Which results on gender and science every mathematician should know

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Collaborations in algebra, representation theory and ethics
ENS de Lyon, 29 October 2025

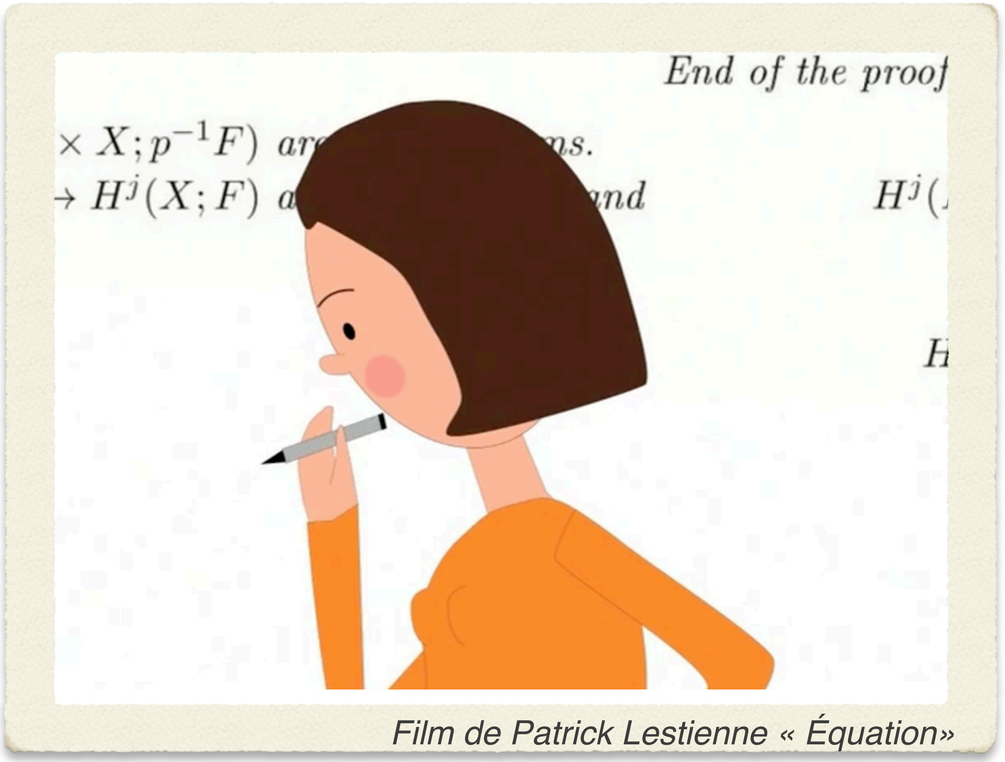
Mathematics as cultural practice

1. Mathematical outreach : « I will share mathematics with everybody ! » VS a public full of retired male engineers…

2. Early career researcher : « A joyful mathematical community ! » VS loneliness as a PhD and a post-doc

3. My « favorite » question : How is it to be a woman in mathematics ?

4. Mathematics and the Empire



Film de Patrick Lestienne « Équation»

Plan of the talk

Question : What does the underrepresentation of women, people coming from lower social classes and minorities in mathematics say about how mathematics is constructed today as a cultural practice ?

A. Absent from math : how much and why ? (numbers and epistemologies)

B. Construction of Western mathematical subjectivity

Denis van Waerbaeke « Voyages au pays des maths »

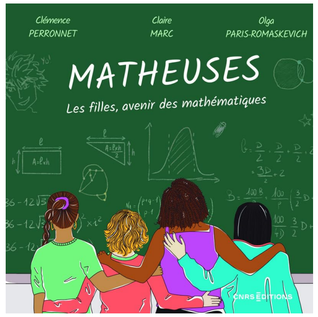
Main scientific references

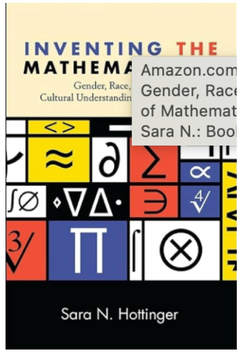
Laurence Broze

Isabelle Régner

Clémence Perronnet

Sara N. Hottinger



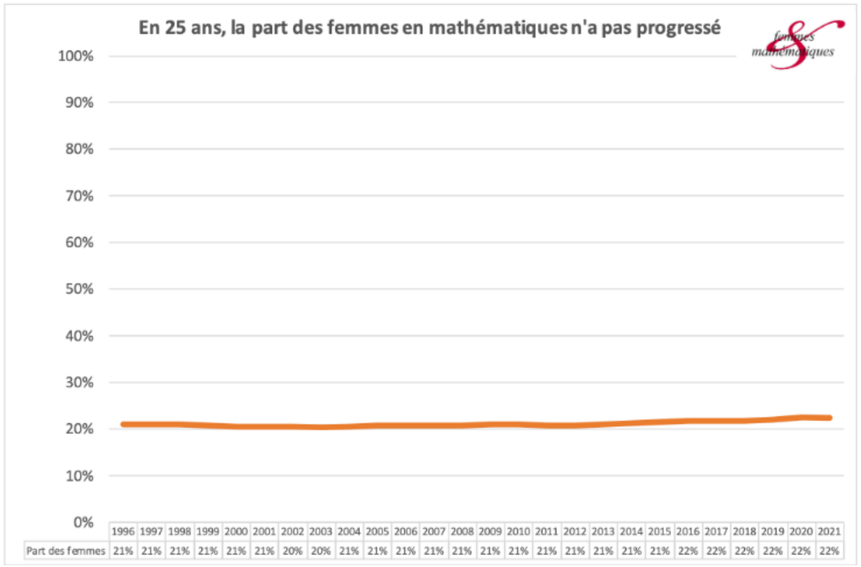


"You have found only one proof," said a history professor to Kolmogorov. "That is not enough for a historian. You need at least five proofs." At that moment, Kolmogorov decided to change his concentration to mathematics, where one proof would suffice.

Studying mathematics in France

- **54%** girls in French schools
- but only **30%** enroll into math programs in universities and « classes préparatoires »
- **18%** in « Grandes Écoles » (Polytechnique, ENS, Centrale, Les Mines)
- **23%** of female PhD students
- **14%** of researchers in fundamental mathematics

20% of women in math since 1996
with not much change (and proportions getting slightly worse for CR and DR in CNRS)



21% en 1996 et 22% en 2021 (référence : 40% pour l'ensemble des disciplines).

Laurence Broze

Not only women disappear from mathematical research careers

Social inequality (France)

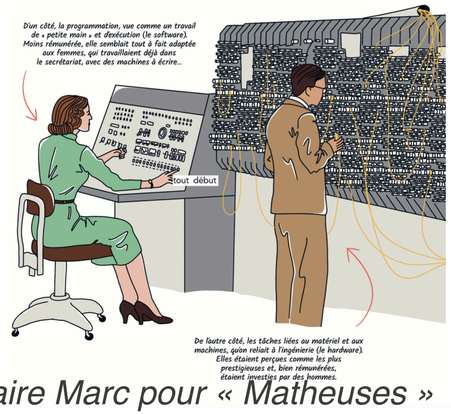
30% of school students coming from lower social class in France

- but only **17%** enroll into « classes préparatoires »
- **10%** in « Grandes Écoles »
- less than **7%** in PhD programs

Racial inequality (United States)

17% of Black students and **25%** of Hispanic students in Unites States

- but only **11%** and **18%** of them follow « Algebra 1 »
- **5%** and **11%** study maths in first year University programme
- **4%** and **6%** have a PhD in math



Claire Marc pour « Matheuses »

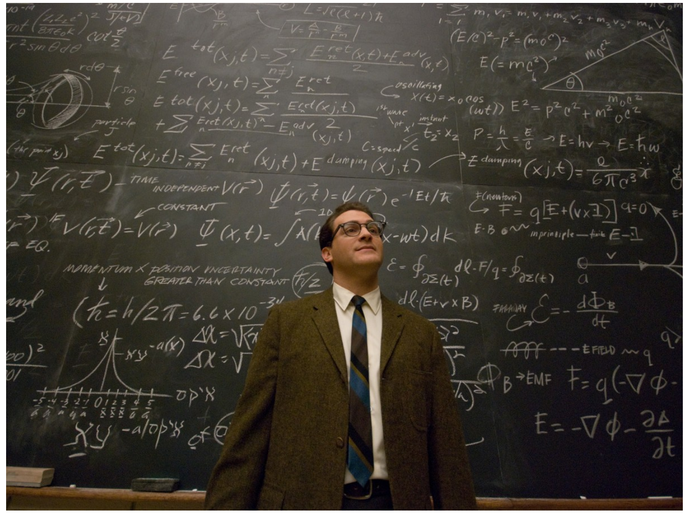
Women, people coming from lower social classes and minorities are underrepresented in mathematics, informatics, physics and engineering. It is both a problem for ***social and economic justice*** and for ***science.***

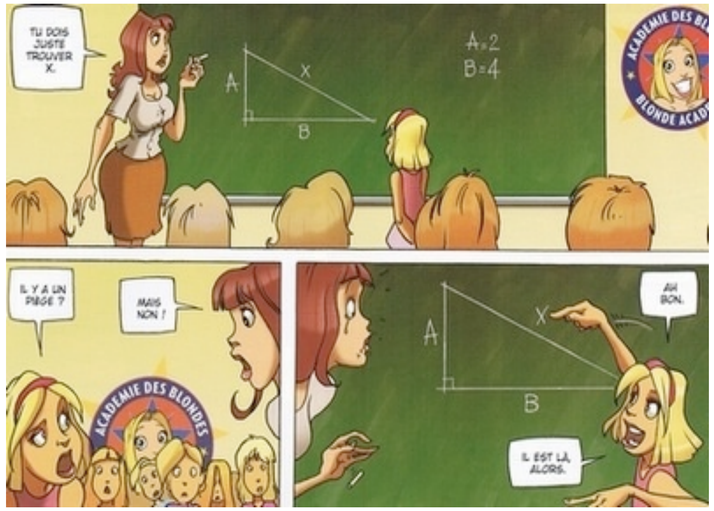
Social psychology : stereotype threat and implicit bias

A **social stereotype** is a set of beliefs — about the traits, behaviors, or attributes — shared by a social group about the characteristics or attributes of another group (or of one's own group). Stereotypes are **social in origin and function**, not just individual opinions: they help groups make sense of social reality, justify social hierarchies, and maintain group identities. (Leyens, Yzerbut, Schadron, 1994)

They are based on a process of social categorification — **functional** but **simplifying**!

Social psychology : stereotype threat and implicit bias





Social gender stereotypes construct « men » in a binary opposition to « women » :

- **men** : competitive, rational, good in math and bad at reading, caring for others and dealing with human interactions
- **women** : sensitive, emotional, bad in math and good at reading, bad in logic and spatial orientation as well as leadership, good for care

There is a lot of research on how social stereotypes influence their « targets » but also their « carriers ».

Social psychology : stereotype threat

1. Let C denote an arbitrary constant. Then $\int e^{ex}\,dx =$

(A) $e^{ex-1}+C$ (B) $e^{ex}+C$ (C) $e^{ex+1}+C$ (D) $xe^{ex}+C$ (E) $\frac{e^{ex+1}}{ex+1}+C$

The first study that coined the term *stereotype threat* studied women's math performance.

- GRE mathematics test (difficult enough)
- Completed at least one semester of calculs and received at least a B
- Two groups : 1 — standard « We are developing some new tests that we are evaluating across a large group of University of Michigan students. Today you will be taking a math test. » ; 2 — falsification: « The test had never shown gender differences in the past. »

Spencer, Steele, & Quinn (1999). Stereotype Threat and Women's Math Performance. *Journal of Experimental Social Psychology, 35*

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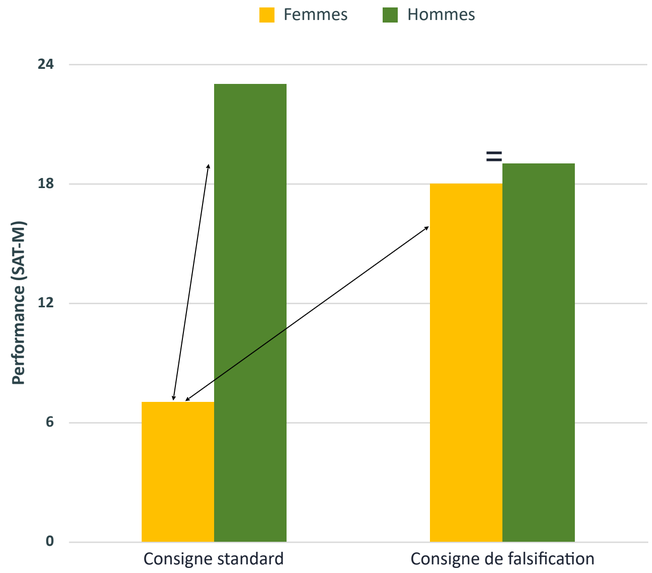
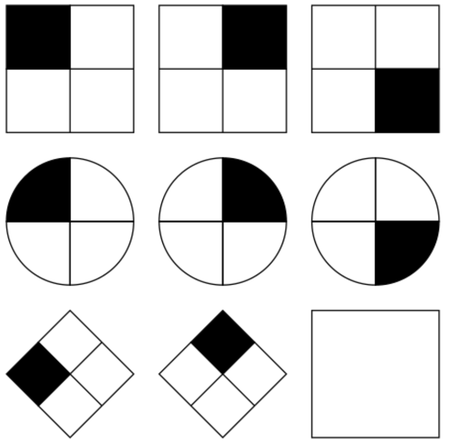


Spencer, Steele, & Quinn (1999). Stereotype Threat and Women's Math Performance. *Journal of Experimental Social Psychology, 35*

(c) Isabelle Vezina

Social psychology : stereotype threat

This test has been replicated in the context of Grandes Écoles by Régner et al. (Raven's Progressive Matrices) : same results for women, men perform less well in a « falsification » group.



Régner, I., Smeding, A., Gimmig, D., Thinus-Blanc, C., Monteil, J.M., & Huguet, P. (2010). Individual Differences in Working Memory Moderate Stereotype-Threat Effects. *Psychological Science, 21*, 1646-1648.

When one induces stereotype threat by invoking a comparison with a minority group stereotyped to excel at math (Asians), White men performed worse than the controls.

Aronson, J., Lustina, M. J., Good, C., Keough, K., Steele, C. M., & Brown, J. (1999). When White men can't do math: Necessary and sufficient factors in stereotype threat. *Journal of Experimental Social Psychology, 35*(1), 29–46.

Social psychology : implicit bias

- 127 professors (men and women) in biology, chemistry or physics in 6 American universities
- a candidate for scientific management position
- John VS Jennifer

Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman (2012). *PNAS*, 109, 16474-16479

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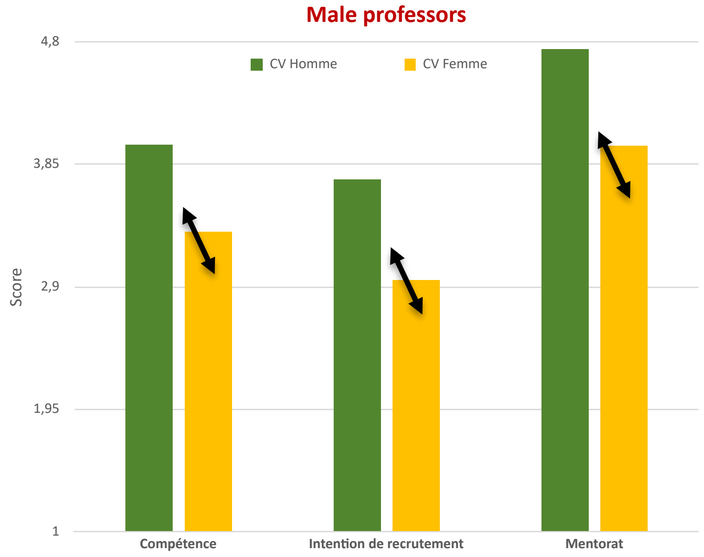

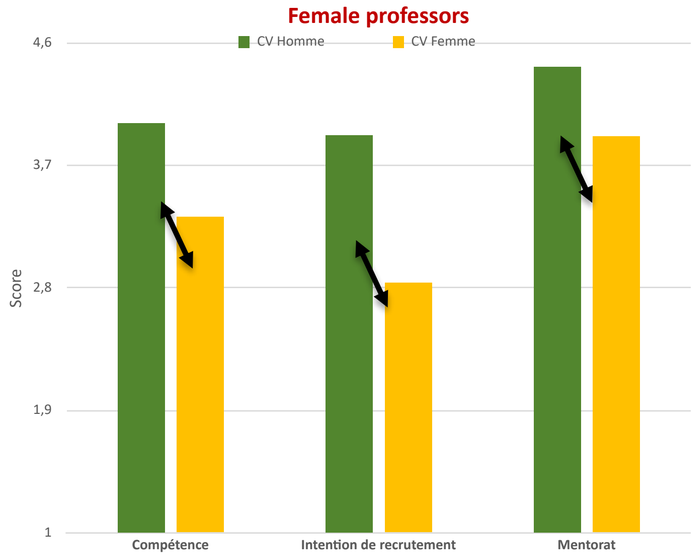

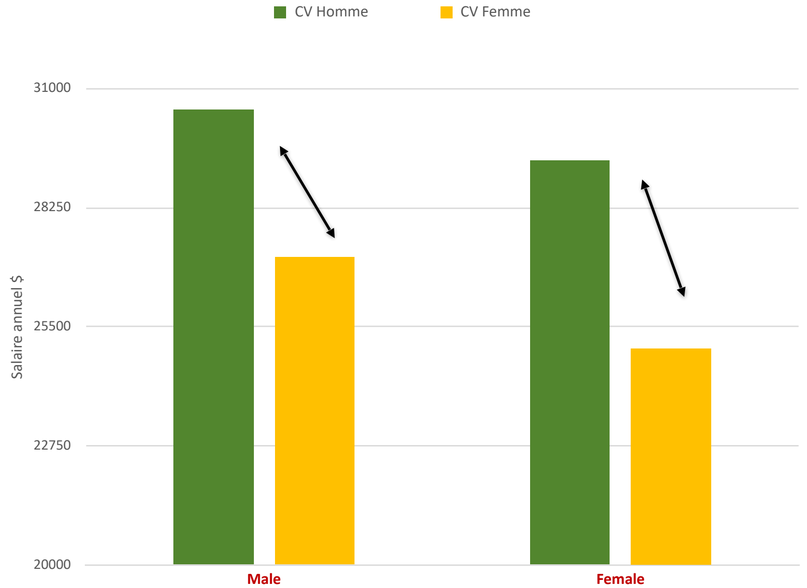

(c) Isabelle Régner

Social psychology : implicit bias

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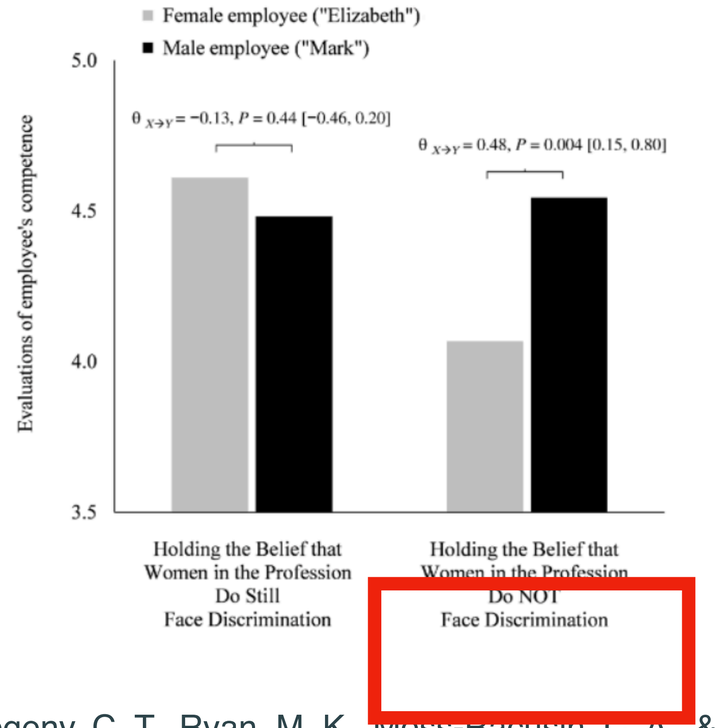
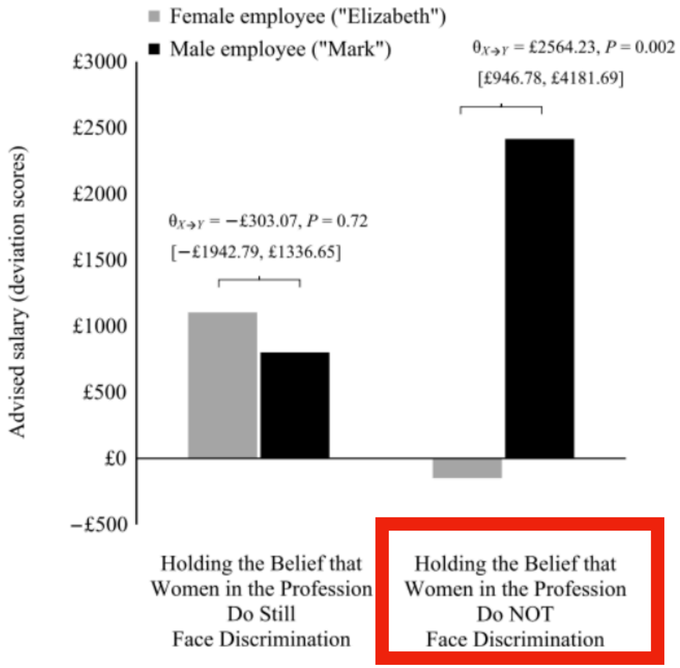




Begeny, C. T., Ryan, M. K., Moss-Racusin, C. A., & Ravetz, G. (2020). In some professions, women have become well represented, yet gender bias persists-Perpetuated by those who think it is not happening. Science advances, 6(26), eaba7814.

Gender bias persists, Perpetuated by those who think it is not happening.

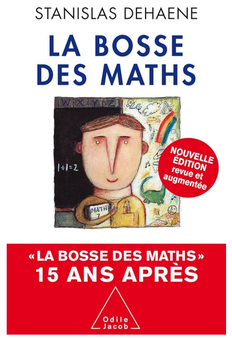
nature human behaviour
26 August 2019
ARTICLES
https://doi.org/10.1038/s41562-019-0686-3

Committees with implicit biases promote fewer women when they do not believe gender bias exists

Isabelle Régner[1*], Catherine Thinus-Blanc[1], Agnès Netter[2], Toni Schmader[3,5] and Pascal Huguet[4,5*]

Sociology : mathematics as social practice

Sociology studies « how it happens that people do what they do » — human social behaviour, from general tendencies to « exceptions », in the underlying structure of social stratification, and power relations, with qualitative and quantitative techniques.



« Research in mathematics is socially situated : 70 % of mathematicians have a parent from upper class (20 % of society) and 43 % have a parent who is teacher or researcher. (Bernard Zarca, *Mathematician : elitist and masculine profession*, 2006, France)

Sociology of scientific culture is interested in how the interest and talent in mathematics are *socially constructed* and negotiated with identity through family heritage, cultural practices (extracurricular activities for example), socialisation, etc.

Claire Marc pour « Matheuses »

« Cicadas » school in Marseille, CIRM

1. One week introduction to research in mathematics and informatics for high-school girls

2. Sociological study by Clémence Perronnet and Alice Pavie (1h30-2h interviews of 45 participants + observation at 2 editions of the school)

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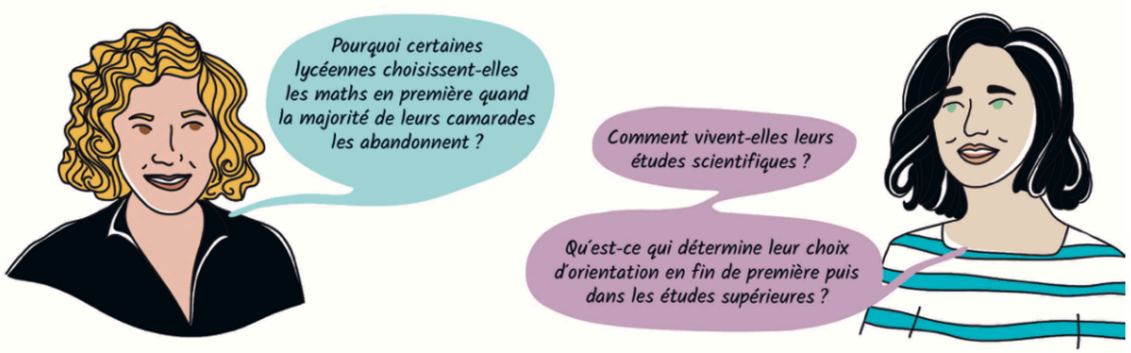
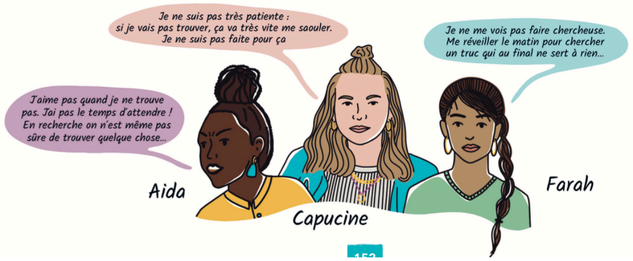


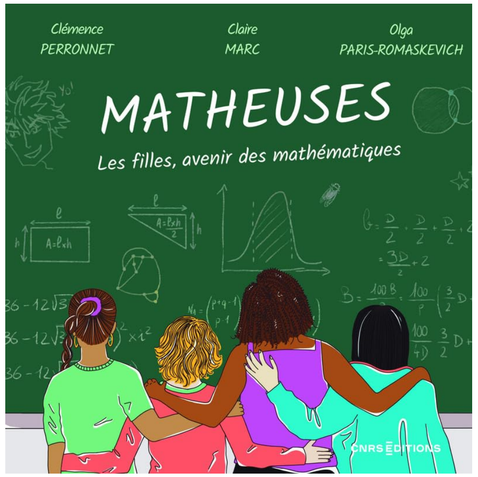
Claire Marc pour « Matheuses »

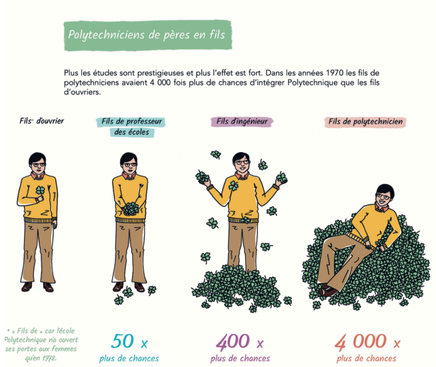
Mathgirls : a book on sociology of mathematical practice (with C. Perronnet and C. Marc) — in French

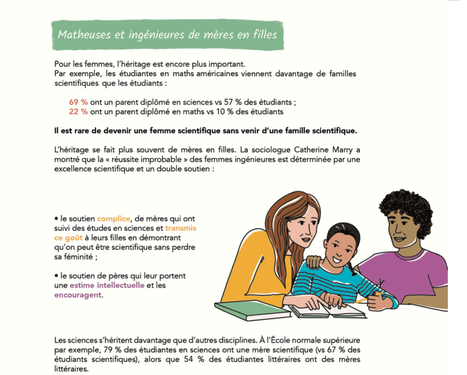
LIST OF CHAPTERS

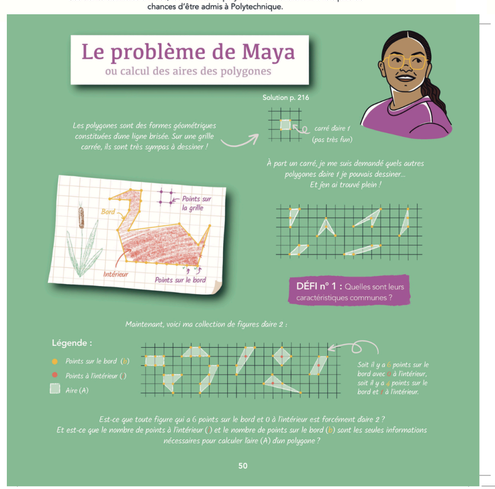
1. Does one need to have scientists as parents to become a mathematician ?
2. Does one need to be intelligent to be a mathematician?
3. Being strong in math, can it be learned or we are either born with it or not?
4. Why girls are more present in medicine studies than in math?
5. Why informatics pushes girls away?
6. Why girls are less confident than boys in their math capacities?
7. Is math reserved to elites?
8. What about racism ?
9. Are girls-only events a useful tool for equality?
10. Are role-models creating scientific aspirations in girls?

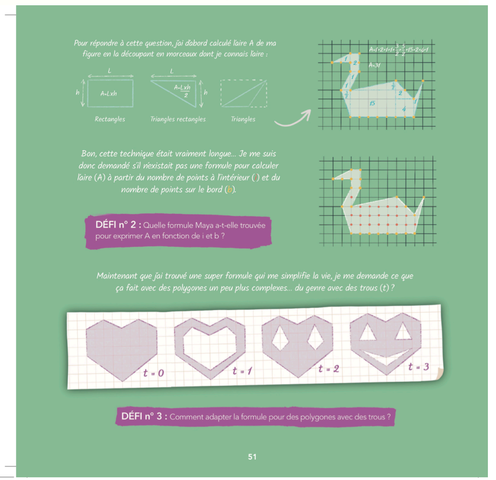










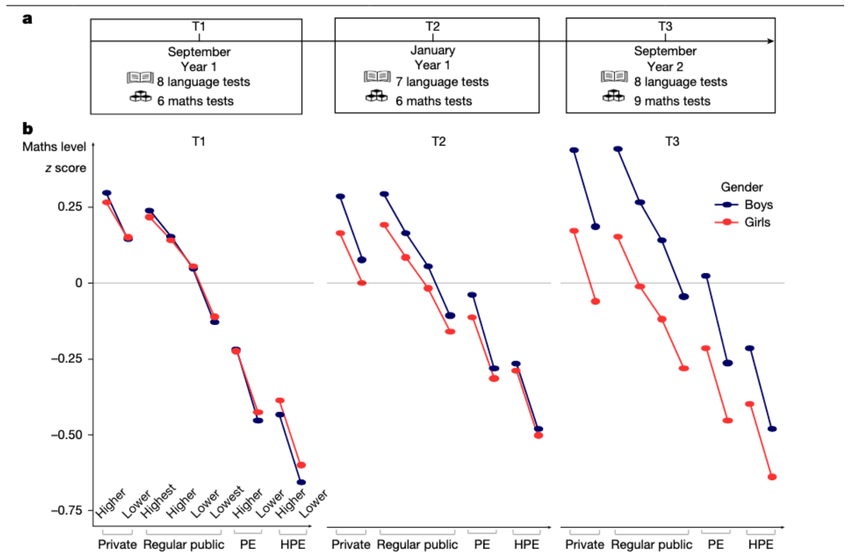


Claire Marc pour « Matheuses »

Why so few girls invest themselves in mathematics ? Sociology : mathematical brilliance and masculinity

Before 6 years old (before school and formal math training), girls and boys think that their gender is « more intelligent » and math performances are equal. **Starting school**, both consider that men are more intelligent than women. This positions them differently with respect to mathematical knowledge. (Perronnet, *Matheuses*, 2024)

The gender gap is created in **4 months.**



P. Martinot et al. Rapid emergence of a math gender gap in first grade, Nature, 2025

« Many women and girls who have done very well in mathematics are nevertheless unable to understand themselves as good in mathematics, they are *successful but not succeeding*. Girls are praised for following the rules. But success in mathematics is defined by a student's desire and ability to challenge the accepted practices in the field.» (Walkerdine, *Counting girls out*, Routledge, 1998)

« I have a lot of capacities, I do not work much and do not use my intelligence. I had at least 15/20 without working at all, there is no merit to that. I feel guilty sometimes, I feel I am taking the place of someone else. » Célie

Claire Marc pour « Matheuses »

Why so few girls invest themselves in mathematics ? Sociology : sexist violence and its denial

Claire Marc pour « Matheuses »

« All girls regularly hear remarks from their classmates, family and professors. These remarks constitute **sexist violence.**

In France, at least **18%** of school girls were victims of sexist slurs and **10%** were victims of behaviours of sexual character.

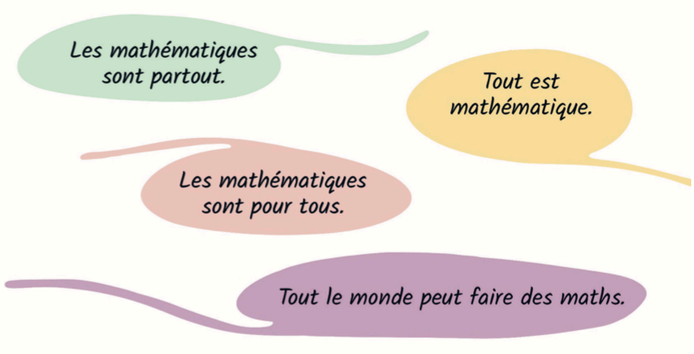
- 1 in 10 students in engineering school has been sexually assaulted
- 1 in 4 students (**23%**) in Polytechnique and Centrale Supélec has been sexually assaulted
- 1 in 2 (**49%**) female researchers has been sexually harassed

This violence in schools, universities, laboratories is denied and minimised. This provokes guilt and/or disengagement from science. »
(Clémence Perronnet, *Matheuses*, 2024)

Mathematics as culture : mathematical subjectivity

How do we think and speak about mathematics today ?

- *« Mathematics is everywhere and accessible to anybody (universal). »* Two reasons why this discourse might be problematic : denial of injustice of access to math and hierarchisation of knowledge.



- *« Mathematics is a cumulative science. »* This justifies erasing from memory previous achievements that do not enter the linear narrative.

James Maynard Fields

Hugo Duminil-Copin Fields

- *Internalist/platonic approach* (discover what is already there) VS *externalist approach* (heroic mathematical subjectivity) (S. Hottinger, 2016). Either an identity of a mathematician is totally erased behind the discovery, or it is a hero changing the world… In any case, it is not a woman, nor a non-White person nor a poor person.

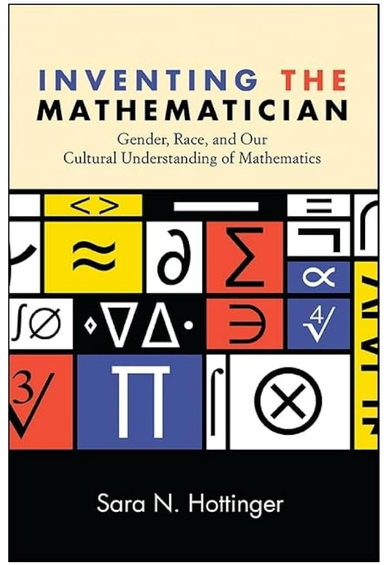
Mathematics as culture : other mathematical subjectivities, other ways to practice mathematics?

Sara N. Hottinger gives insight into the key role mathematical subjectivity plays in the construction of Western subjectivity and West itself. She argues that « this is precisely why mathematical subjectivity is only available to those who **benefit** from the dominant discursive regimes at the heart of Western culture. »

In professional universe of mathematicians, the detachment from real life problems and valorisation of beauty and elegance of maths gets more recognition that that of its usefulness. This posture dissimulates the conditions (mostly, economical comfort) that permit this detachment. »

C. Perronnet, Matheuses, 2024

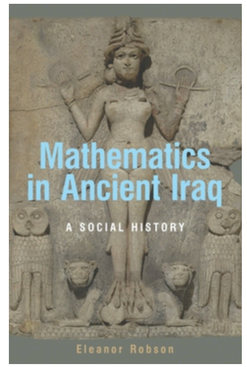
A norm of mathematical subjectivity is linked to the Others it seeks to exclude. Hottinger argues that in order for mathematics to be accessible to all excluded groups, ***multiple alternative mathematical subjectivities*** are to be constructed.

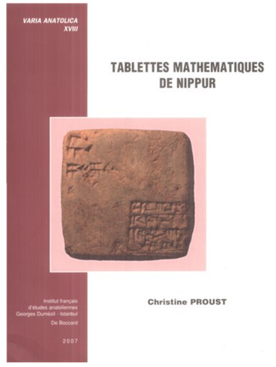


« Many understand mathematics to be separate from human concerns and call mathematical knowledge value-free. I argue that we cling to this understanding of mathematics - a rational, universal system that relies on logic to arrive at truth — because it is a key component of how West understands itself. »

S. Nottinger, 2016

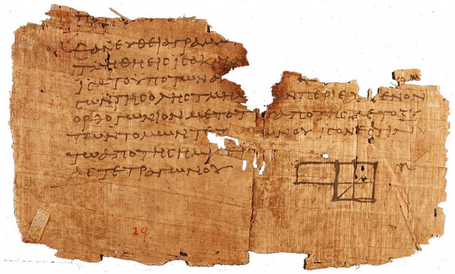
Mathematics and the appropriation of the West : example of Babylonian mathematics





Mathematics textbooks either dismiss Babylonian mathematics or present it as proto-Greek (via « domestication » of translations). Eleanor Robson argues that the comparison of Babylon and Greek mathematics shows few points of commonality, with no convincing historical arguments for transmission.

In sum, then, we are dealing with two, perhaps three, very different mathematical cultures, even if we dismiss matters of language, script, media, and numeration as surface presentation. **Old Babylonian mathematics is inherently metric: all parameters have both quantity and measure, explicit or implicit, as well as dimension.** Later Babylonian mathematics is increasingly arithmetic, as geometrical operations are replaced by arithmetical ones Both varieties, however, are entirely inductive: solutions to specific problems serve as generic examples from which generalisations are inferred (not always correctly); and **starting assumptions (axioms or postulates) are not stated explicitly**. In contrast, the **classical Greek tradition is inherently geometric: parameters have dimension but no quantity or measure.** It is also **heavily deductive and axiomatic:** the emphasis is on deriving general proofs from explicitly stated theorems and axioms.



Textbooks are hence reducing complex historical narrative to a simple tale of mathematical progress. Robson characterises the erasure of Babylonian identity from the history of mathematics as a form of Western appropriation of the Middle Eastern past.

Conclusion

Mathematics is constructed today as a cultural and social practice in a way that it systematically excludes women, lower class people and minorities. Research in social psychology, sociology, history and cultural studies not only helps to understand how this happens but shows **the way to change.**

Fighting implicit bias :

1. Be conscious that **it exists**
2. Know that one might be influenced by these biases and understand how this influence is produced (automatisms of the brain)
3. Know that it is possible to control these automatisms : by **being alert** in the important phases of evaluation process, standardising criteria and regulating the discussion

Fighting any form of discrimination :

1. Be conscious that **it exists** and that it is a massive structural problem and not « unique cases, in some other lab, not ours »
2. Stop the violence and intervene if you see it happening, do not stay « neutral »

Changing the culture of mathematics:

1. Collective structural change of practices
2. Rejecting naturalising approaches of men and women, but also of taste, talent and merit
3. Welcome, study and construct alternative mathematical subjectivities
4. Develop interdisciplinary knowledge on critical history and epistemology of mathematics

It's not since one is brilliant that one becomes good at math. It's much more the inverse : once you invest yourself in mathematics, others recognise your talent and intelligence, **because mathematics has symbolic and social power**. (Clémence Perronnet, 2024, *Matheuses*)

Discussion

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Olga Pochinka, professor of mathematics in Nizhny Novgorod, dancing with her daughter at a conference she organised