



Queen's
UNIVERSITY

Quo vadis PhD? (Whither goest thou PhD?) The future of graduate studies?

James M Fraser

Associate Dean (Grad) – Faculty of Arts and Science

Program Leader – NSERC CREATE Materials for Advanced Photonics and Sensing

Professor, Department of Physics, Engineering Physics & Astronomy

Queen's University

Kingston ON Canada

Queen's
UNIVERSITY

NSERC CREATE

MATERIALS FOR ADVANCED
PHOTONICS AND SENSING



Warm-up talk: hope on the horizon

Travel back to 2017

CAP Congress 2017
(Queen's University)

**Perhaps calling it the gender gap is
missing the point!**

Anneke Gretton and James M. Fraser
Department of Physics, Engineering Physics & Astronomy
Queen's University, Kingston



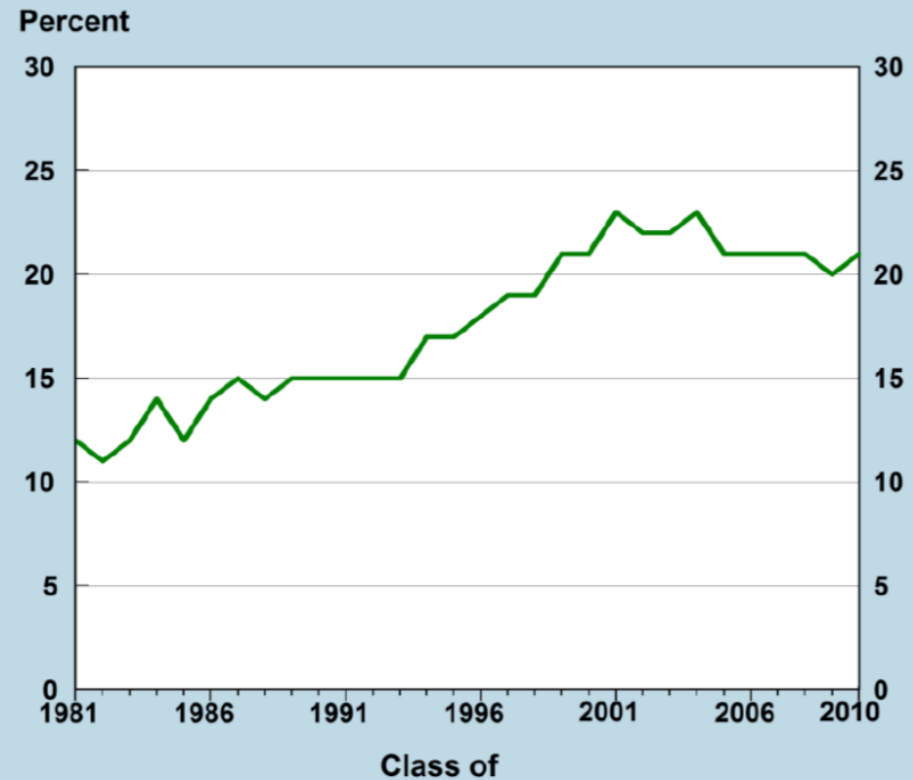
Queen's
UNIVERSITY



CAP Congress 2017
(Queen's University)

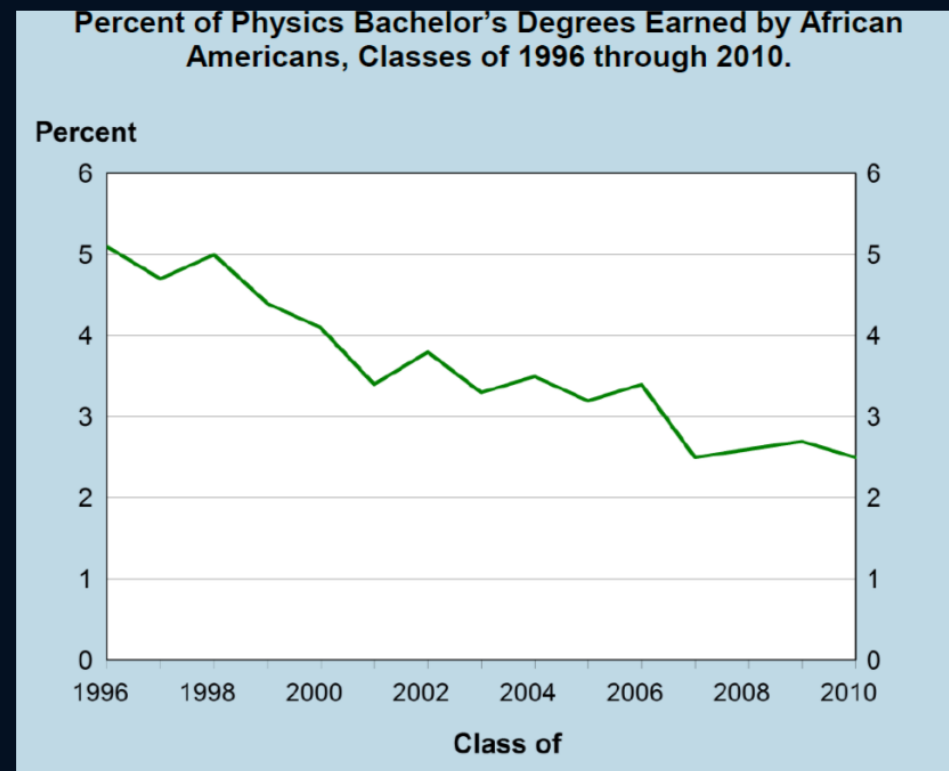
What is the trend?

Percent of Physics Bachelor's Degrees Earned by Women,
Classes of 1981 through 2010.



CAP Congress 2017
(Queen's University)

Calling it a gender gap misses the point....



"Physics bachelor's degrees: Results from the 2010 survey of enrollments and degrees," P. J. Mulvey and S. Nicholson, Focus On, American Institute of Physics Research Center (American Institute of Physics, College Park, 2012).



CAP Congress 2017
(Queen's University)

First hypothesis

Physics identity mediates the physics gap.



CAP Congress 2017
(Queen's University)

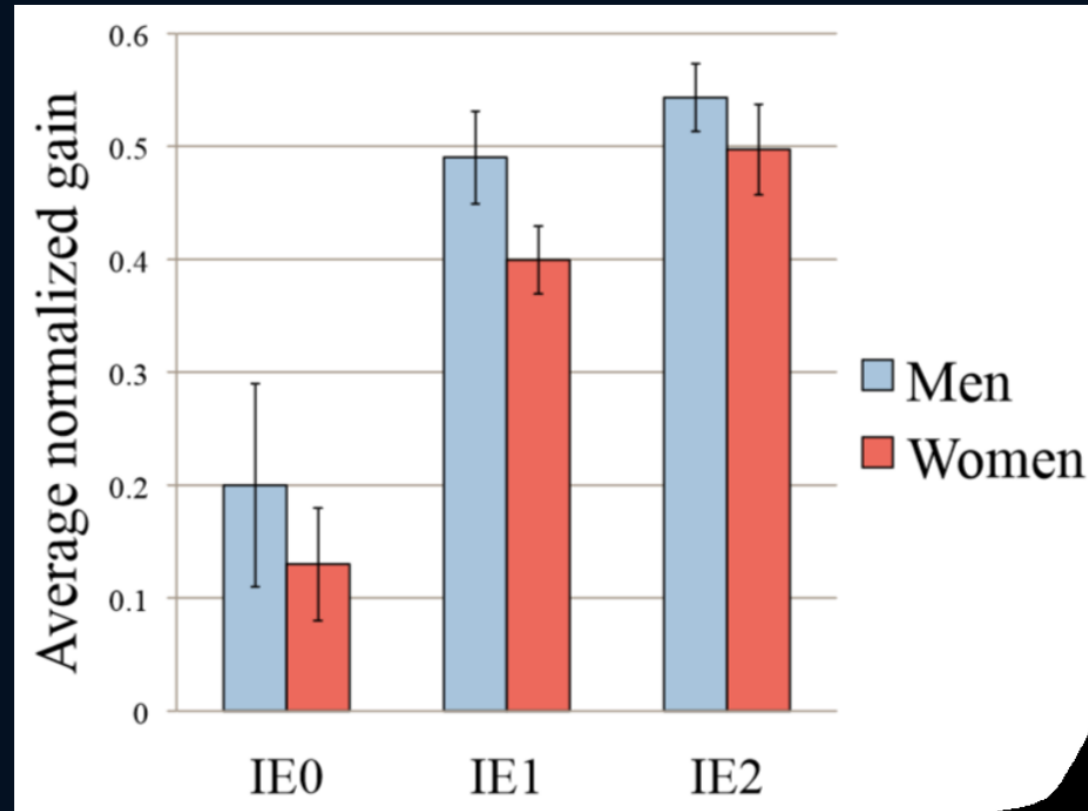
Second hypothesis

Instructional strategies that build community
reduces the gender gap in physics.



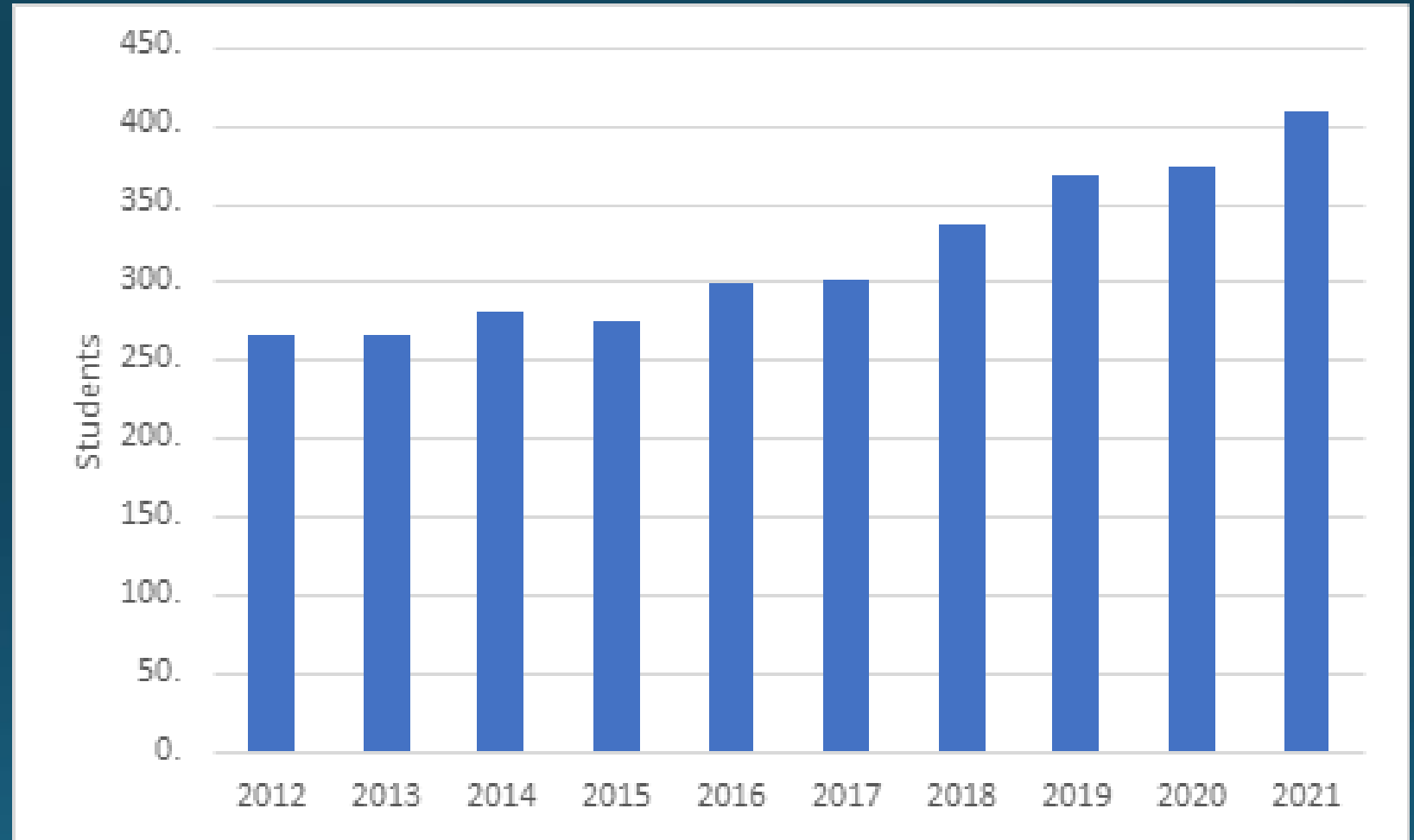
CAP Congress 2017
(Queen's University)

Our meta-analysis: everyone wins!

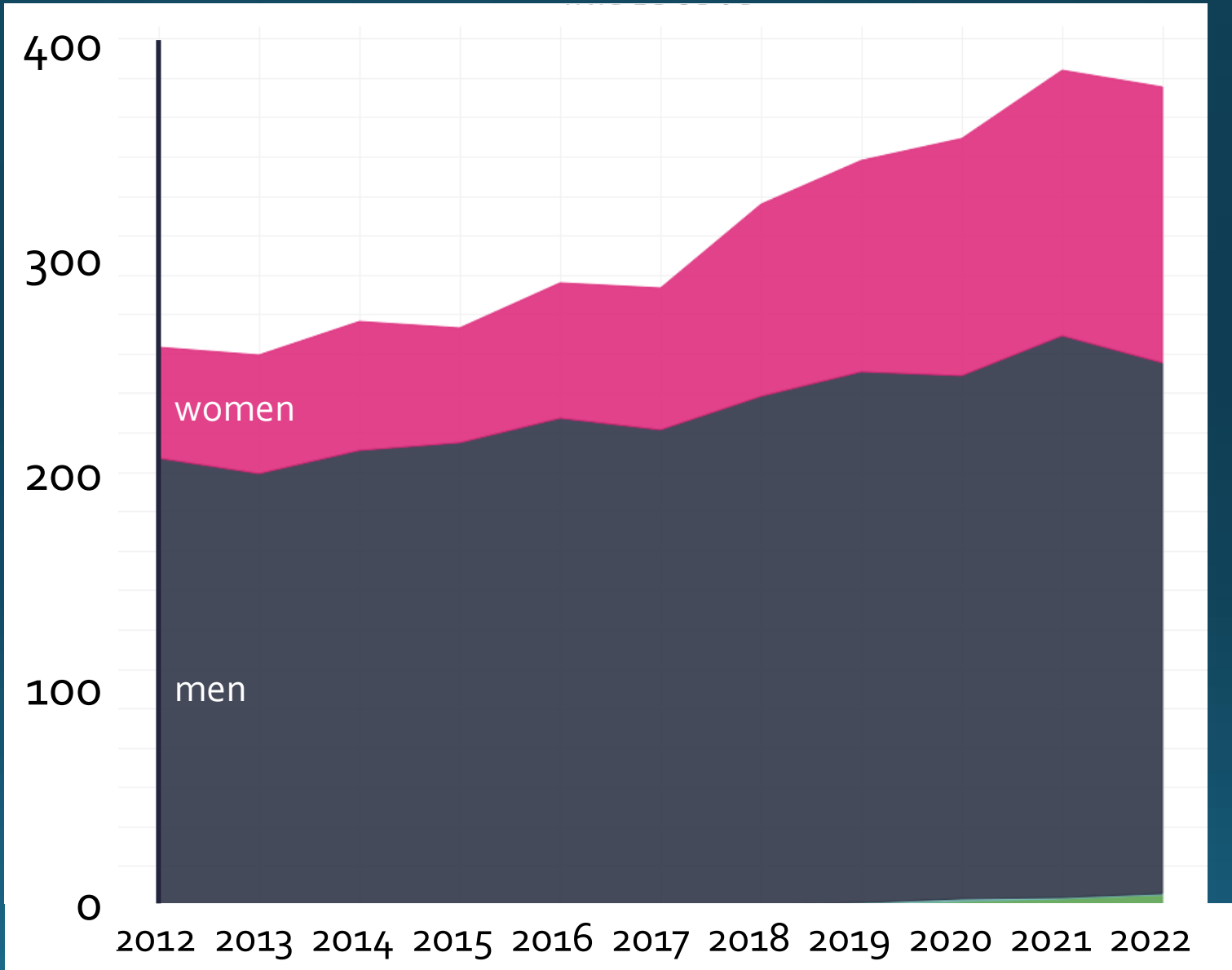


And now: CAP Congress 2023 (UNB)

Queen's undergraduates in PHYS, ENPH (2-4th years)



Total undergraduate enrollment
(PHYS, ENPH, 2nd-4th yr)



Focus on PHYS

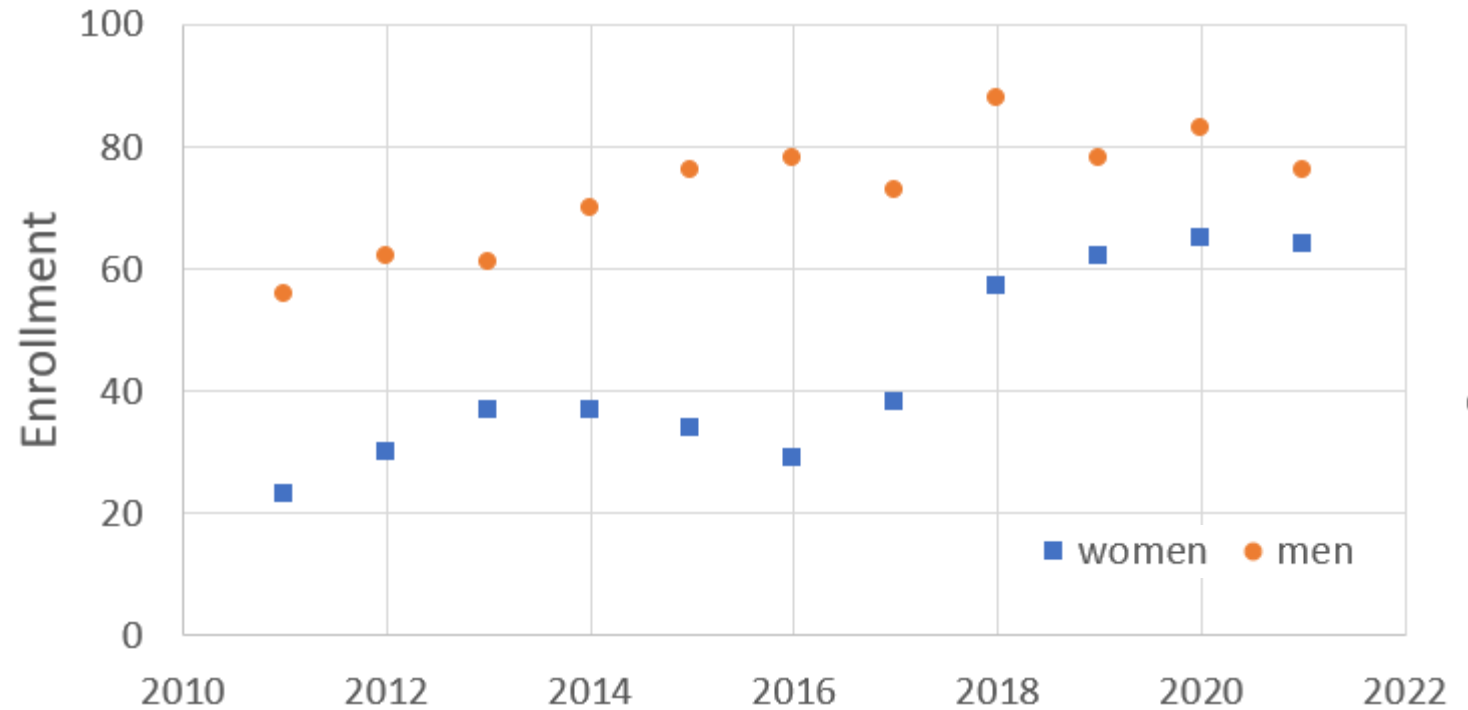


2023 graduating class –
More women (and gender
minorities) than men

Undergraduate enrollment
(PHYS, 2nd-4th yr)



Many factors at play!





Queen's
UNIVERSITY

Quo vadis PhD? (Whither goest thou PhD?) The future of graduate studies?

James M Fraser

Professor and Associate Dean (Grad) – Faculty of Arts and Science
Program Leader – NSERC CREATE Materials for Advanced Photonics and Sensing
Department of Physics, Engineering Physics & Astronomy
Queen's University
Kingston ON Canada

Queen's
UNIVERSITY

NSERC CREATE

MATERIALS FOR ADVANCED
PHOTONICS AND SENSING

Main talk: a litany of problems

Problem 1

The student-supervisor relationship
Apprenticeship into what?

Problem 2

We dropped the ball
Funding funding funding

Problem 3

Poorly designed feedback systems

Possible solutions you can implement immediately.

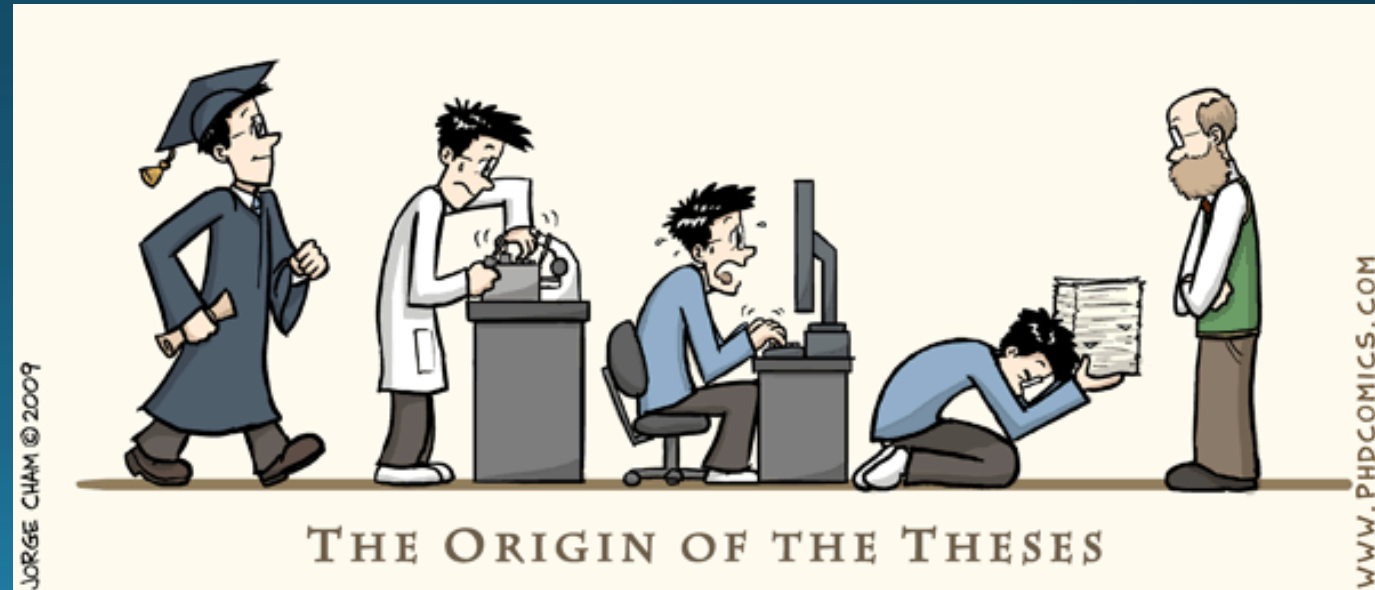


Problem 1

The student – supervisor relationship

“when the [mentor/mentee] relationship is good, it is very, very good . . . unfortunately, when the relationship is bad, it can be horrid”

- Golde *et al.* (2009)



Problem 1

The student – supervisor relationship

“Graduate education broadly and STEM graduate education specifically, have historically reflected a socialization model (Bragg, 1976). Socialization is the “process by which individuals acquire the values, attitudes, norms, knowledge, and skills needed to perform their roles” (Bragg, 1976, p. 6) for membership into a specific group. “

Minshew et al., AERA Open 7: 1-16 (2021)

Apprenticeship model



Image from the Maciejowski Bible



Problem 1

Apprenticeship into what -an academic career? Problems with your math!

In the US in 18-19, 1903 [Physics] PhDs were conferred while only 369 new tenure-track positions advertised

AIP reports [“Faculty Job Market in Physics and Astronomy Departments”](#) [“Trends in Physics PhDs”](#)



Image:
University of
Toronto

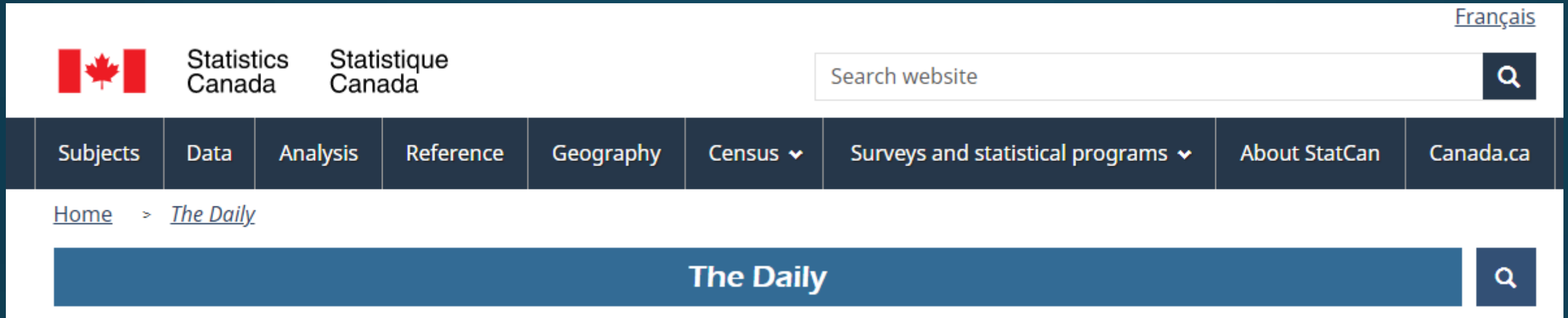


Problem 1

Is the problem that there are just too many graduate students in the Canadian system?



Productivity benefits from advanced training



The screenshot shows the top navigation bar of the Statistics Canada website. On the left is the Canadian flag and the text 'Statistics Canada' and 'Statistique Canada'. On the right is a search bar with the text 'Search website' and a magnifying glass icon. Below the navigation bar is a dark blue menu with the following items: 'Subjects', 'Data', 'Analysis', 'Reference', 'Geography', 'Census' (with a dropdown arrow), 'Surveys and statistical programs' (with a dropdown arrow), 'About StatCan', and 'Canada.ca'. Below the menu is a breadcrumb trail: 'Home > [The Daily](#)'. Below the breadcrumb trail is a dark blue header for the 'The Daily' section with a magnifying glass icon on the right.

“Canada lagged other countries in the share with graduate degrees, at 9.3% (8.2% with a master's degree or equivalent and 1.1% with an earned doctorate), whereas in the other G7 countries, this share ranged from 13% to 15%.”



Problem 1

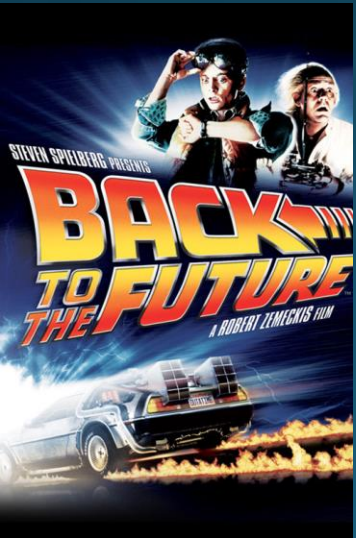
What are we training them for?



Problem 1

- *“We are currently preparing students for jobs that don’t yet exist ... using technologies that haven’t been invented ... in order to solve problems we don’t even know are problems yet.”*
 - —attributed to Richard Riley, former US Secretary of Education

And we do a really bad job of predicting the future.



A personal example: solar research at Brookhaven National Laboratory

1989



BROOKHAVEN BULLETIN

Vol. 43 - No. 30 August 4, 1989
BROOKHAVEN NATIONAL LABORATORY

Update: 1990 Funding

On July 25, the Laboratory learned that the Senate Appropriations Committee's Subcommittee on Energy and Water Development had unexpectedly recommended reducing funding for BNL's Alternating Gradient Synchrotron by \$30 million in fiscal year 1990.

The next day, New York Senator Alfonse D'Amato, a member of the Appropriations Committee, offered an amendment reinstating \$20 million of the proposed cut. The amendment passed.

While the final budget proposal approved by the full Senate now calls for a \$10 million reduction in AGS funding, the corresponding appropriations bill passed by the full House of Representatives contains no such cut. The final resolution of these differences is the task of the Senate-House Conference Committee.

This budgetary uncertainty last week prompted BNL Director Nicholas Samios to institute a Laboratory-wide freeze on hiring, which will continue at least until the Senate-House Conference Committee has resolved the

The Next Generation of Scientists



The Kappa team of the High School Honors Science Program at work at the National Synchrotron Light Source, beam line X-26; Allan Kolker (back, seated), Department of Applied Science, and guest scientist Mark Rivers (back, standing), University of Chicago, help out team members (from left) Steven Alexander, Louisiana; Juan Vazquez, Puerto Rico; Monica Emelko, Connecticut; Samuel Rivera, New Mexico; Angela McKean, Iowa; and Benjamin Martin, South Carolina. Also on hand is Maryann Librizzi (left), a high school teacher research associate.

Fifty-eight high school students — one from each state as well as the District of Columbia, Puerto Rico, Canada, France, Italy, Scotland, Japan and West Germany — converged on BNL Wednesday, July 26, for this year's High School Honors Science Program, sponsored by the U.S. Department of Energy (DOE).

The focus of the two-week program is a series of six experiments at the National Synchrotron Light Source (NSLS), which study the photoelectric effect, infrared spectroscopy and X-ray diffraction, absorption and fluorescence.

The students have been divided into 10 experimental groups, each of which performed three experiments from last Sunday to Tuesday. Wednesday morning, the rough drafts of their experimental reports were due; their final reports are due tomorrow.

"It's really very similar to the way scientists live their lives," said Don Metz, who heads the Office of Educational Programs (OEP). "The students come in as a team to do a common experiment, they work together, they work on the report... essentially, they go through a publication process."

That process will culminate in students' presentations of their exper-

(Continued on page 2)



By 1989, BNL solar energy efforts overgrown with weeds.

Investments in solar R&D by industry and government.



My conclusion: solar is DEAD.



Back to 2023....

[OUR SCIENCE](#) | [ABOUT](#) | [DEPARTMENTS](#) | [PARTNER WITH US](#) | [CAREERS](#) | [NEWS](#) | [CONTACT](#) | [DIRECTORY](#)

[Q SEARCH](#)



Northeast Solar Energy Research Center



[Home](#) | [Equipment, Services & Specs](#) | [Business Model](#) | [Real-Time Data](#) | [Renewables and Grid Modernization](#)



NSERC

A multi-purpose research facility on the Brookhaven campus

Problem 1



Apprenticeship model

In
tension
with

“We are currently preparing students for jobs that don’t yet exist ... using technologies that haven’t been invented ... in order to solve problems we don’t even know are problems yet.”

- —attributed to Richard Riley, former US Secretary of Education

My grad students should not become “mini-me’s”!
They need to become so much more!



Quid Pro Quo

May 29, 2023 | Alex Usher

More Thoughts On ...

[Academia](#)

[Access](#)

[Administration](#)

[Assessment](#)

".. in general make [grad degrees] faster, outcomes-focused and for God's sake end the apprenticeship system – make graduate students' progress the responsibility of the entire department not a single prof."

Main talk: a litany of problems

Problem 1

The student-supervisor relationship
Apprenticeship into what?

Problem 2

We dropped the ball
Funding funding funding

Problem 3

Poorly designed feedback systems

Possible solutions you can implement immediately



Problem 2 – we dropped the ball

Canada (and Ontario) grossly undervalues graduate student contributions.

We (supervisors, academic leaders) are complicit.



Canada (and Ontario) grossly undervalues graduate student contributions

2023
Natural Sciences and Engineering Research Council of Canada
 www.nserc-crsng.gc.ca

[Français](#) | [Home](#) | [Contact us](#) | [Help](#) | [Search](#) | [canada.ca](#)

Home > Students and fellows > Postgraduate programs > Canada Graduate Scholarships – Master’s program

[Back](#) | [Print](#) | [Bookmark](#) | [Larger](#) | [Smaller](#)

Students and fellows

- Undergraduate programs
- Postgraduate programs**
- Postdoctoral programs

Canada Graduate Scholarships – Master’s program

Overview

Value	\$17,500 for 12 months, non-renewable
--------------	---------------------------------------

2013

[How to Apply](#)
[Resource Videos](#)
[Contact Newsletter](#)
 Tri-Agency Harmonization of the Canada Graduate Scholarships

Canada Graduate Scholarships-Master’s Program

CIHR – Frederick Banting and Charles Best Canada Graduate Scholarships
NSERC – Alexander Graham Bell Canada Graduate Scholarships
SSHRC – Joseph-Armand Bombardier Canada Graduate Scholarships

Overview

Value	\$17,500 for 12 months, non-renewable
--------------	---------------------------------------

2003

Natural Sciences and Engineering Research Council of Canada
 Conseil de recherches en sciences naturelles et en génie du Canada
 Canada

[Français](#) | [Contact Us](#) | [Help](#) | [Search](#) | [Canada Site](#)
[Home](#) | [Program Guides](#) | [Program News](#) | [On-line Services](#) | [Funding Decisions](#)

[NSERC Prizes](#) | [Program Guides](#) | [Program News](#) | [On-line Services](#) | [Funding Decisions](#)

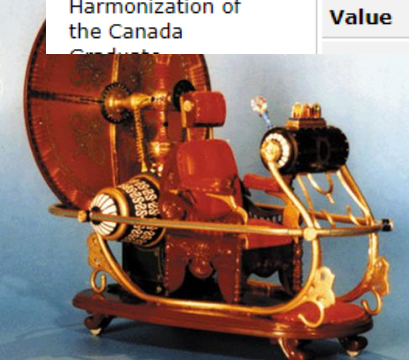
For Students and Fellows – Overview – Postgraduate

Canada Graduate Scholarships (CGS) and NSERC Postgraduate Scholarships (PGS)

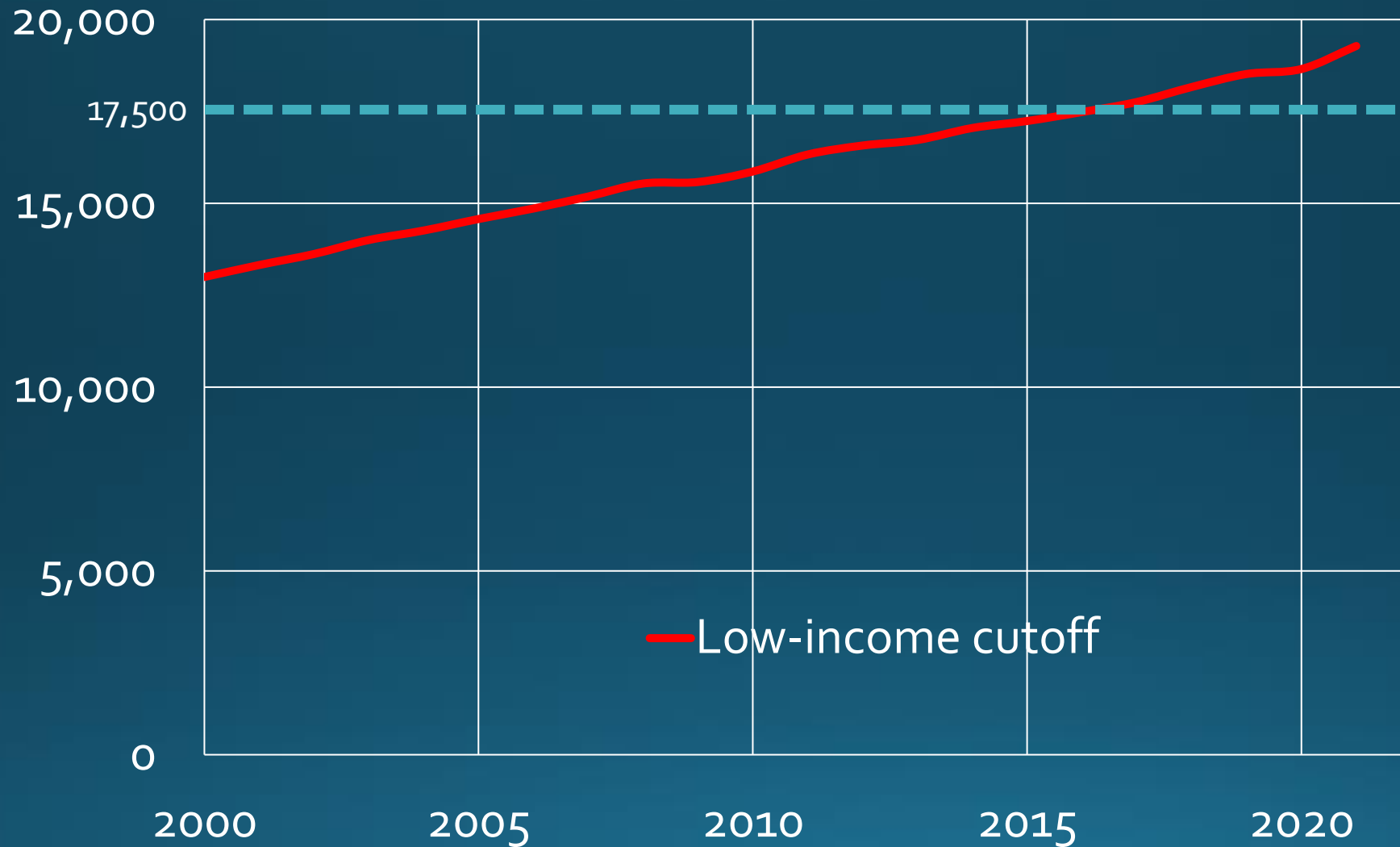
[Read Me First](#)
[Program Guide for Students and Fellows](#)
[Eligibility Criteria](#)
[Policies & Guidelines](#)
[Award Holder’s Guide](#)


[Print Friendly Version](#)

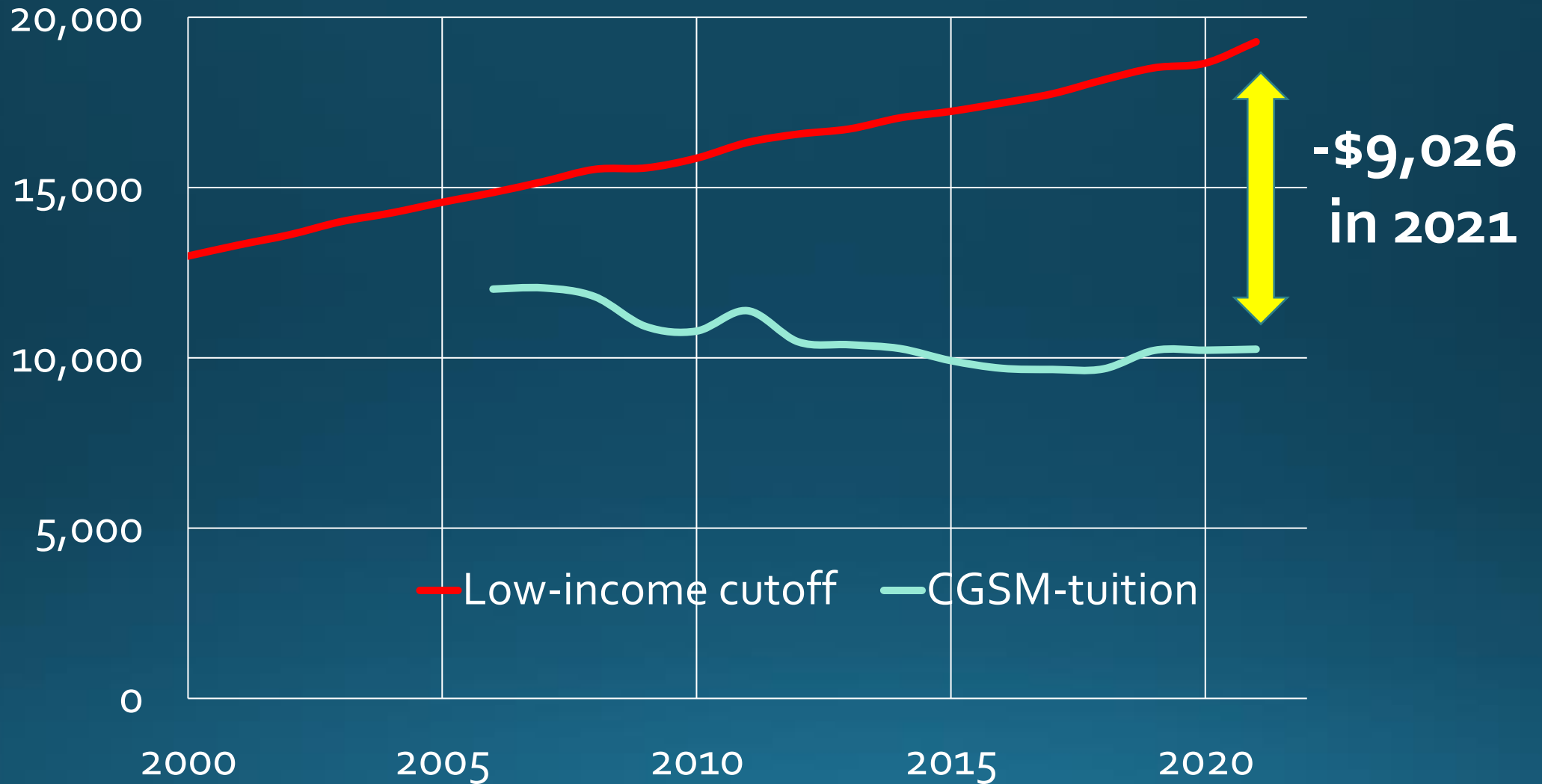
	Value	Application Deadline	How to Apply
Applicants applying through a university:			
CGS Master's	\$17,500 (for one year)	Set by university	Form 200
PGS Master's	\$17,300 (for one year)	Set by university	Form 200
CGS Doctoral	\$35,000 a year (for up to three years)	Set by university	Form 200
PGS Doctoral	\$21,000 a year (for up to three years)	Set by university	Form 200



The funding gap



The real funding gap



Bouchard Report (March 2023)

Report of the Advisory
Panel on the Federal
Research Support System



To put it starkly, current support for graduate students—the researchers of tomorrow—is at a breaking point. The values of the government's awards for university research trainees have remained virtually stagnant for the past 20 years. ...

This has a disproportionate impact on marginalized or underrepresented groups, affecting diversity in the talent pool for years downstream. “

Recommendation 6: Funding for graduate students and postdoctoral fellows should be increased to an internationally competitive level.

We can't wait for government to solve this problem.



Main talk: a litany of problems

Problem 1

The student-supervisor relationship
Apprenticeship into what?

Problem 2

We dropped the ball
Funding funding funding

Problem 3

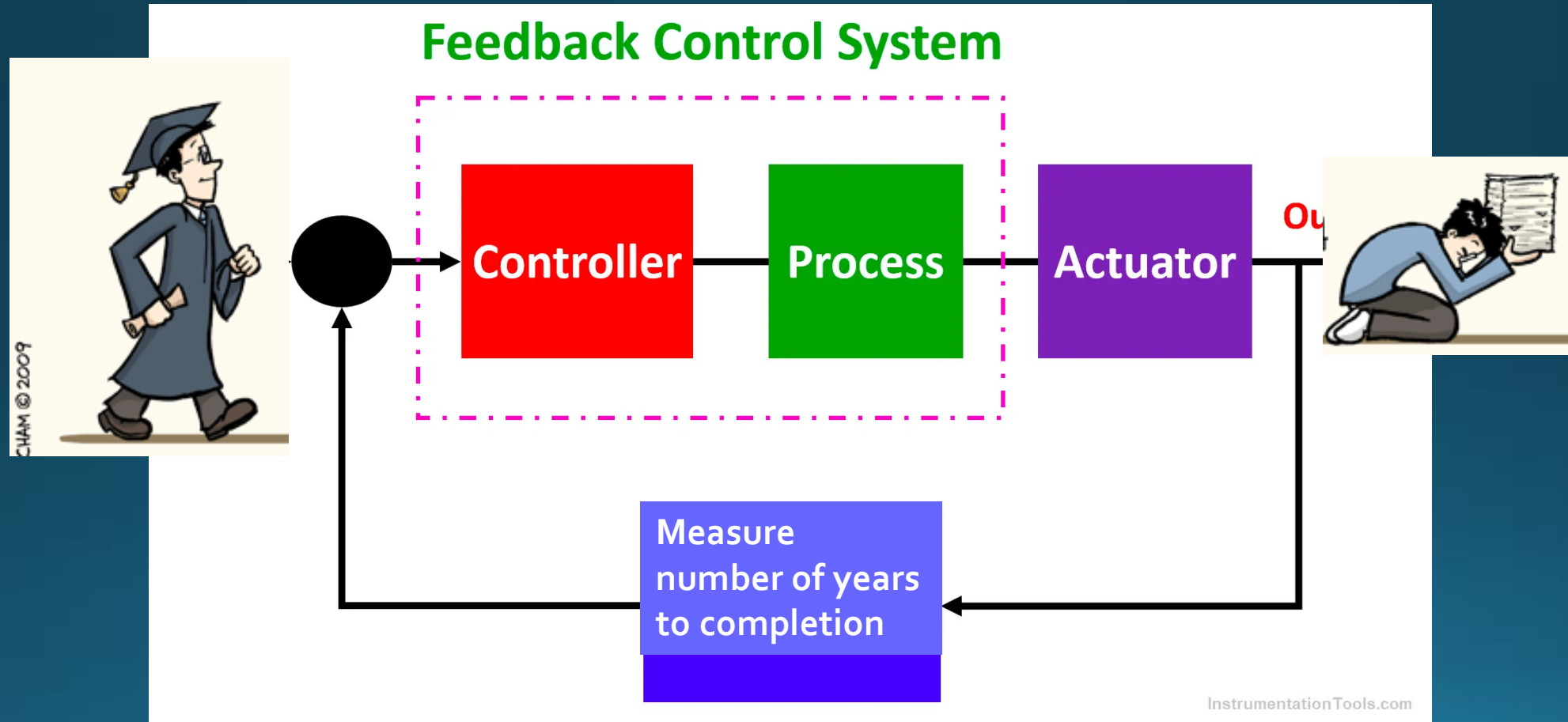
Poorly designed feedback systems

Possible solutions you can implement immediately



Problem 3 – poorly designed feedback loops

Without relevant and timely feedback, a system will not operate well.



What percentage of PhD students graduate within 6 years of starting their doctorate at your school?

A) ~100%

B) ~75%

C) ~50% or less

D) I have no idea

Recall: expectation is completion within 4 years.



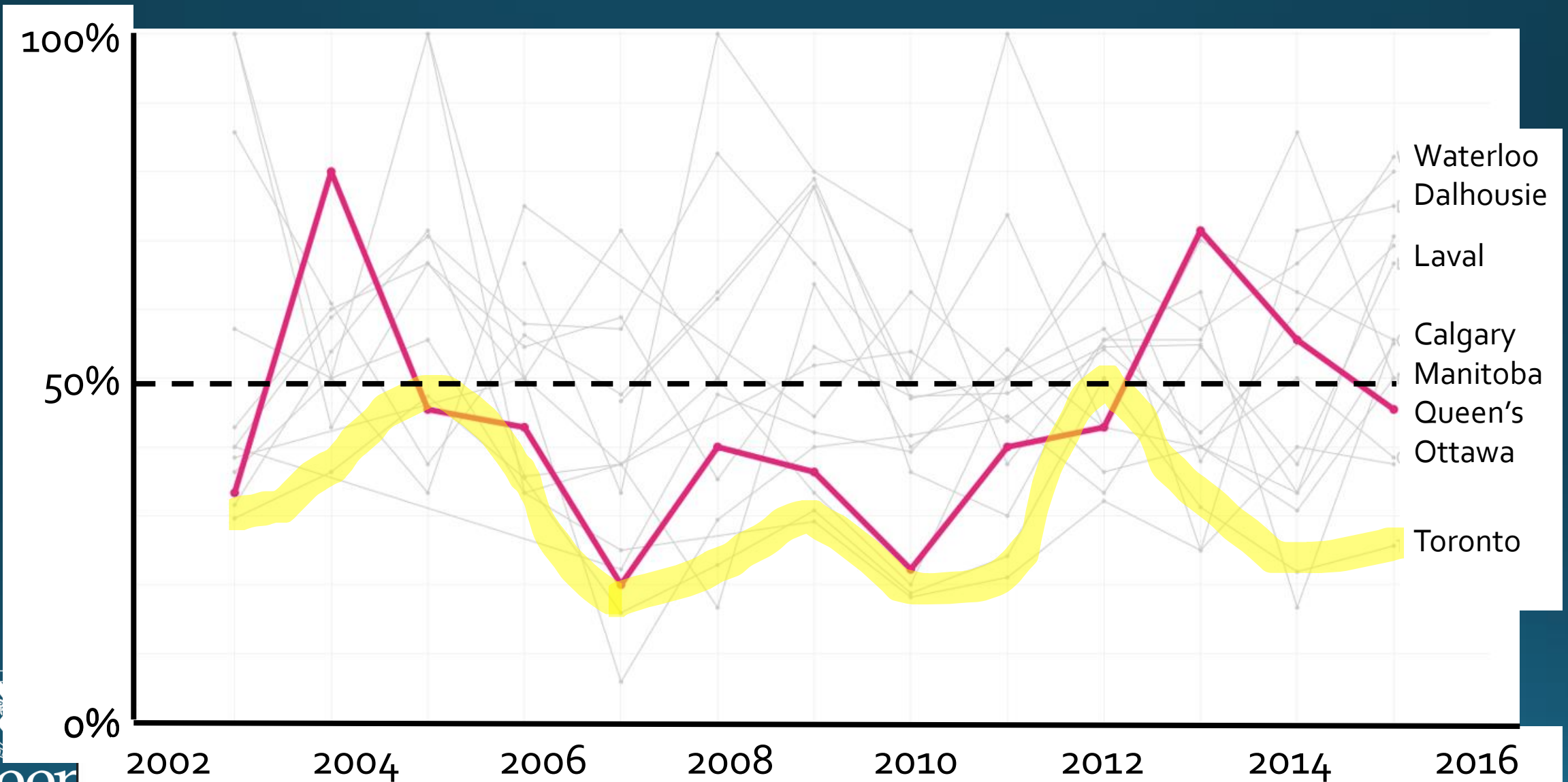
Problem 3 – badly designed feedback loops

“Paradoxically, the most academically capable, most academically successful, most stringently evaluated, and most carefully selected students in the entire higher education system—doctoral students—are the least likely to complete their chosen academic goals. Stunningly high rates of doctoral student attrition, which consistently range from 40 to 50%, are one of academia’s well-kept secrets ([Berelson, 1960](#); [Bowen & Rudenstine, 1992](#); [Lovitts, 1996](#)). Indeed, so wide-spread and persistent is the norm of attrition and the lack of research about it that Bowen and Rudenstine, authors of a landmark book on doctoral education, say: “The practice has been (for understandable reasons) to concentrate on those students who actually earn doctorates, allowing those who drop out to disappear from sight” (1992, p. 107).”

Golde, Review of Higher Education 23 (2000)



PhD 6-year completion rates



Litany of problems

Problem 1

The student-supervisor relationship
Apprenticeship into what?

Problem 2

We dropped the ball
Funding funding funding

Problem 3

Poorly designed feedback systems

Possible solutions you can implement immediately



Some possible answers

Queen's
UNIVERSITY

NSERC CREATE

MATERIALS FOR ADVANCED
PHOTONICS AND SENSING



Sandbox to try new things in graduate training



Queen's
UNIVERSITY

Some possible answers



2023 May 1

Recap: FAS Grad Summit

Imagining the future of graduate studies in FAS

The screenshot shows the CAGS website with a navigation menu including NEWS, ABOUT, PUBLICATIONS, ANNUAL CONFERENCE (highlighted), AWARDS & COMPETITIONS, PROJECTS, and OUR PARTNERS. The main content area features the title "61ST ANNUAL CAGS CONFERENCE" and the subtitle "Inclusive Excellence in Graduate Supervision and Mentorship". The dates "7-10 NOVEMBER 2023" and location "VICTORIA, BRITISH COLUMBIA" are listed, along with the format "IN-PERSON FORMAT WITH LIVE-STREAM OF MAIN EVENTS". A search bar and a "RECENT NEWS" section are visible on the right side of the page.

CAGS | Canadian Association for Graduate Studies

NEWS ABOUT PUBLICATIONS **ANNUAL CONFERENCE** AWARDS & COMPETITIONS PROJECTS OUR PARTNERS

61ST ANNUAL CAGS CONFERENCE

Inclusive Excellence in Graduate Supervision and Mentorship

7-10 NOVEMBER 2023
VICTORIA, BRITISH COLUMBIA
IN-PERSON FORMAT WITH LIVE-STREAM OF MAIN EVENTS

SEARCH ...

RECENT NEWS

 CAGS Launches New Strategic Plan, 2023-2027
May 24, 2023 | CAGS News, FEATURE POST SLIDER

 CAGS President Delivers Remarks at House of Commons Standing Committee on Science and Research



Some possible answers

Diversify supervision: primary, secondary and external mentor.

Internships

Problem 1

The student-supervisor relationship
Apprenticeship into what?

Problem 2

We dropped the ball
Funding funding funding

Problem 3

Poorly designed feedback systems

Possible solutions you can implement immediately



What you can do immediately

Augment supervisory committees

Decide on its purpose: mentorship or evaluation?

Put it in the workload document.

Measure participation and share the results to your faculty

-perhaps normalized to PI's own team size, or +/- statistic

Problem 1

The student-supervisor relationship
Apprenticeship into what?

Problem 2

We dropped the ball
Funding funding funding

Problem 3

Poorly designed feedback systems

Possible solutions you can implement immediately



What you can do immediately

Increase graduate student funding

Set funding = Low-income cut-off + tuition (+ fees/health care)

Problem 1

The student-supervisor relationship
Apprenticeship into what?

Problem 2

We dropped the ball
Funding funding funding

Problem 3

Poorly designed feedback systems

Possible solutions you can implement immediately



International Masters student: \$34,449
Domestic Masters student: \$26,539

Known implication: fewer graduate students



What you can do immediately

Define desired outcome(s)

e.g., significant international experience, conference presentation, outreach, mentored jr student, teaching skills development
align desired outcomes with deliverables: supervisory meetings and thesis

Define metrics and collect data

times to completion
drop rates
supervisor feedback (e.g, 360° feedback)

Problem 1

The student-supervisor relationship
Apprenticeship into what?

Problem 2

We dropped the ball
Funding funding funding

Problem 3

Poorly designed feedback systems

Possible solutions you can implement immediately



Summary

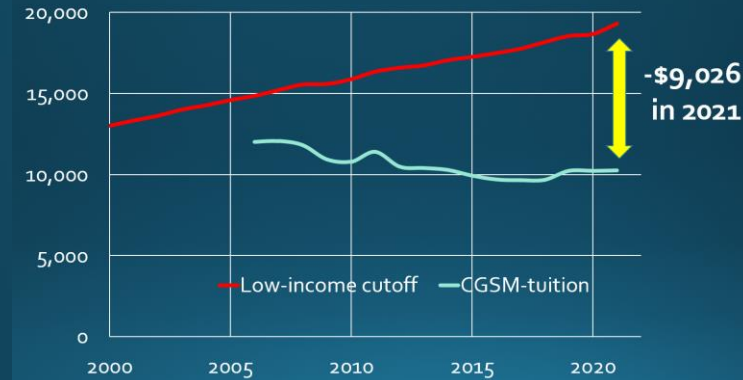


Apprenticeship model makes no sense

Add external mentor

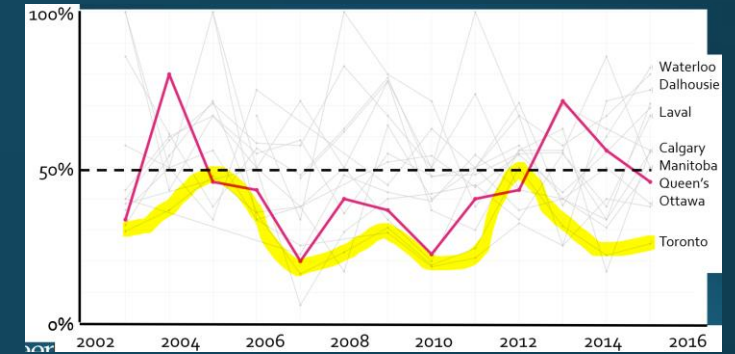
Internships

Empower supervisory committees



Dropped the ball on funding

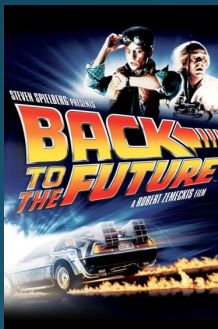
Increase their funding



Poorly designed feedback systems

Decide what matters

Measure it



Travel to 2033

Work on problems relevant to themselves across disciplinary boundaries while developing range of professional skills. Finish on time and are able to communicate their value to a range of audiences. **Graduate students feel valued and that they belong.**

