Patterns of Gendered Performance Differences in Introductory STEM Courses

Koester BP, Grom G, McKay TA. (2016). “Patterns of Gendered Performance Difference in Introductory STEM Courses.” arXiv:1608.07565

Matz RL, Koester BP, Fiorini S, Grom G, Shepard L, Stangor CG, … McKay TA. (2017). “Patterns of Gendered Performance Differences in Large Introductory Courses at Five Research Universities.” AERA Open.

Warm up:

1. In general, do you think STEM courses tend to **give higher or lower grades** than humanities or social science courses?

2. Do you think **average grade differences between male students and female students** are larger in STEM courses or humanities/social science courses? Why or why not?
   - Do you think **lecture** courses disproportionately advantage male students or female students?
   - Do you think **lab** courses disproportionately advantage male students or female students?

3. Do you think courses with **exams** disproportionately advantage male students or female students?

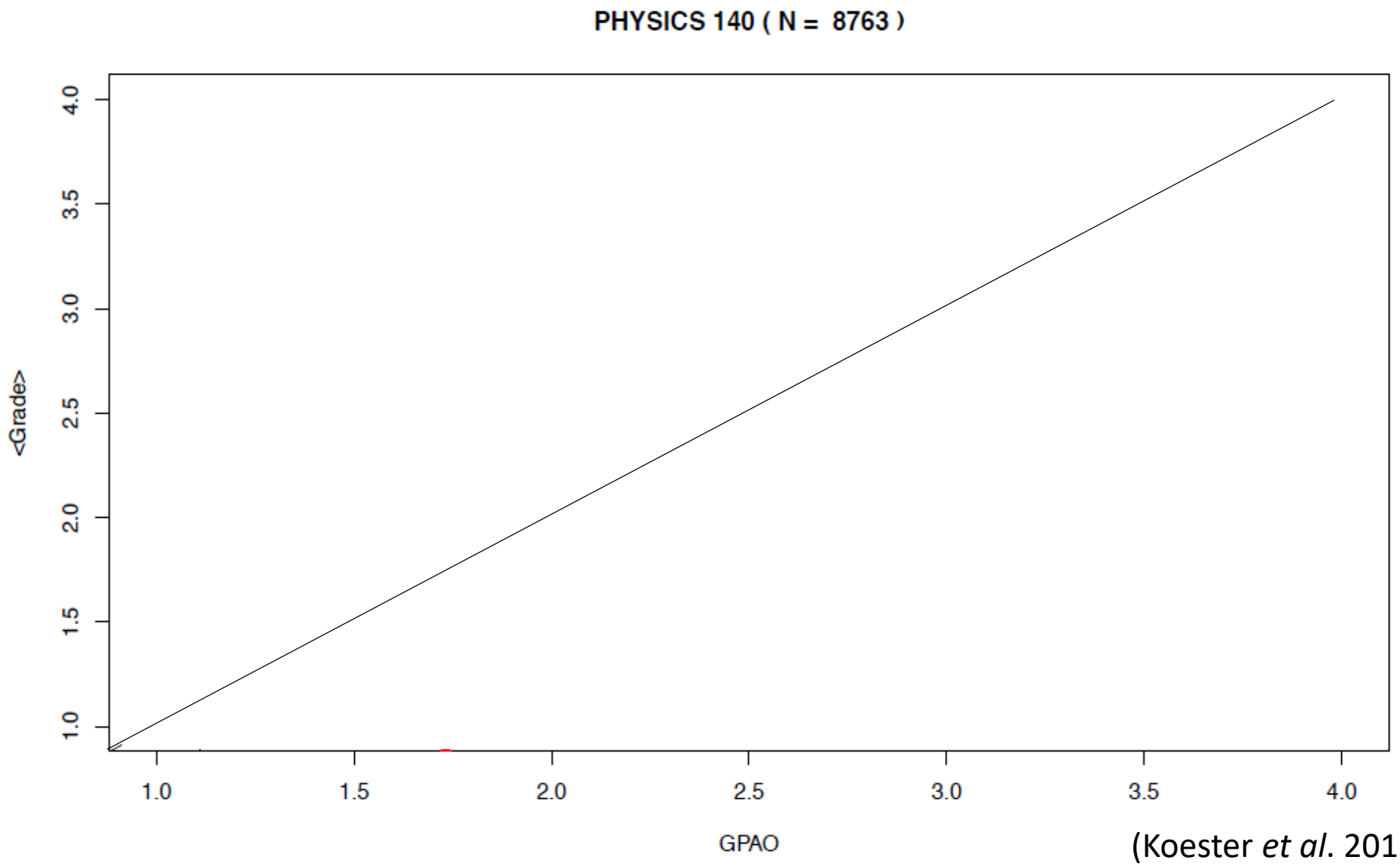
4. Do you think male students tend to get higher grades than female students **in your course**?

What does it mean for a course to advantage one student group vs another?

- First, define controls and variables:
  - Grades students earn in all other courses: "GPA Other" ("**GPAO**")
  - **Grade** student earned in a particular course
  - GPAO turns out to be the strongest predictor for a student's grade in a course

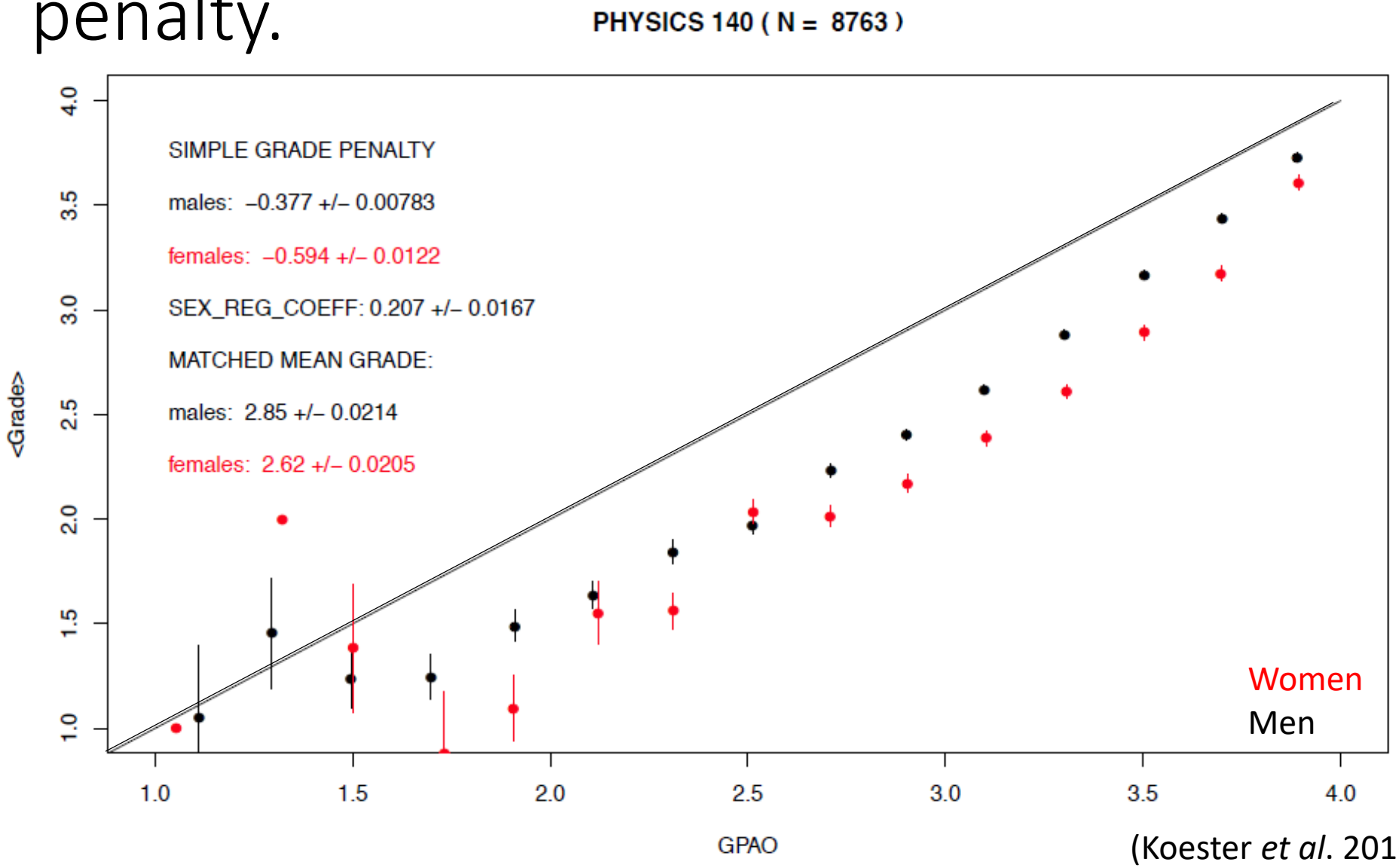
- Koester (2016) looked at every class at UMich >200 students over seven years (2008 – 2015)
  - 116 courses corresponding to 627,998 students

- To control for student preparation, they matched students with similar ACT scores and high school GPAs



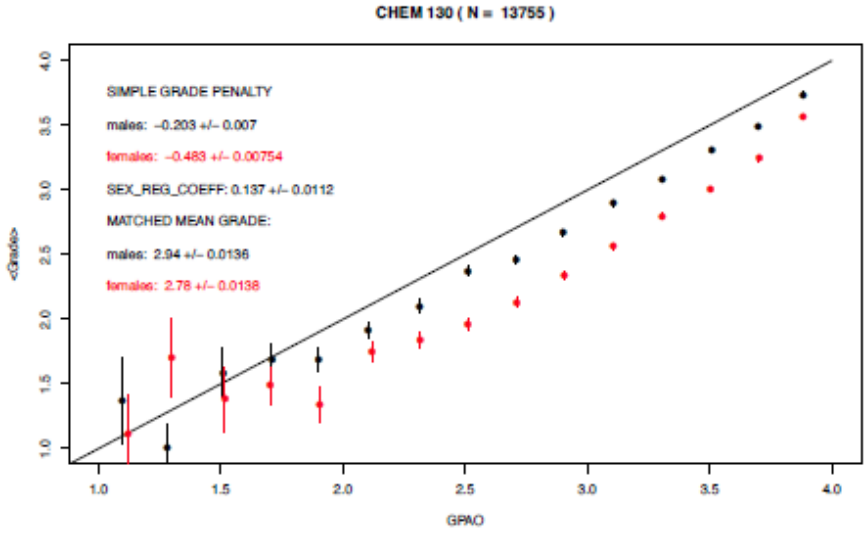
(Koester *et al*. 2016)

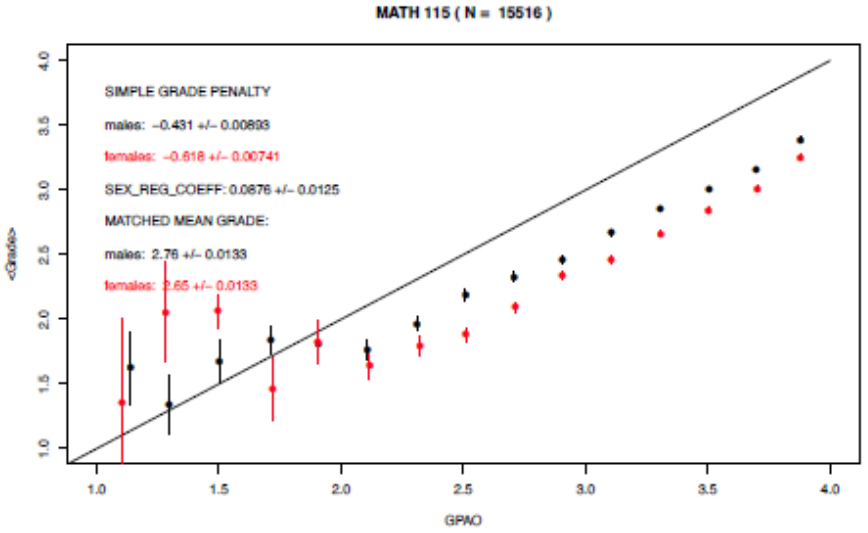
All students suffer a grade penalty in Phys140. Women suffer a larger grade penalty.

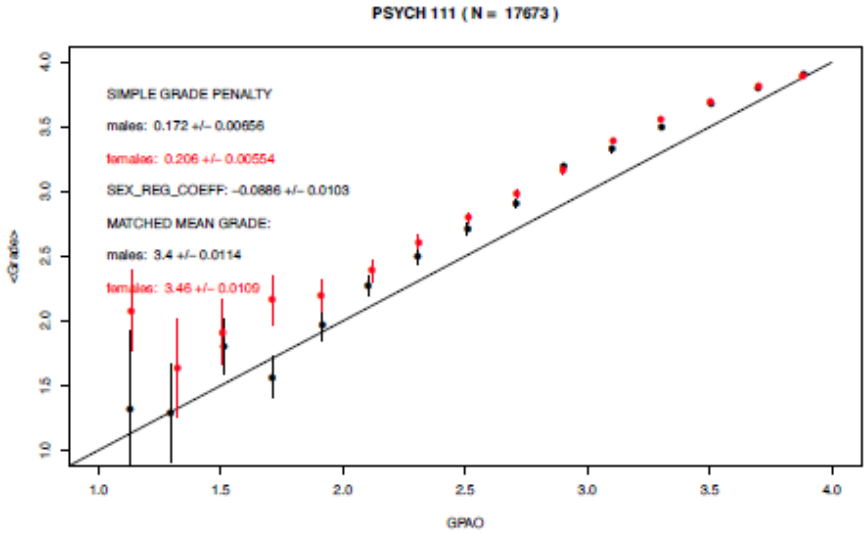


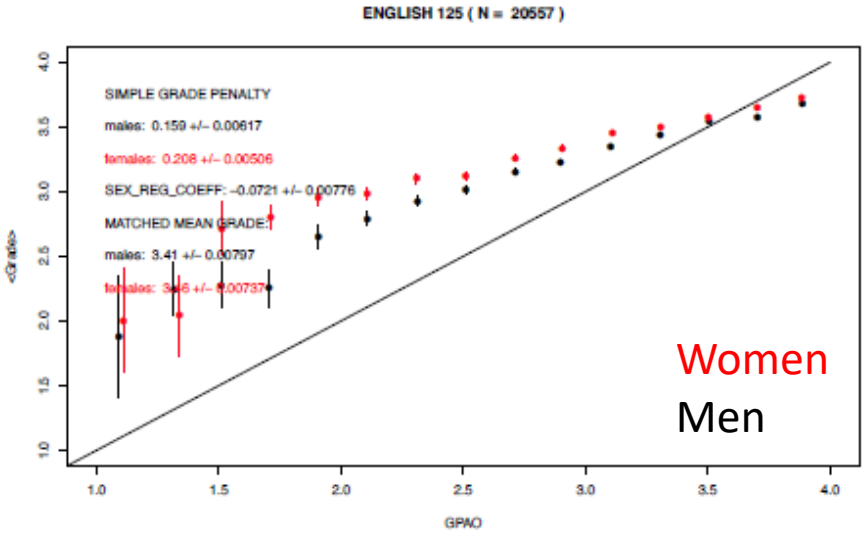
(Koester *et al*. 2016)

Comparing large intro chem, math, psych, and English courses









(Koester *et al*. 2016)

Grade Penalty

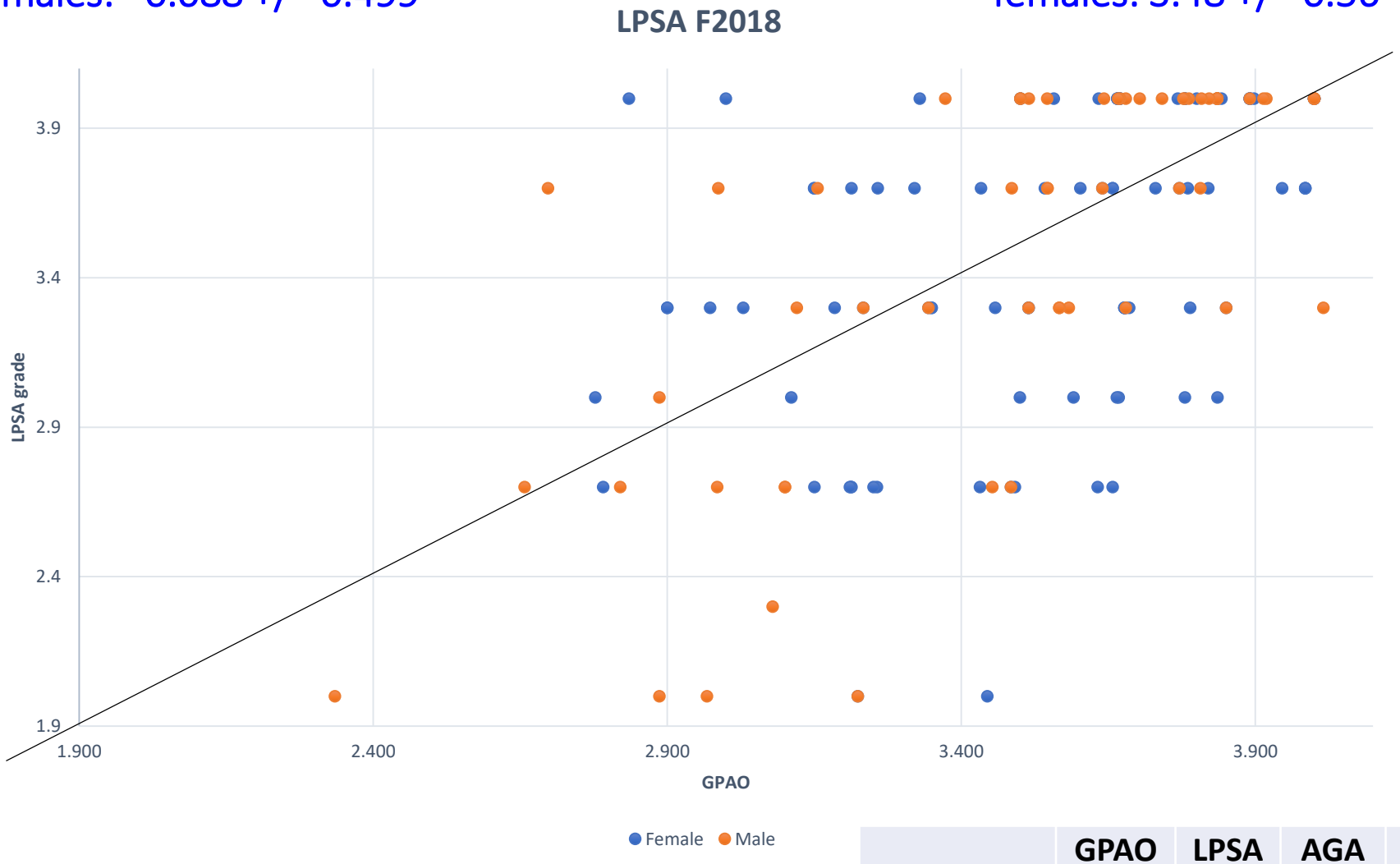
males: −0.042 +/− 0.464

females: −0.088 +/− 0.499

Mean Grades

males: 3.44 +/− 0.71

females: 3.48 +/− 0.56



Gendered Penalty Difference ("GPD"):

GPD = AGA_f – AGA_m = -0.09 - -0.04 = -0.05

	GPAO	LPSA	AGA	#
Average M	3.48	3.44	-0.042	65
Average F	3.56	3.48	-0.088	99
Average T	3.532	3.46	-0.07	164

Adjusted Grade Anomaly ("AGA"): Grade - GPAO

	A	B	C	D	E	F	G	H	I	J	K
1	Student name	LPSA grade	LPSA Number	Gender	GPA	No. of courses	Total	Total grade minus LPSA	No. of courses minus LPSA	GPAO	AGA
2	Student 1	A	4.0	F	3.918	4	15.672	11.7	3.0	3.891	0.1093
3	Student 2	A	4.0	F	4.000	4	16	12.0	3.0	4.000	0.0000
4	Student 3	A	4.0	M	3.918	20	78.36	74.4	19.0	3.914	0.0863
5	Student 4	A	4.0	M	4.000	4	16	12.0	3.0	4.000	0.0000
6	Student 5	A	4.0	F	3.918	4	15.672	11.7	3.0	3.891	0.1093
7	Student 6	A	4.0	M	3.890	3	11.67	7.7	2.0	3.835	0.1650
8	Student 7	A	4.0	F	4.000	3	12	8.0	2.0	4.000	0.0000
9	Student 8	A	4.0	M	3.890	3	11.67	7.7	2.0	3.835	0.1650
10	Student 9	A	4.0	F	4.000	19	76	72.0	18.0	4.000	0.0000
11	Student 10	A	4.0	F	4.000	3	12	8.0	2.0	4.000	0.0000
12	Student 11	A	4.0	F	3.918	4	15.672	11.7	3.0	3.891	0.1093
13	Student 12	A	4.0	F	4.000	3	12	8.0	2.0	4.000	0.0000
14	Student 13	A	4.0	M	3.890	3	11.67	7.7	2.0	3.835	0.1650
15	Student 14	A	4.0	M	3.667	3	11.001	7.0	2.0	3.501	0.4995
16	Student 15	A	4.0	F	3.777	3	11.331	7.3	2.0	3.666	0.3345
17	Student 16	A	4.0	F	4.000	3	12	8.0	2.0	4.000	0.0000
18	Student 17	A	4.0	F	3.835	4	15.34	11.3	3.0	3.780	0.2200
19	Student 18	A	4.0	M	4.000	3	12	8.0	2.0	4.000	0.0000

Gradebook_Final | AGA_Total | Sheet3 | Sheet5 | Sheet4 | Chart2 | Sheet6

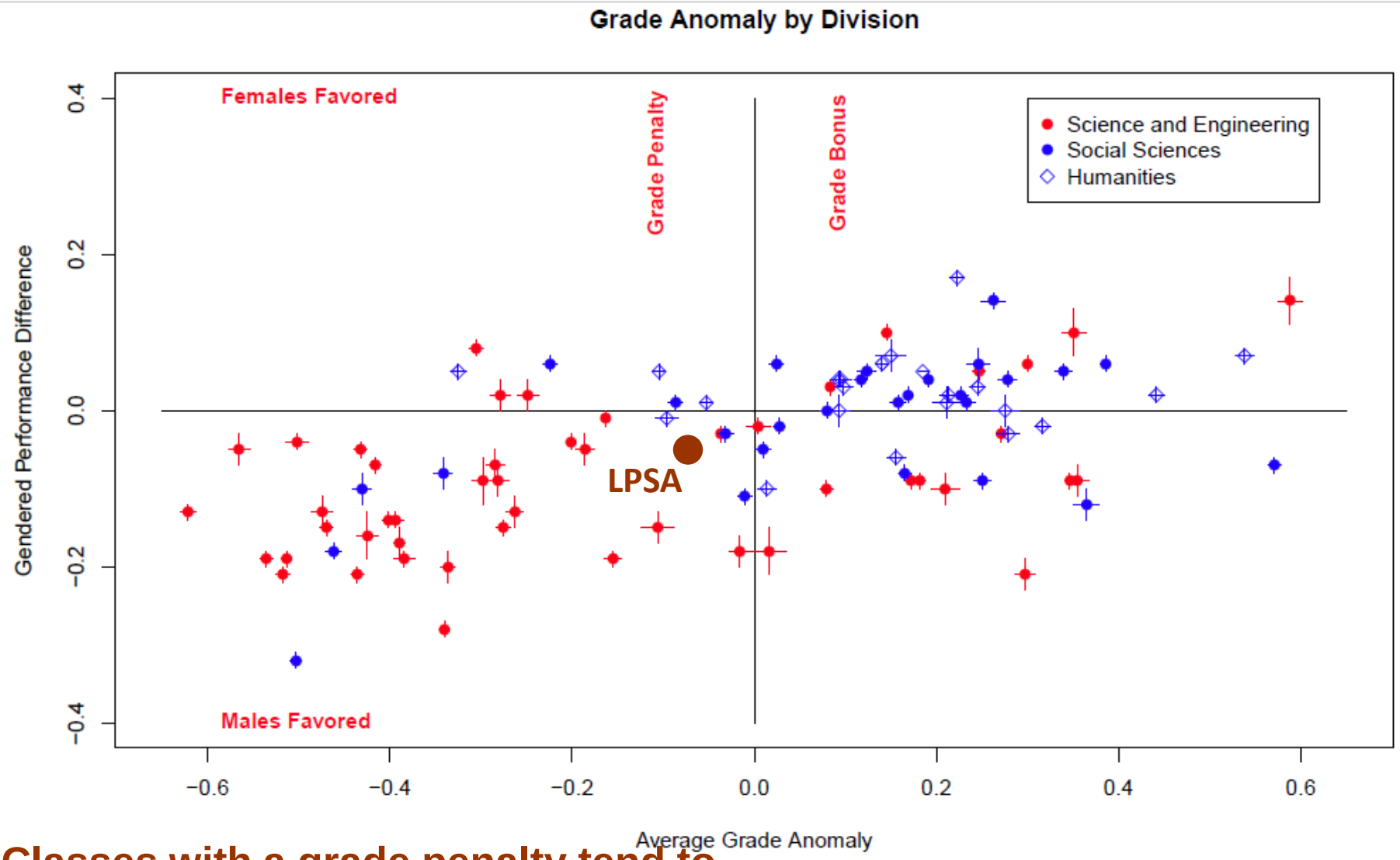
Ready

Gendered Penalty Difference ("GPD"):

$GPD = AGA_f - AGA_m$

University-wide: 116 courses

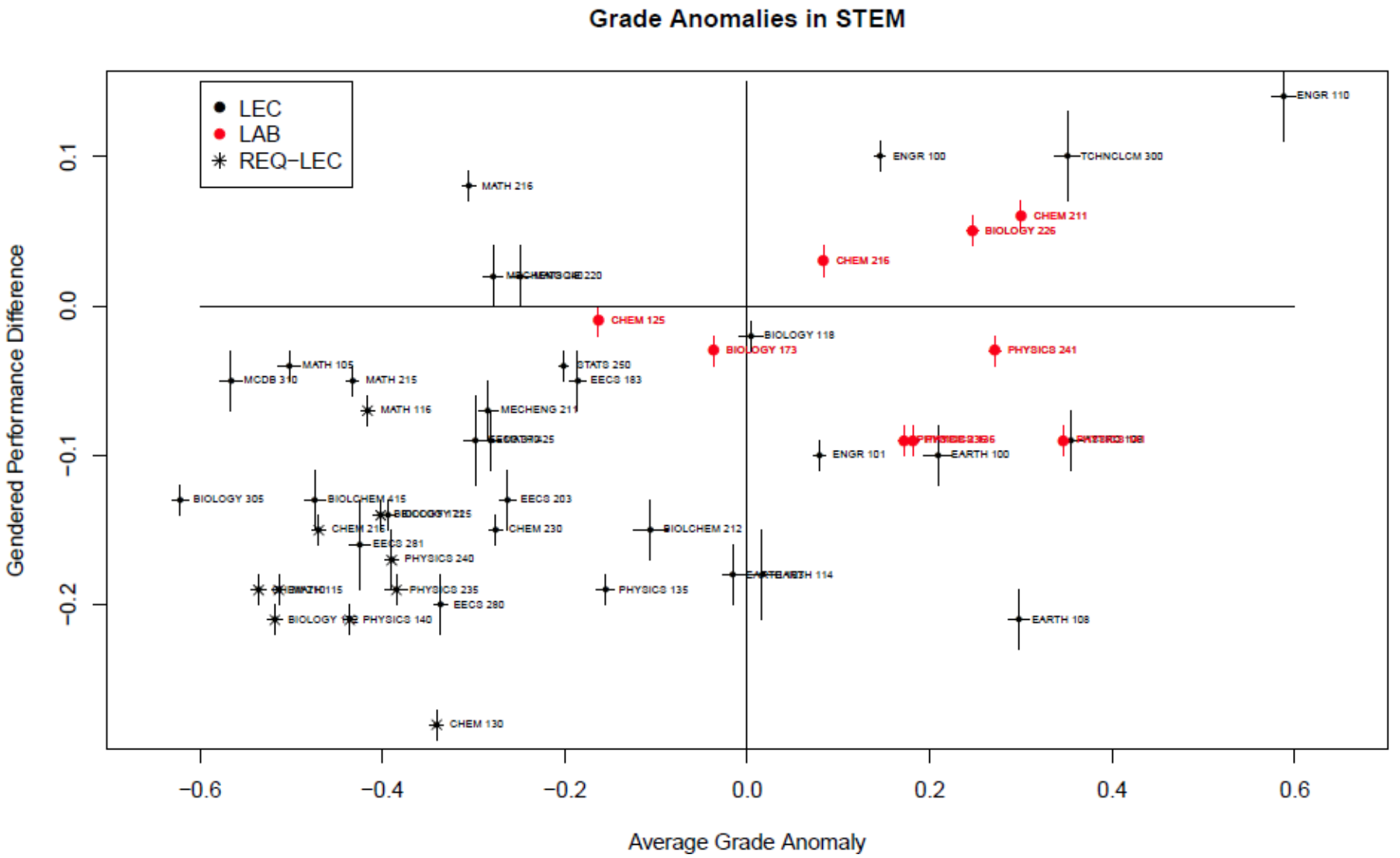
Gendered Penalty Difference:
$GPD = AGA_f - AGA_m$



Classes with a grade penalty tend to favor men (negative. GPD)

(Koester *et al*. 2016)

Lecture vs Lab



Summary from U Mich

- Gendered Penalty Differences ("GPD") are ubiquitous in large intro STEM lecture
  - Consistent over 6+ years
  - GPDs are seemingly absent in STEM labs and lectures in other disciplines

- GDP is about -0.07 for lectures, and about -0.1 for mixed courses
- Labs tend to yield a grade bonus
- Women tend to do better than men in college, so negative GDPs are unusual

- Women typically earned half a letter grade lower in large, introductory STEM courses than in their other classes at the university.
- Men earned a third of a letter grade lower in large, introductory STEM courses.

→Women earn a 1/5 of letter grade lower than men in large, introductory STEM lectures.
  - Generally half of a +/- letter grade
  - Can determine borderline grades
    - E.g., a B- for a male student can be a C+ for a female student

Women earn grades in **lab** courses that are a bit higher than their male peers

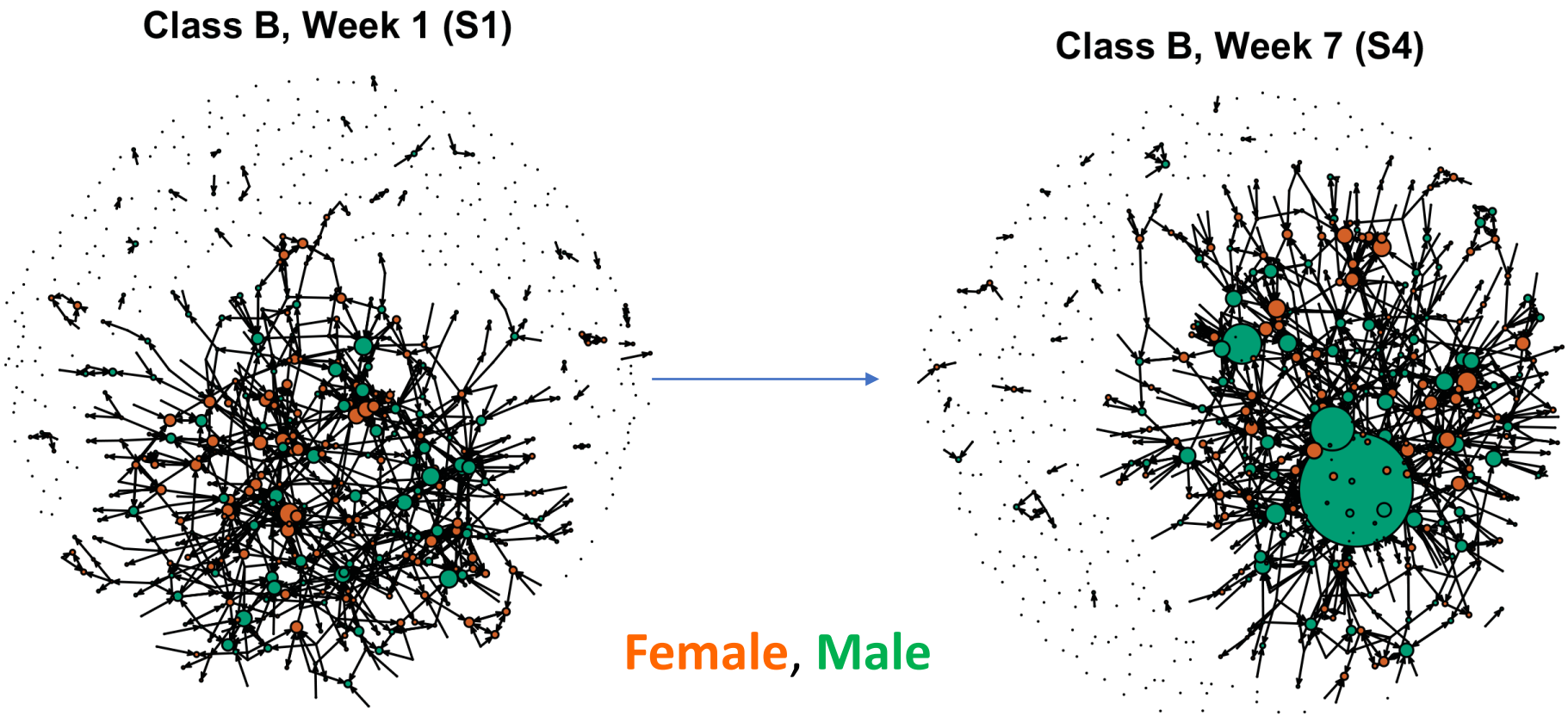
- Despite labs covering the same subject matter as the lectures
- Students have more time in lab to do their experiments and “polish up their reports” until they are done
- Lectures are assessed by timed exams (1 or 2 midterms and a final)
  - Timed tests add extra stress, which can trigger self-doubt and anxiety (and stereotype threat)

How can we level the playing field?

- Why might women be earn lower grades than men in large intro STEM lectures?
  - Male dominated classes? → Stereotype threat
  - **Dominant male behaviors**

- What are some ways we can design courses to minimize this disparity?
  - Swap out a few high-stakes exams with biweekly in-class quizzes (lower stakes, lower stress)
  - Reduce time pressure on exams
  - Incorporate more open-ended questions, rather than predominantly multiple-choice questions
  - Make all students feel more included, calm, capable, and welcome

Males Under-Estimate Academic Performance of Their Female Peers in Undergraduate Biology Classrooms

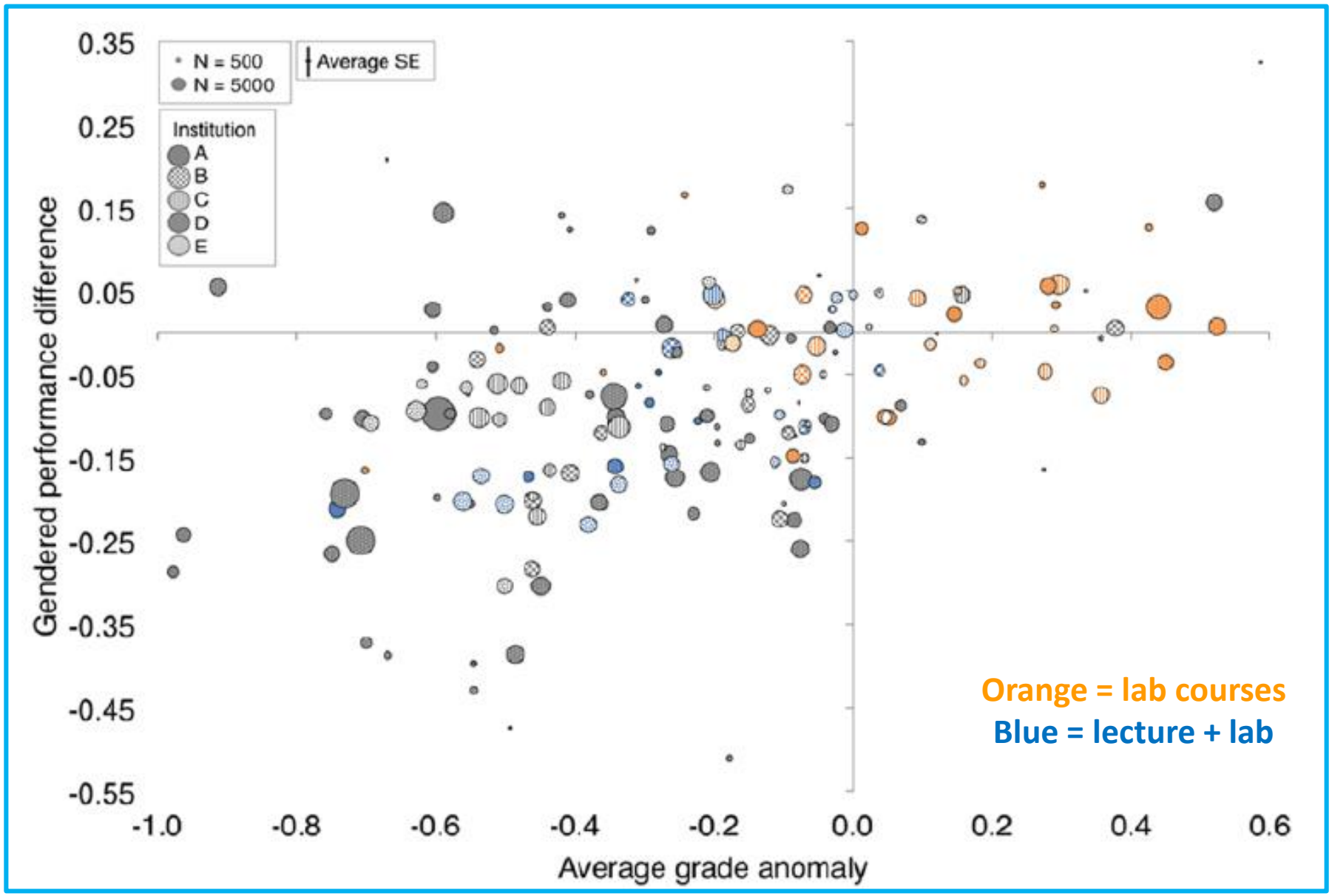


Grunspan *et al.* (2016).

Matz extended this analysis to four other Big Ten universities

- Koester (2016) looked at UMich, is this a global problem?

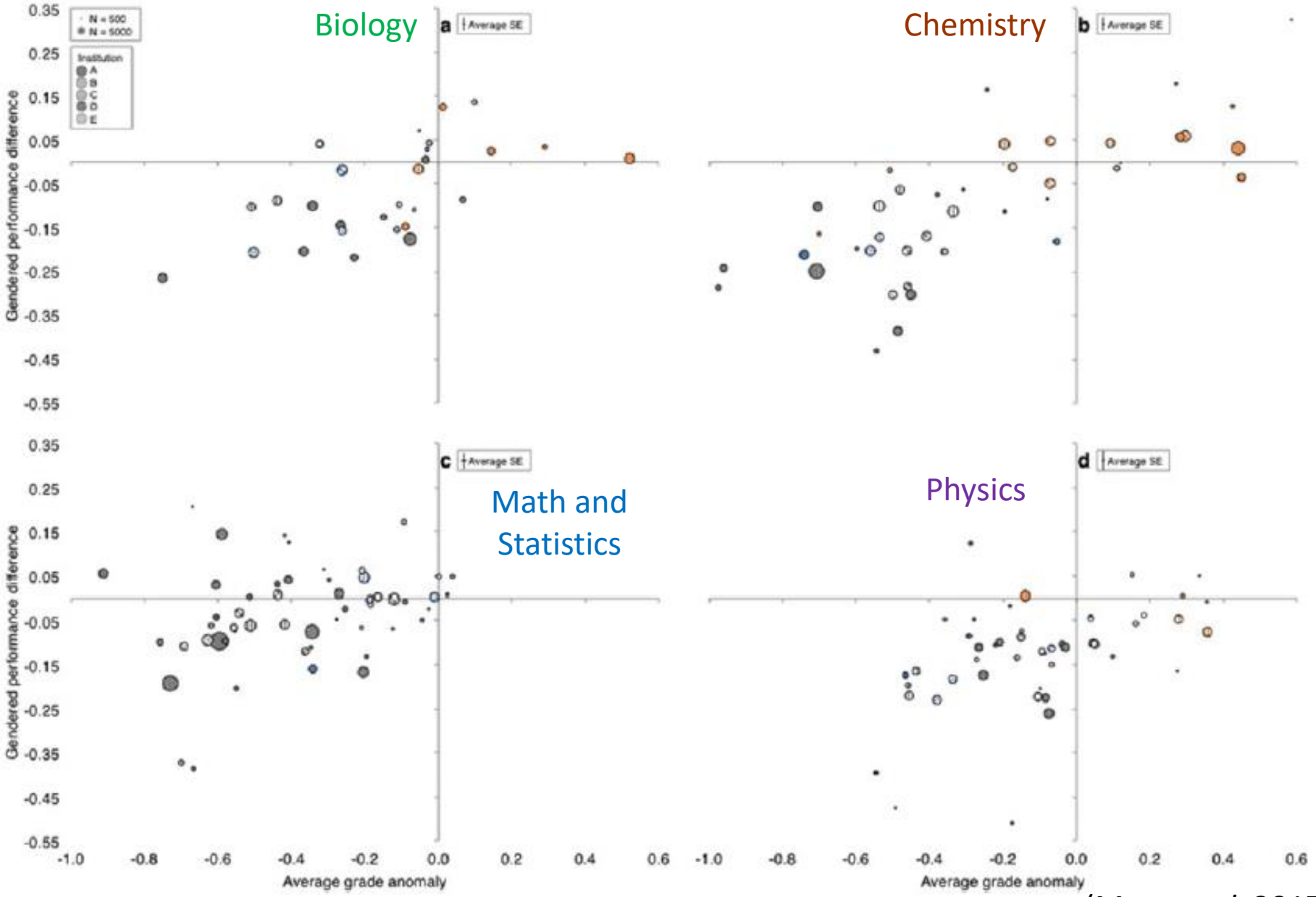
- Matz (2017) looked at five total universities
  - >1 million students
  - 250ish of courses
  - Biology, chemistry, physics, accounting, and economics **lecture** courses regularly exhibit statistically-significant gendered performance differences
    - **Lab** courses in the same subjects do not



(Matz *et al*. 2017).

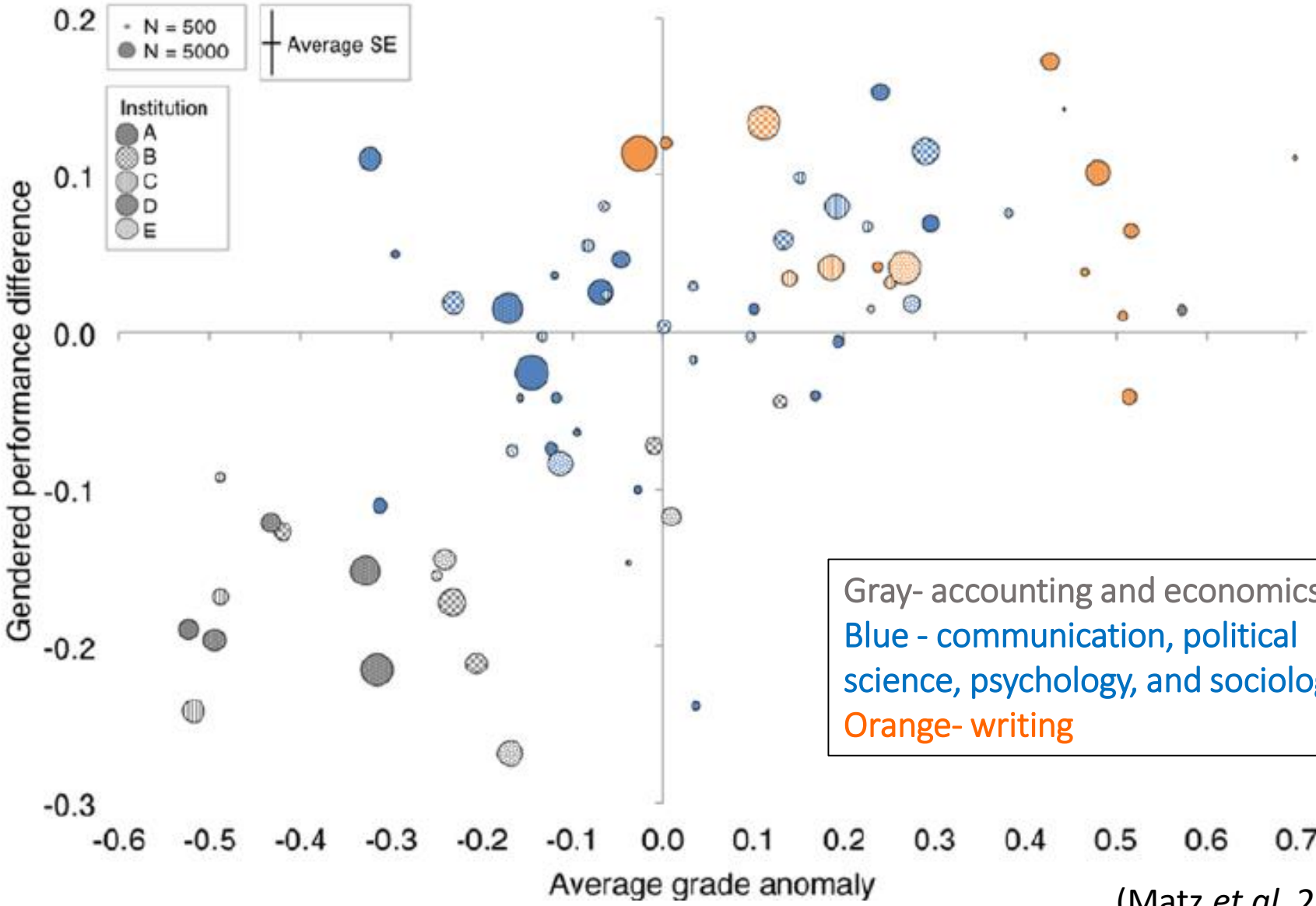
Lecture vs Lab

Orange = lab courses



(Matz *et al*. 2017).

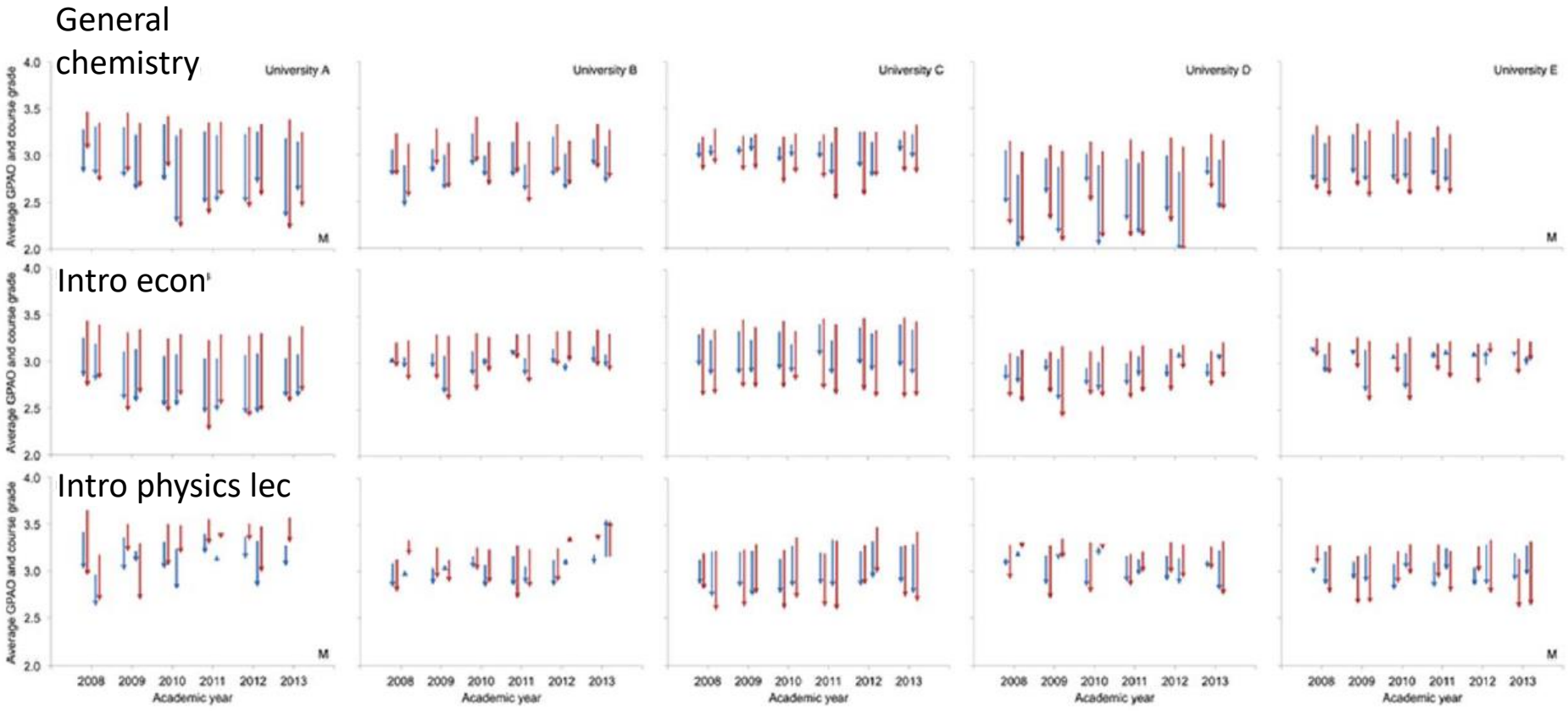
Non-STEM courses



Gray- accounting and economics
Blue - communication, political science, psychology, and sociology
Orange- writing

(Matz *et al*. 2017).

Year-by-year trends, per university



Arrow indicates direction from GPAO to course grade

Male, Female, M- mixed lecture and lab

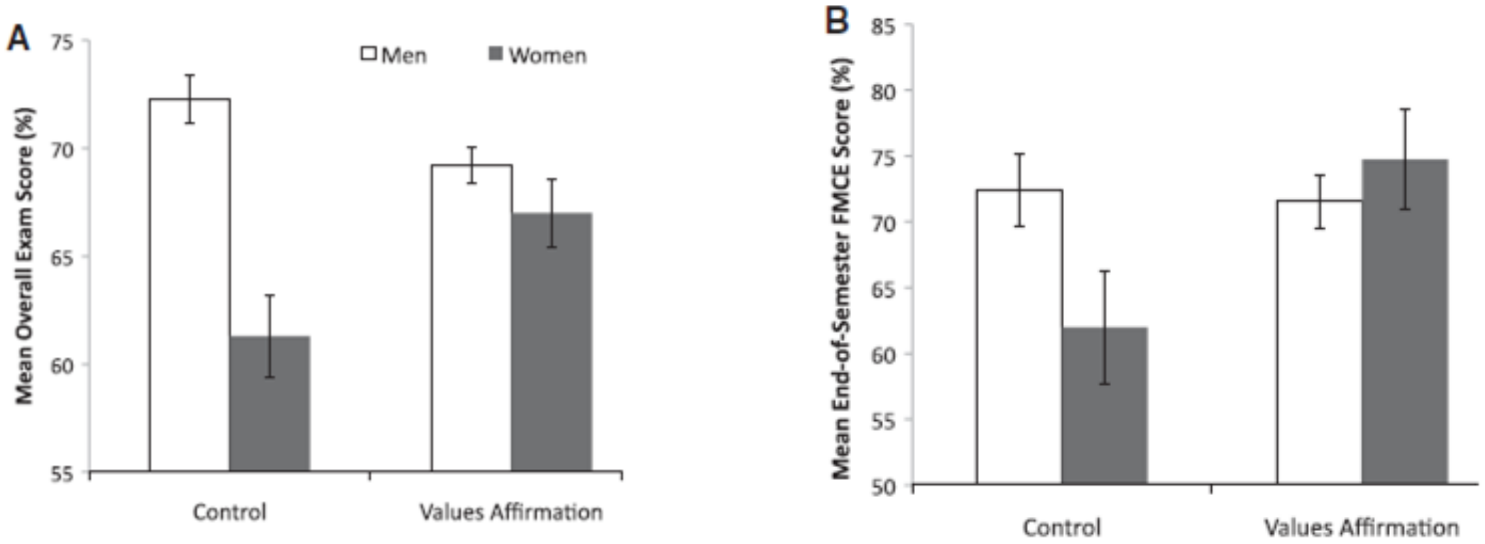
(Matz *et al*. 2017).

Are lecture courses the problem, or are (timed) exams the problem?

- Some possible solutions:
  - Values affirmation ("VA") interventions- students choose their most important values from a list and then write about why those values matter to them
    - E.g., "friends and family," "independence," "sense of humor"
    - Gives students a chance to reflect on their own self-worth
  - Utility value ("UV") interventions- students reflect on how the course material relates to their own personal goals
    - E.g., Students write about how course topics are relevant to their own lives or useful for themselves or others
    - Prompts students to think about why they are learning something.
    - Can be hw writing assignments
    - "**Community utility value**" intervention: students prompted to think about how biomedical research could address communal goals such as helping others and/or working with others

(Harackiewicz and Priniski, 2018.)

Values Affirmation Intervention to Reduce Test Anxiety / Stereotype Threat



- The **values affirmation group** were provided a list of options that are **unrelated** to the course material (including options such as “friends and family” or “art and music” or “learning or gaining knowledge” that may be personally important to the student).
- The students are asked to identify the one options from the list that they identify as *most* valuable personally to them, and to write about why it is meaningful to them for 10-15 minutes once in class and once as homework.

Miyake A *et al*, “Reducing the gender achievement gap in college science: a classroom study of values affirmation.” Science. 2010 Nov 26; 330(6008): 1234-7.

Tips from research on either type of intervention

- Values Affirmation interventions reduced:
  - gender gaps in a physics course
  - social class achievement gaps in a biology course
  - performance gaps between students with high and low senses of *belonging*
  - Achievement gaps between first-generation students and continuing generation students
    - Particularly when the essays focused on a student's "independence"

- Utility Value interventions seem to be best when when they focus students on "self-transcendent" goals, such as helping others

(Harackiewicz and Priniski, 2018.)

Summary

- Across five universities:
  - Women typically earned **half a letter grade lower** in large, introductory math or science courses than in their other classes at the university.
  - Men earned a **third of a letter grade lower** in large, introductory STEM courses.
  - All students earned lower grades on average in large, introductory STEM courses than in other courses.
  - Universities seem to have consistent grade penalties across courses
- How should we help our students **feel competent, stay motivated**?
  - What if this causes female students to feel less capable in STEM disciplines than in other disciplines?
- Is this because STEM classes are male dominated (re: population or behavior)?
  - Do gender penalties widen with courses that are more male dominated?
- Why do **labs** incur less of a penalty? Are the *aspects* of lab we can incorporate in lecture classes?
- Would you consider using a **utility-value** or **value-affirmation** intervention in your courses?