Physics Education and Unconscious Gender Bias

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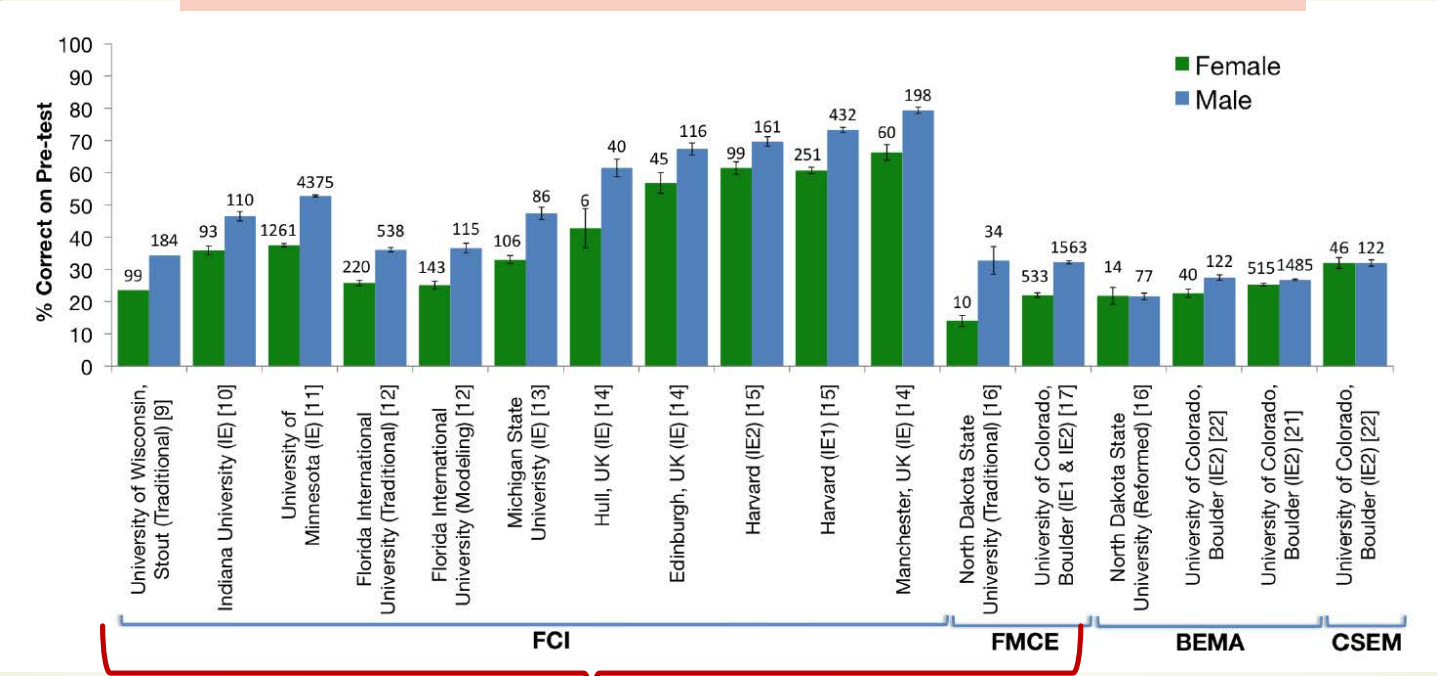
Physics Education Research Subcommittee in SCJ

- Report to the Physics committee, Science Council of Japan
- On the FCI (Force Concept Inventory) survey on Japanese high school and introductory university physics courses,
- We recognize serious problems of misunderstanding and misconception
- The activities of the subcommittee started in 2018, considering the importance of improving physics education in introductory university physics courses,
  - to improve understanding of correct physics views
  - to be more attractive, and to solve the gender gap in physics.

Physics Education Research (SIC)

Gender Gap in Physics Understanding

Gender Gap = <%Correct Male> – <%Correct Female>



Madsen et al. Phys. Rev. ST-PER 9 (2013)

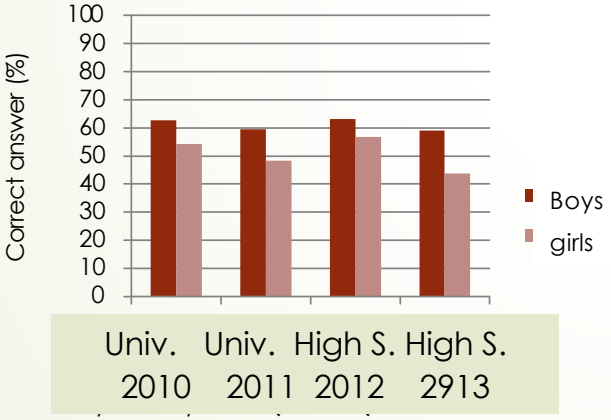
WIP_ FCI & FMCE **Pretest** Gender Gap ~13%

Physics Education Research (SIC)

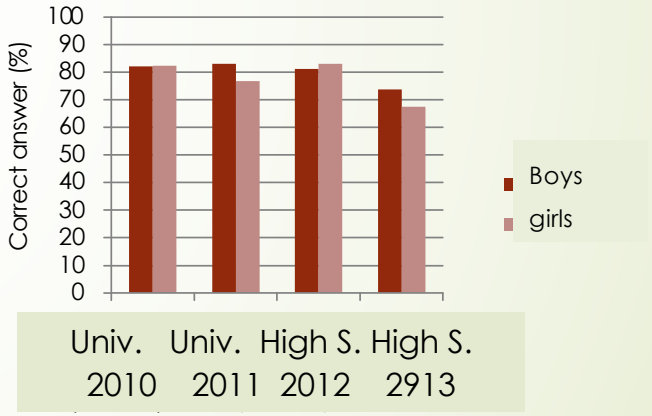
Gender Gap in Physics Understanding

- Some examples : Innovation in physics education shows benefits for girls. (remind: not always)

Before discussion



After discussion

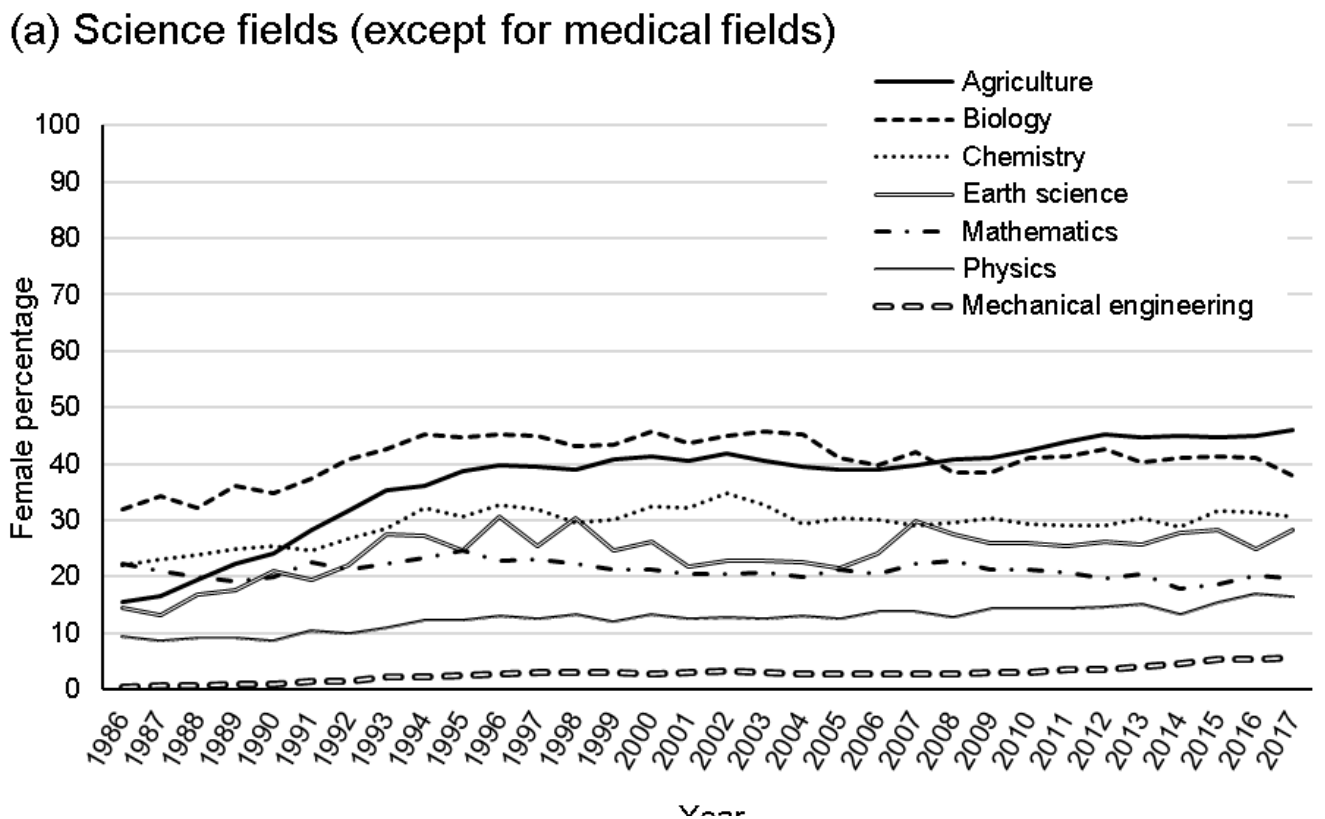


References:

H. Nitta, H. Uematsu, M. Moriguchi, University Physcis Education (JPS) 20S S53 -S56 (2014)

E.Mazur : *Peer Instruction: A user's manual* (Pearson-Prentice Hall, 1997)

Gender Gap in Japanese University Enrollments in Physics: percentage of female students



For more than 30 years, Physics stays the second from the bottom among 7 science field.

The physics percentage increased by about a factor of 1.6.

Y. Ikkatai, et al., Journal of Science Communication 19(01)(2020)A08

2024/12/6

Discussion - Unconscious bias

- Gender gap in enrollments among many STEM fields: 2 issues are pointed out by H. Yokoyama.

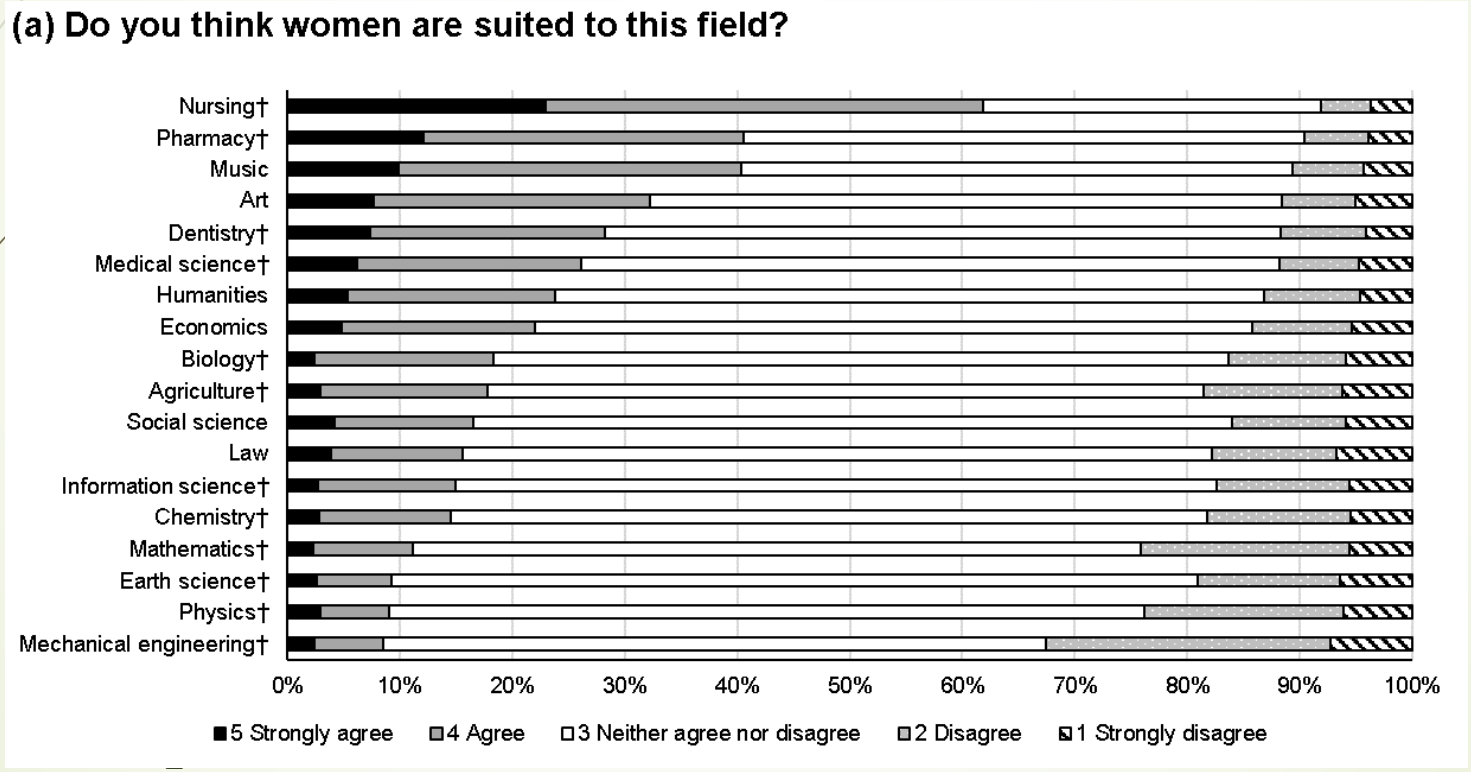
✓ the masculine image of physics and mathematics

(ref. Y. Ikkatai, et al., Physical Review Physics Education Research 17(1),(2020), and Public Understanding of Science 30(7) 810-826 2021)

✓ egalitarian attitudes toward gender roles,

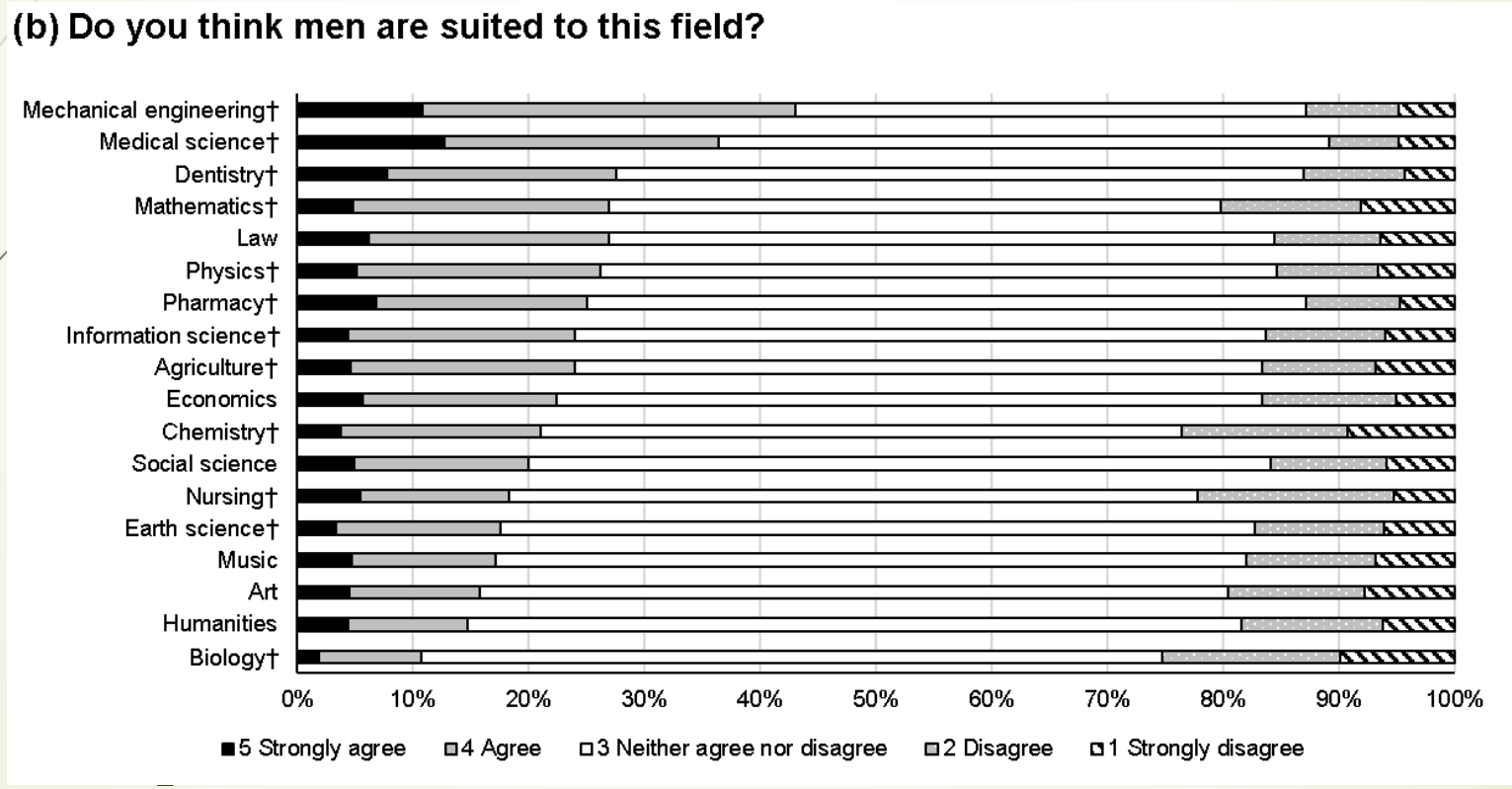
(ref. Y. Ikkatai, et al., Journal of Science Communication 19(01)(2020)A08)

Gender gap in enrollments among many STEM fields



Ikkatai et al., Journal of Science Communication 19(01)(2020)A08)

Gender gap in enrollments among many STEM fields



Ikkatai et al., Journal of Science Communication 19(01)(2020)A08)

Underlying factors in gender gap

- In spite of our various activities,
- Why the percentage of female students is still low ?

- Unconscious gender bias
- Are there more underlying factors ?

The Prize in Economic Sciences in Memory of Alfred Nobel 2023

- Claudia Goldin, Harvard University, has won the prize.

"Econometrics"

- She uncovered key drivers of gender differences in the labour market.
- Historically, **much of the gender gap in earnings could be explained by differences in education and occupational choices.** However, Goldin has shown that the bulk of this earnings difference is now between men and women in the same occupation, and that it largely arises with the birth of the first child.
- Jakob Svensson, Chair of the Committee for the Prize says "Thanks to Claudia Goldin's groundbreaking research we now know much more about the **underlying factors** and which barriers may need to be addressed in the future,"

Underlying factors in Physics

- In addtion to the differences in education and occupational choices, the gap arises with the birth of the first child in the labour market.

- What are the underlying factors in Physics ?

- Hint ! Try to find them in my career.

Why I could have a career in physics for more than 50 years?

ages	Education	Underlying factors
6-18 Elementally Middle/high schools	Excellent	Encouragement from Parents (father – physicist)
18-22 University	Excellent	Extreme minority (9:1000, 2:40)
22-28 Graduate School	Excellent but spoiled a bit Away from hard works (Experimental nuclear physics)	Marriage Birth of the first child. Support from Parents Day-care services in Universities

Why I could have a career in physics for more than 50 years?

years	Occupational Chances	Underlying factors
28 – 32 Post Doctoral position Stanford-Berkeley-Osaka	Difficult situation Negative/positive No success to get a permanent	Birth of the second child. Support from Parents Day-care service in Universities
32 - 64 Institute/University	Excellent Professorship Project leader	The tide of Gender equality was running Difficulties among professors Caregiving of parents
64 – 76 or more	Researcher with less responsibility	Healthy Long life

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In my career, Thanks to

I. The tide of Gender equality

II. Day-care sevices in Universities : Prof. Masako Bando et al., of Kyoto University

III. Support from Parents

IV. Strong influence from my father. “Physics is the base of science”

Concluding Discussion - Education

- Gender gap in understanding

  Innovation of Physics Education in high schools and universities is needed

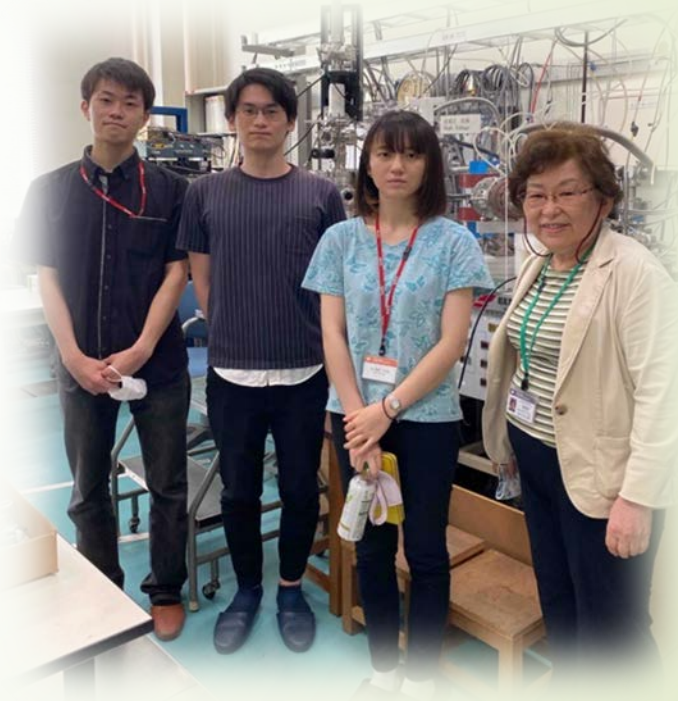
Concluding Discussion - unconscious bias

- Gender gap in enrollments of physics among many STEM fields:
- The underlying factor is “unconscious bias” : the masculine image and egalitarian attitudes toward gender can be pointed out.
- The key is education for young ages, sufficient early experience.
- Not only Physics teachers, but teachers of other subjects in science have to have correct understandings of physics and have to know the attractiveness of physics.

Concluding Discussion – other factors

- Onset of gender gap on the first child
  - Substantial support service system of child care
  - We can recover it by healthy long life
- Difficulties in communication among leaders
  - Address the importance to hear and understand opinions of women leaders.
  - This is the real diversity.

Thank you for you attention



Ikkatai et al., Journal of Science Communication 19(01)(2020)A08)

Regarding possible internal factors, it may be that girls are often affected by the stereotype threat phenomenon: some girls unconsciously perform less well in mathematics in order to conform to the stereotype that boys are better than girls at mathematics [Spencer, Steele and Quinn, 1999; Spencer, Logel and Davies, 2016]. However, a previous study suggest that the impact of stereotype threat can be reduced by some form of psychological intervention. For example, women performed as well as men at mathematics when they were instructed to read a sentence stating that there was no gender difference in mathematics [Spencer, Steele and Quinn, 1999].

Cheryan et al. proposed a model that explains women's lower representation in computer science, engineering, and physics in the US using three factors: "masculine culture of the fields," "insufficient early experience," and "gender gaps in self-efficacy"

Egalitarian attitudes regarding gender roles

Egalitarian attitudes regarding gender roles were measured using the Japanese version of the short form of the Scale of Egalitarian Sex Role Attitudes (SESRA-S). SESRA-S consisting of 15 items about gender roles [Suzuki, 1994; Ui, 2001; Uji et al., 2006]. The participants were asked to rate each question on a five-point Likert scale (from strongly disagree = 1 to strongly agree = 5). The 15 questions consisted of four non-reversed items and 11 reversed items. The five-point scale was reversed in the reversed items when calculating the total score for SESRA-S. The total scores for the 15 questions were calculated as SESRA-S scores (ranging from 15 to 75). In this study, the mean SD of the participants was 52.15 9.41 (n = 1,086, max = 75, min =15). The item that scored the highest was "domestic chores should be shared between spouses."

Ikkatai et al., Journal of Science Communication 19(01)(2020)A08)