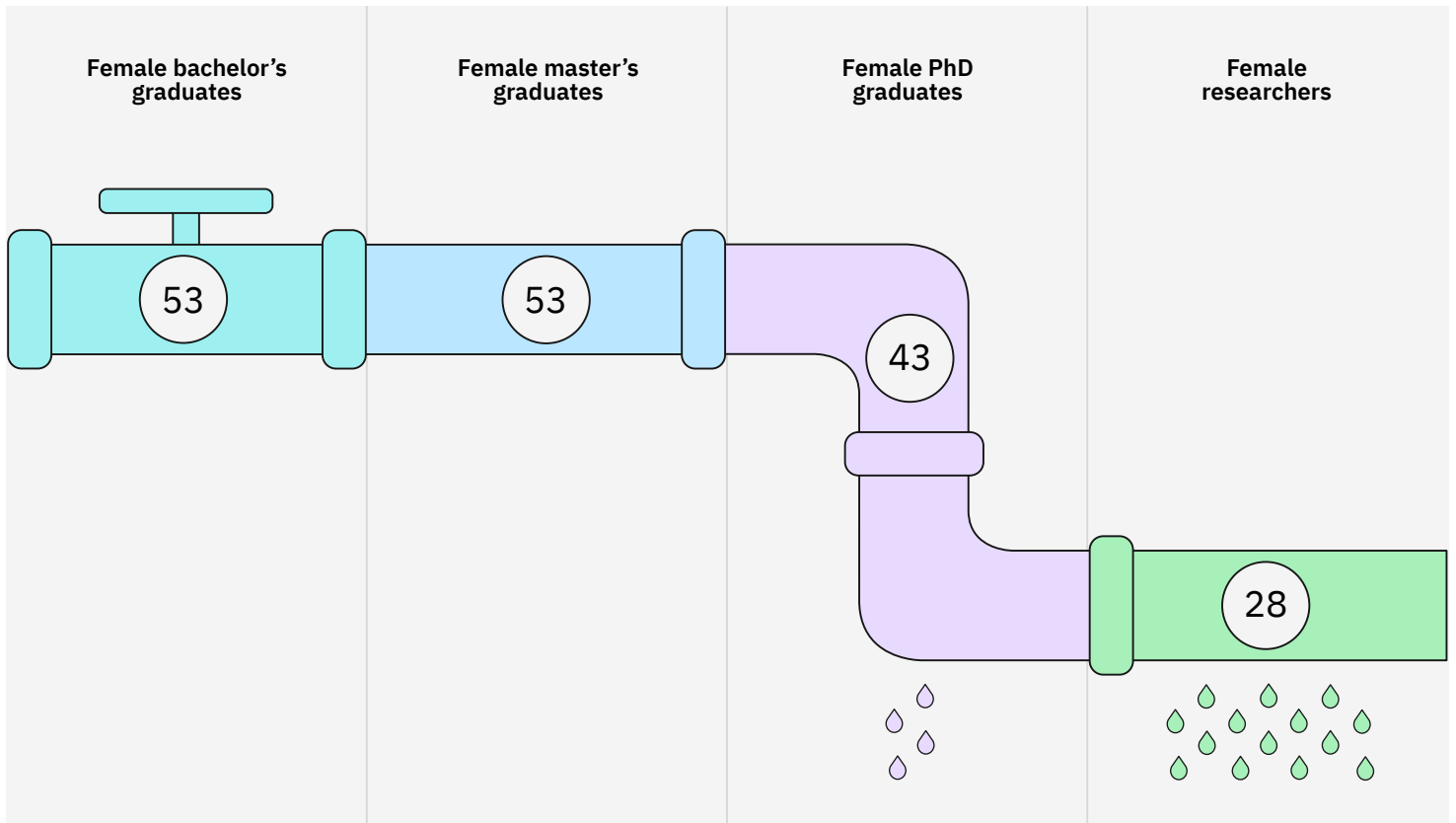
As part of the predictive analysis, we investigated the actual trend of female presence in the IBM patents, how it's evolving, and by which year we estimate equality will be reached between men and women. Social actions are then required to accelerate, close this gap and alleviate all negative factors that could impede this objective.

Five factors that hold women back

IBM has already started to take actions to accelerate equality for women.[7] Before highlighting these actions, we examined the literature to identify factors that have led to female underrepresentation and have hindered their success:

1. Women participate in the labour market at lower rates than men. This finding serves as an overall indicator of economic activity by women and their potential participation in innovation activity.
2. Lack of childhood exposure to female inventors is a factor that affects the probability that a woman invents.
3. It has been found that children's chances of becoming inventors may be impacted from birth, due to such factors as their race, gender and parents' socioeconomic class. Women and minorities are significantly less likely to become inventors.

4. As shared earlier, underrepresentation of women in STEM fields is a key reason for the gender disparity in innovation and patenting.
5. Even when women participate in STEM fields, they face numerous challenges to becoming patent inventors: things like household burdens, caregiver responsibilities that hinder travel to conferences, cultural constraints and more. As a result, their participation in research declines with each step up the ladder of the scientific research system. The high attrition rate for women in STEM and research has been termed "the leaky pipeline," as illustrated in the next figure.[8]

Female bachelor's graduates	Female master's graduates	Female PhD graduates	Female researchers

The leaky pipeline

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Actions IBM is taking to close the gender gap and increase STEM awareness

According to the 2021 Environmental, Social and Governance report (ESG), IBM is actively fostering a culture of conscious inclusion and active allyship. From 2020 to 2021, IBM grew the representation of women globally by 3.7 points and increased hiring 2.3 points.[9]

Furthermore, IBM has pledged to provide [30 million people](#) of all ages and genders with new skills needed for the jobs of tomorrow by 2030, particularly those from underresourced or traditionally underrepresented populations.

To that end, IBM has developed **IBM® SkillsBuild®**, a free program that prepares users for in-demand, entry-level IT and non-IT roles in many industries. SkillsBuild operates in 159 countries, offering over 1,000 courses in 19 languages in technical disciplines, such as cybersecurity, AI, quantum computing or data analysis, as well as workplace skills. As of February 2022, 1.72 million students and job seekers worldwide have joined IBM SkillsBuild and completed nearly 4.5 million learning hours.

IBM SkillsBuild for Job Seekers is a free, digital training program that helps adults develop valuable new skills and find jobs, regardless of their background or education. Its goal is to reskill or upskill learners, particularly those from underresourced or underrepresented backgrounds, and to make them job ready within six months. The program provides diagnostics, online coursework, resume-building certifications, one-on-one coaching from mentors, and project-based learning. Participants earn IBM-branded digital credentials to certify their relevant skills, and a global network of 90 nonprofit partners helps connect learners with local job opportunities.

To link education with career readiness, IBM also offers **IBM SkillsBuild for Students**. This program offers free learning journeys to teens through engaging, interactive, online curricula, and instills technical and professional workplace skills through videos, coursework, gamified assessments, a moderated forum and badge certifications. Teachers also have access to activities and lesson plans, complete with a dashboard that lets them monitor progress and assign content.

	2019	2020	2021		2019	2020	2021
Women (global)							
Representation				**New hires**			
Overall	33.3%	33.9%	37.6%	Overall	39.1%	38.3%	40.6%
Management	28.5%	29.0%	31.7%	Management	29.7%	30.9%	34.0%
Technical	26.6%	28.1%	31.3%	Technical	28.8%	30.7%	34.8%
Executive	27.6%	28.3%	29.3%	Executive	33.5%	29.9%	32.8%

Data includes active regular employees

10 recommendations for all areas of STEM fields

To increase awareness of the importance of diversity in STEM and patenting and foster collaboration between multiple types of organizations, such as governments, the United Nations system, business and enterprises, and academia, 10 recommendations are suggested:

1. Implement a variety of labour market policies that stimulate women's labour market participation.
2. Alleviate gender-specific policy and regulatory restrictions on stereotypical "women's work" and facilitate an affordable work-life balance, for example, childcare, parental leave, support in cultural attitudes, flexible work arrangements and so on.
3. Promote and encourage the pursuit of STEM studies and careers by funding scholarships and internships for women and girls.
4. Share inspiring stories about successful female role models by celebrating their journeys and success.
5. Create patent clubs for girls and women.
6. Offer diversity, equity and inclusion (DEI) workshops for employees.
7. Establish grant facilities to provide awards specifically for women's research and innovation.
8. Address the sociocultural issues and bias that inhibit women's innovative potential.
9. Support campaigns and educational awareness to promote female role models in patenting.
10. Facilitate the patenting process and reduce its complexity and cost.

Conclusion

This article illustrates the economic benefits of gender equality for IBM and the STEM fields. It also explores the most common challenges that hold women back from patenting at greater rates and actions are being taken by IBM to shrink and close this gender gap.

The SDG goals can be achieved by 2030, but much work remains to be done. The gender disparity gap is a well-known phenomenon in all areas of STEM fields, as has been illustrated through the IBM case study for patenting and inventorship. To accelerate and achieve equality by 2030, recommendations that require concerted, collaborative efforts between organizations have been proposed.

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