Georgia Tech

PER @ GT

The Science of Science Communication

Lessons from Research on Giving Presentations and Teaching Them, Too

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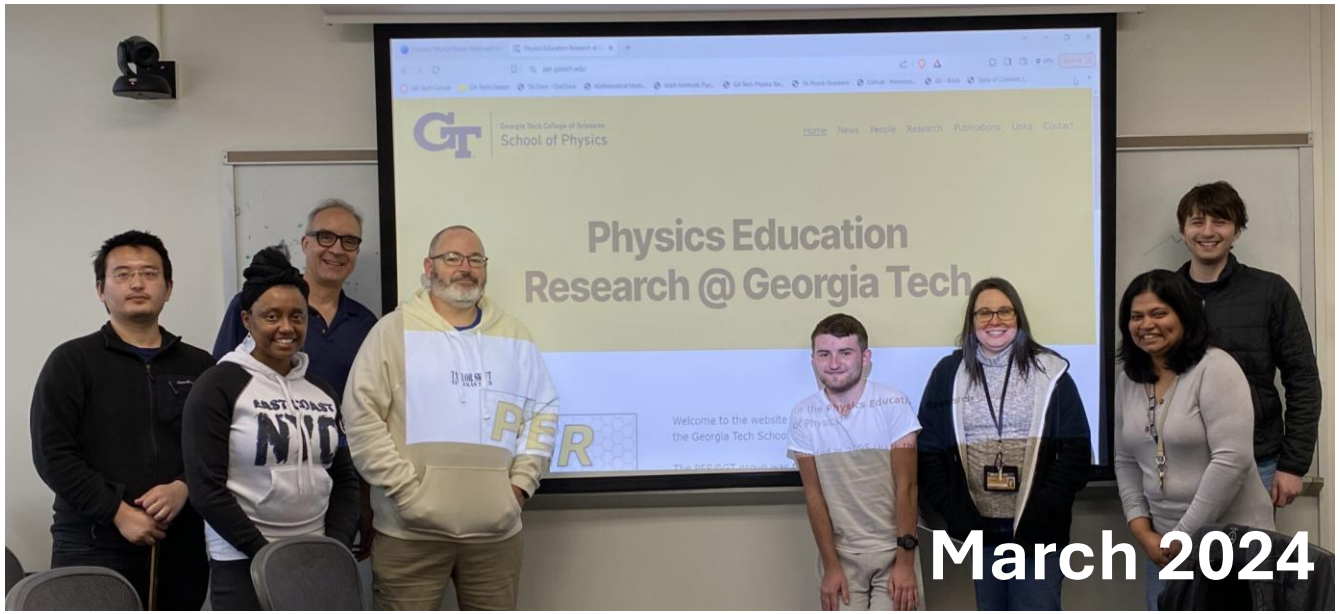
Science Café, October 16, 2026

With utmost respect to those who have helped me…

Thank you to
PER @ GT group members:

Current	&	Former
Dr. Emily Alicea-Muñoz		Dr. Andrew Wu
Dr. Michael Schatz		Gregory Carroll
Dr. Edwin Greco		Anika Jones
Dr. Prabha Padukka		Alex Ronemus
Dr. Paul Sell		Abigail Creyts
Kevin Nguyen		Carson Hill



Thank you to collaborating instructors:

Dr. Colin Parker
Dr. Itamar Kimchi
Dr. Mary Peek
Dr. Sven Behrens

…I don’t know how to give this talk.

(or any science talk for that matter)

No one taught me.

Implementation of relevant science communication resources has been slow and highly localized.

- National organizations **emphasize** the importance of developing **science communication skills** in students.
- Oral presentations help students develop effective **presentation, language, and research skills** [Aryadoust, 2015].
- Still, employer accounts suggest physics graduates are **deficient** in social and communicative skills [Sarkar et al., 2016].

A student today might be in deep trouble if they weren't taught how to do this well.

Competencies Needed by Business Professionals in the AI Age: Character and Communication Lead the Way

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Peter Cardon[1], Carolin Fleischmann[2], Minna Logemann[3], Jeanette Heidewald[4], Jolanta Aritz[1], and Stephanie Swartz[5]

Abstract

Many experts project generative AI will impact the types of competencies that are valued among working professionals. This is the first known academic study to explore the views of business practitioners about the impacts of generative AI on skill sets. This survey of 692 business practitioners showed that business practitioners widely use generative AI, with the most common uses involving research and ideation, drafting of business messages and reports, and summarizing and revising text. Business practitioners report that character-based traits such as integrity and soft skills will become more important. Implications for teaching business communication are discussed.

Employability skills for 21st-century STEM students: the employers' perspective

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Abstract

Purpose – One of the goals of educational institutions is to prepare their graduates to be workplace-ready. The purpose of this paper is to identify the employability skills lacking in the Science, Technology, Engineering and Math (STEM) industry from employers' perspectives to assist STEM educational institutions in creating more relevant programs inclusive of employability skills.

Design/methodology/approach – This study addresses 16 job-specific skills based on data deriving from the responses of 250 Human Resource Managers (HRMs) who represent five manufacturing industries (Aerospace and Defense, Automotive, Consumer Products, Electronics and Industrial Manufacturing) located in five regions (Northeast, Midwest, Southeast, West-Mountain and Pacific) of the United States.

Findings – The median scores for all 16 skills confirmed their importance for employability in the five manufacturing industries. The five highest ranking skills were team player, self-motivation, verbal communication, problem-solving and being proactive, which align with previous studies on workplace skills.

Research limitations/implications – This paper is a call to all STEM educational institution stakeholders, both internal and external, to re-assess current curriculum and programs and collaborate to narrow the gap between graduate competencies and the practical needs of the workplace.

Originality/value – This paper attempts to bridge the gap between the competencies gained in STEM educational institutions and the competencies needed for the future workplace, as confirmed by HRM professionals. Although this study is focused on STEM educational institutions in the United States, it will be of interest to all STEM educational institutions worldwide who play a significant role in preparing the next generation of employees for the global workplace.

Keywords STEM graduates, Workforce skills, Aerospace and defense industry, Human capital, Stem workforce, Manufacturing industry

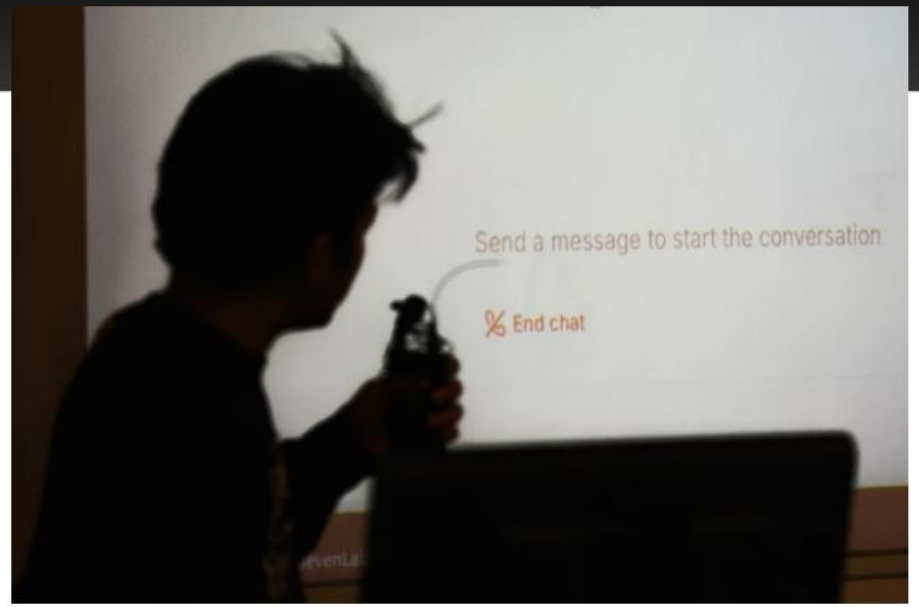
Paper type Research paper

A student today might be in deep trouble if they weren't taught how to do this well.

EDUCATION

AP

Perfect homework, blank stares: Why colleges are turning to oral exams to combat AI



Student Surya Newa is silhouetted while using an oral AI agent during class at NYU Stern School of Business, March 4, 2026, in New York. (AP Photo/Heather Khalifa) License this photo

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BY JOCELYN GECKER

Updated 3:09 PM EDT, April 22, 2026

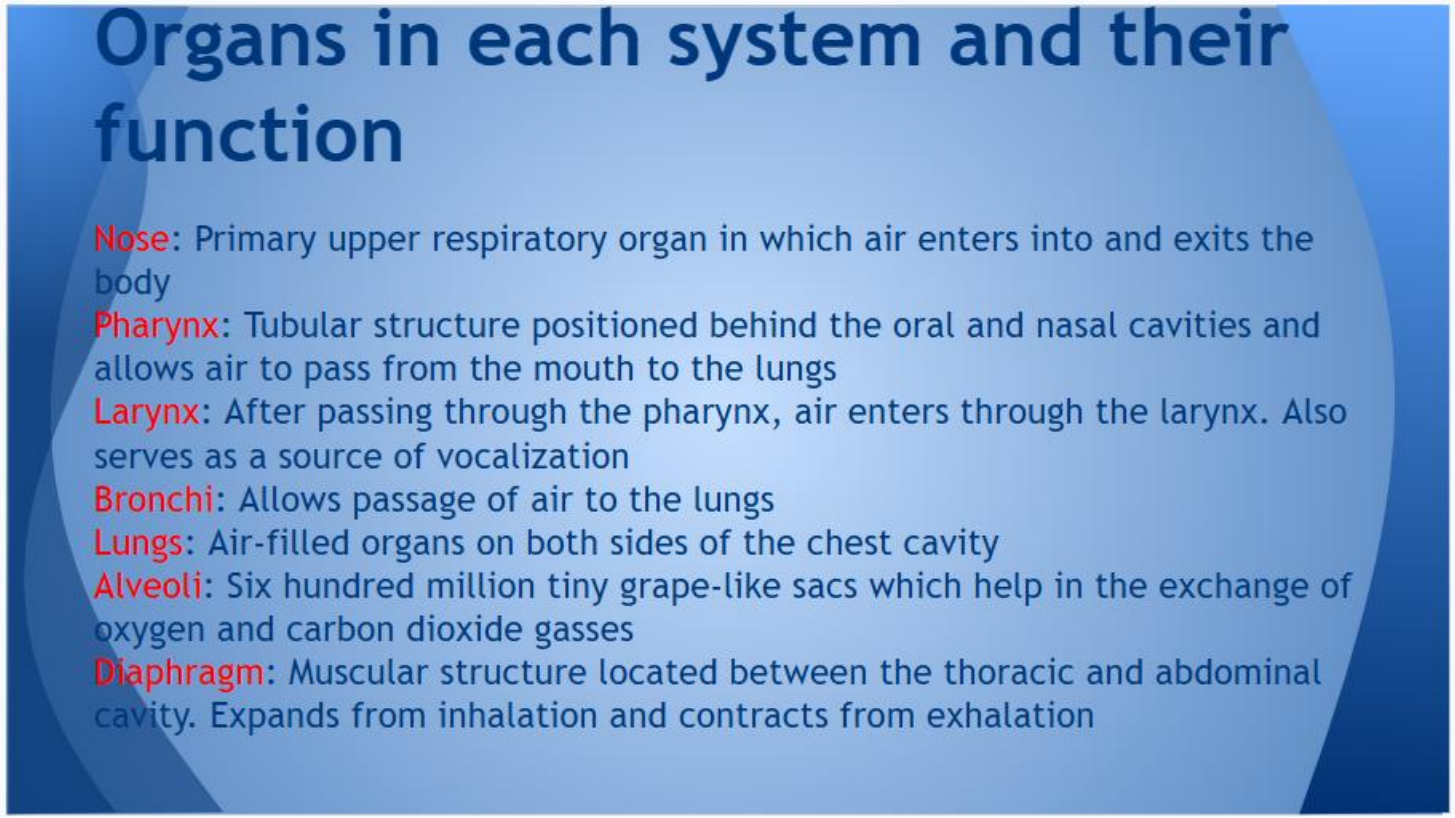
Report of MIT's Ad Hoc Committee on AI Use in Teaching, Learning, and Research Training

August 13, 2026

"We urge instructors to consider forms of assessment that are less vulnerable to AI, and more valuable for learning, such as oral exams, semester portfolios, and out-of-class assignments paired with in-class conversations. This likely means that resources such as TAs and class time will become more central to evaluation and also raises the question of whether we should find ways to limit class sizes."

Training students to communicate science takes more than convincing instructors of its importance.

- High enrollment and limited class resources present **barriers** to providing students ample opportunities **to practice** science presentation skills.
- STEM instructors regularly **prioritize correct content** over successful communication.
- How do we **define "success"** in technical or public-facing science communication?



2015 Steven should **not** have received high marks for this presentation!

Describe the best and worst lectures that you have attended. Be specific!

What made their lecturing the best?

- Your answers go here!

What made their lecturing the worst?

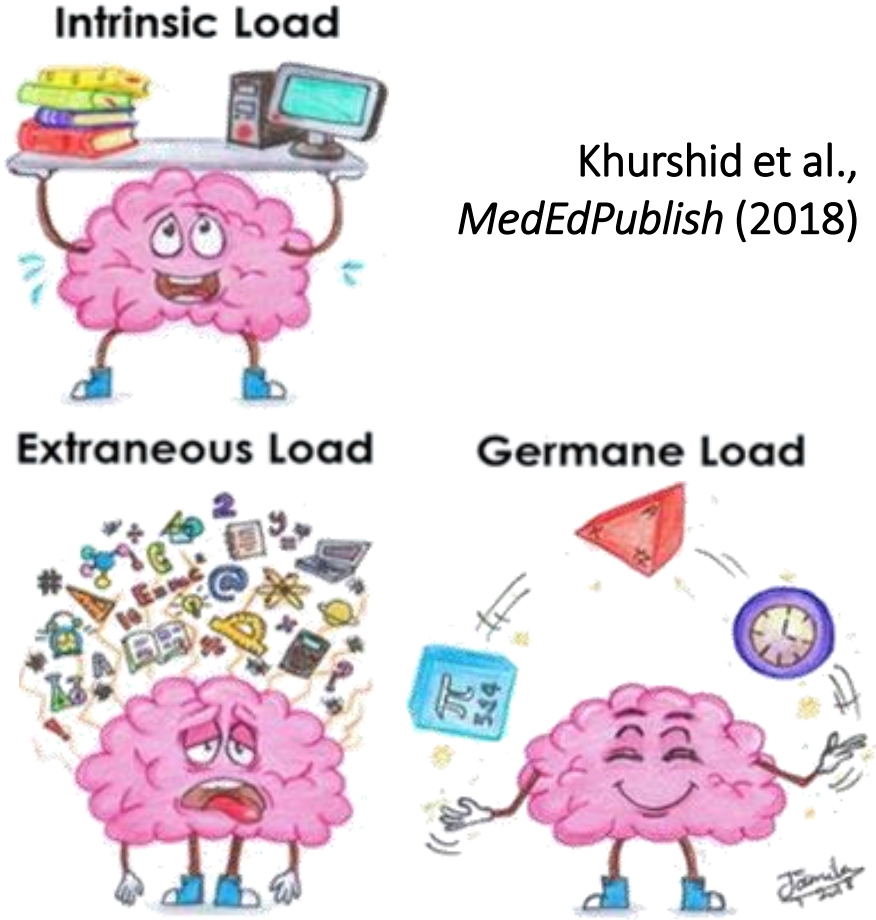
- Your answers go here!

Psychology lends multiple theories to understand multimedia learning.

- **Cognitive Load Theory** emphasizes the limited capacity of short-term memory [Sweller, 1988].

- The **Cognitive Theory of Multimedia Learning (CTML)** models visual and auditory processing [Mayer, 1997].

- CTML makes three foundational **assumptions:**
  1. Independent processing of words and images
  2. Individual limited bandwidths
  3. Learning requires audience engagement

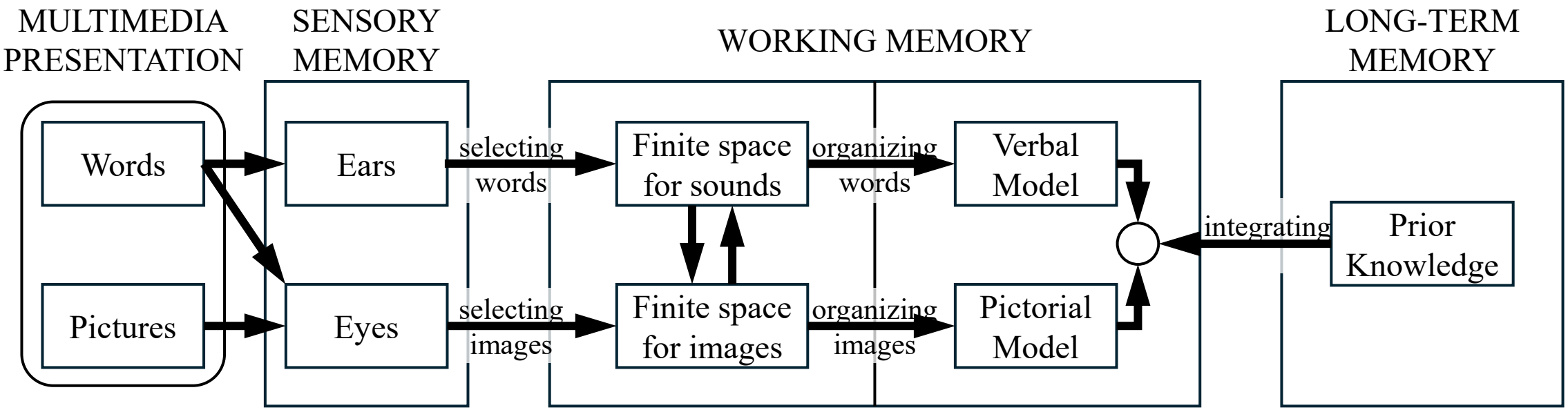


Khurshid et al., *MedEdPublish* (2018)

Sweller's three types of cognitive load occupy one's short-term memory.

Successful multimedia is more than the sum of its parts.

Adapted from Mayer et al., *J. Educ. Psychol.* (2001)



Simultaneous sensemaking across **two channels**

Content curated to **avoid cognitive overload**

Active knowledge construction **guided** by a teacher

Adherence to CTML principles is a proxy for presentation quality.

- **Principles** from CTML **frame** how we understand **presentation quality**.

- 15 multimedia principles:

Coherence	Segmenting	Voice
Signaling	Pre-training	Image
Redundancy	**Modality**	**Embodiment**
Spatial contiguity	**Multimedia**	Immersion
Temporal contiguity	**Personalization**	**Generative activity**

- Which principles apply depends on presentation **context**.

$$\text{Quality} \equiv \#\ \text{principles obeyed} \in [0,10]$$

Coherence:
Omit extraneous details.

Signaling:
Visually guide learners through content organization.

Students have dual roles in the physics and biochemistry communication courses at GT.

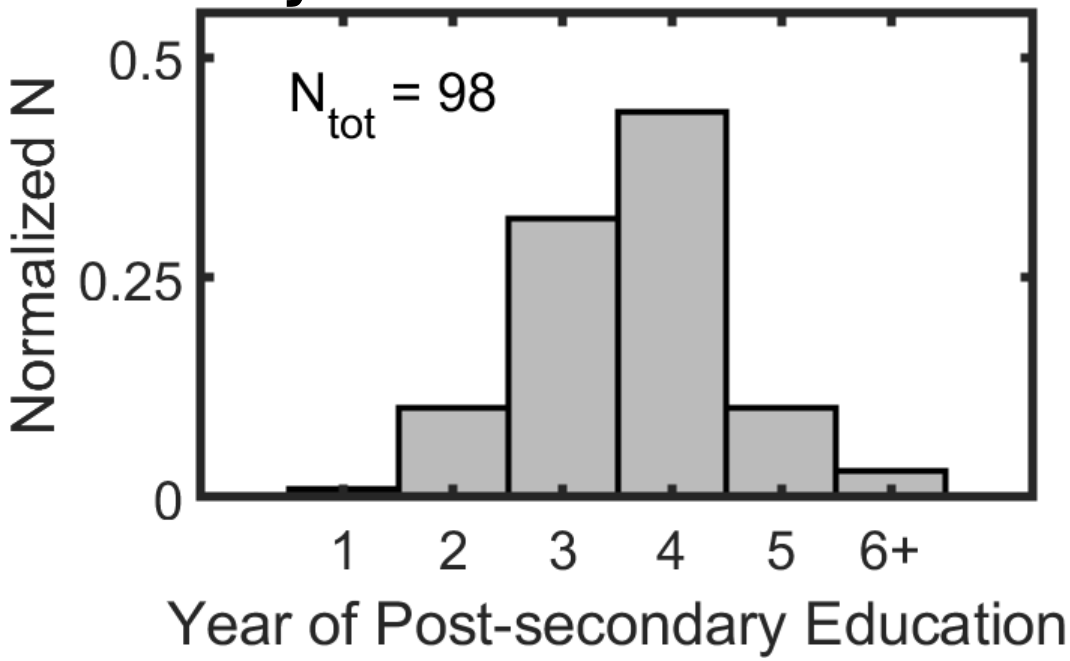
Physics Seminar (1 credit hour)

- Typical semesterly enrollment: 40–50
  - One uncapped section
  - 44% 4th-years, wide range

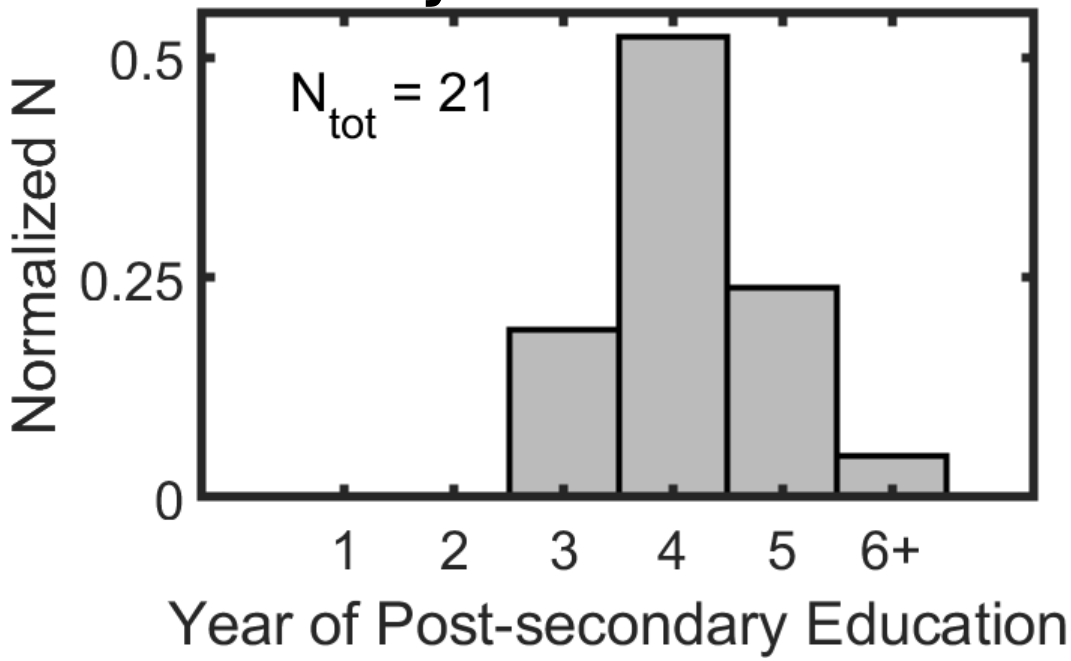
Chemistry Seminar (2 credit hours)

- Typical semesterly enrollment: 29–36
  - Two sections capped at 18 each
  - 52% 4th-years, skews older

Physics Seminar Enrollment



Chemistry Seminar Enrollment



Demographic information is limited to students who filled the Prior Experience Survey.

Students have dual roles in the physics and biochemistry communication courses at GT.

Physics Seminar (1 credit hour)

- Typical semesterly enrollment: 40–50
  - One uncapped section
  - 44% 4th-years, wide range
  - Minimal external SciComm experience
  - Highly varied instruction each semester

Students as presenters

- Students present **1x** per semester.
  - One 8-min presentation + 2-min Q/A
  - Topics: research at GT, summer internships, upper-division course topics

Students as observers

- Randomly assigned written peer evaluations per presentation
- End-of-class quiz on concepts from that day's presentations

Chemistry Seminar (2 credit hours)

- Typical semesterly enrollment: 29–36
  - Two sections capped at 18 each
  - 52% 4th-years, skews older
  - Minimal external SciComm experience
  - 2 hours on slideshows, 1 hour on posters

Students as presenters

- Students present **4x** per semester.
  - One 4-min presentation (No Q/A)
  - Two 20-min presentations + 5-min Q/As
  - One poster symposium + 1-min elevator pitch
  - Topics: journal articles within last 7 years

Students as observers

- Immediate oral feedback per presentation
- End-of-class reflection activity on that day's presentations collectively

Across semesters and departments, students valued direct instruction on and practice with presentation skills.

- PHYS F23: W1 Syllabus review
  - *"It maybe **would be helpful** to have **one or two days of class** going over that. Learning how to pick out the key ideas from your slides, presenting them in one sentence, and just talking about why that's important…."*
- PHYS Sp24: W1 Intro to science presentations, W2–4 Presentation workshops
  - Students **valued guidance** on presentation structure and techniques.
  - **Workshops overstayed** their welcome and did not effectively simulate public speaking.
- PHYS F24: W1 Syllabus review, W2 Intro to science presentations
  - Interesting but **not enough time** for meaningful learning.
  - Not useful or engaging for people with **prior experience**.
- CHEM Sp24 & F24: W1 Science presentations, W4–5 Science posters
  - *"a good introduction into the course and the **expectations**", "very thorough", "a good primer", "very impactful", "good to **lead by example**", "good to see how the **structure of a talk** should be set up… and how to **keep the audience engaged**."*

The revised curriculum integrated education and communications research with GT student values.

W1: Intro to Science Presentations
- (Sp25) Composed by faculty co-instructor
- Expectations, assignments, & learning outcomes
- Slide titles & composition basics [Doumont, 2012]
- (Sp25) Critiquing co-instructor's interview slides
- (Sp26) Storytelling in science

W2: Slide Design
- Applying the Backward Design process [Wiggins & McTighe, 2005] to short presentations
- Primer on multimedia learning [Mayer, 2020]
- Effects of medium on instructional graphic design
- 15-min activity: adapting premade graphics

W3: Presentation Workshop
- Flipped classroom day
- Iterate slides in groups
- (Sp25) Focus on "key slides"
  - Step 1 of Backward Design
  - Includes main takeaway(s)
- (Sp26) Focus on whole narrative

W4: Slide/Outline Critique
- Led by faculty co-instructor
- (Sp25) One "key slide"
- (Sp26) Presentation outline
- Brief public feedback
- Anonymized peer feedback
- Detailed instructor writeup

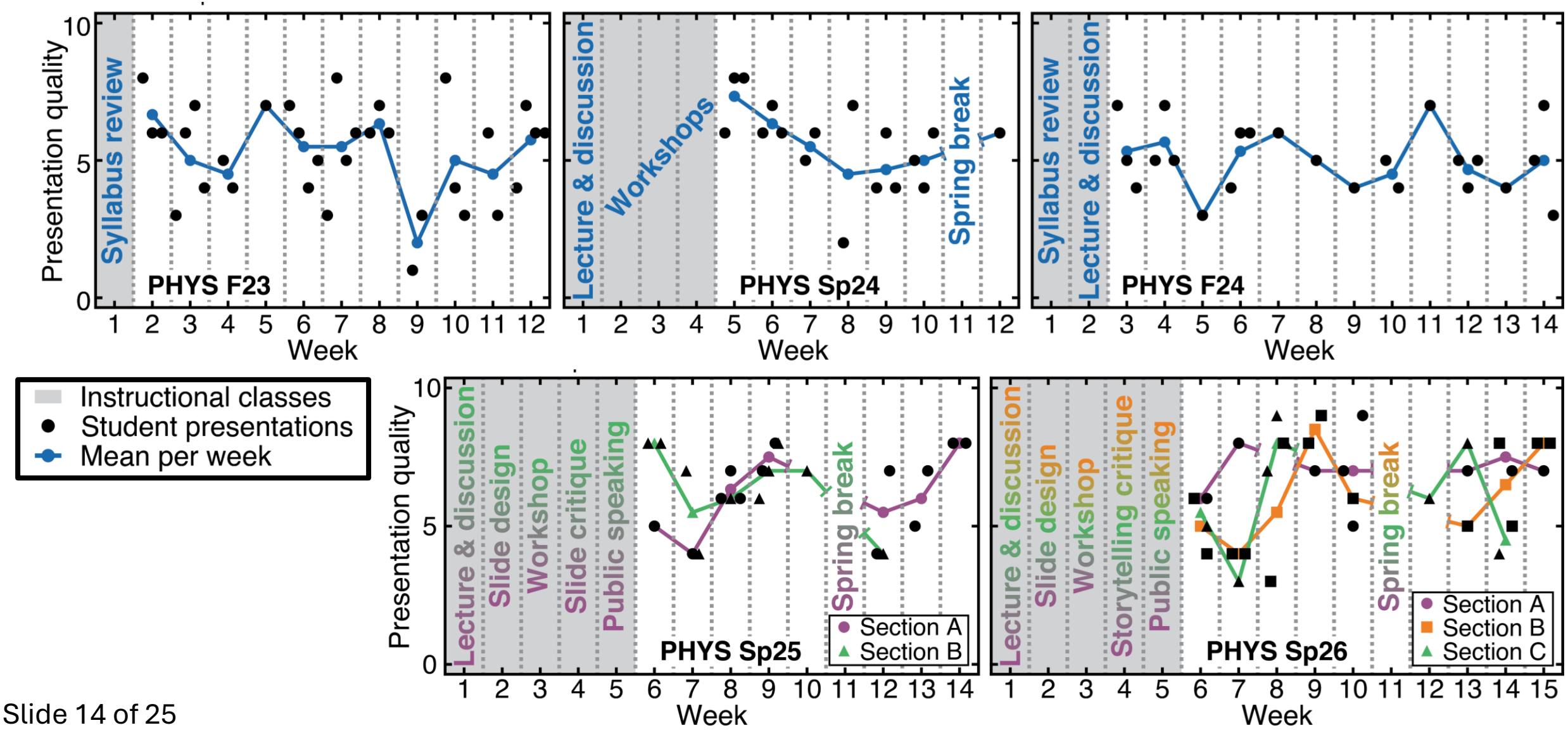
W5: Public Speaking
- Content organization
- (Non)verbal communication
- Managing anxiety
- 1-min challenge: Staying conversational under pressure
- Reflection activity

Students praised many aspects of research-based instruction but still saw room for improvement.

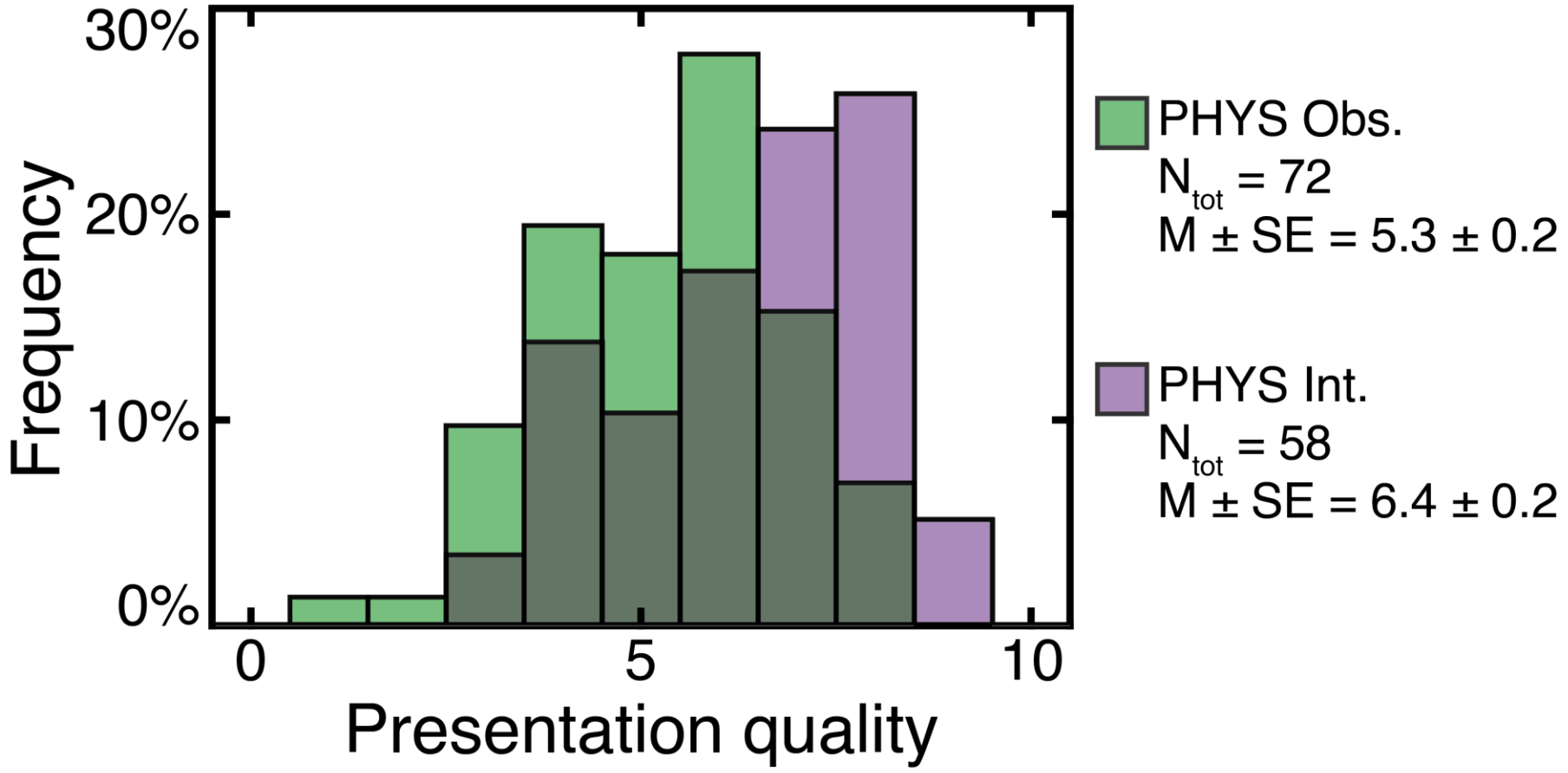
	W1: Intro		W2: Slides		W3: Workshop		W4: Critique		W5: Speech		Ambiguous	
Semester	Sp25	Sp26	Sp25	Sp26	Sp25	Sp26	Sp25	Sp26	Sp25	Sp26	Sp25	Sp26
Positive	1	11	9	9	4	4	1	0	5	2	5	8
Mixed	0	0	1	0	1	1	1	1	1	0	4	4
Negative	0	0	0	0	1	0	4	0	0	0	1	0

1. A new segment in Sp26 (< 20 min!) on **infusing technical communication with narrative structure** skyrocketed perceptions of the introductory lesson.
2. Students appreciated **learning** slide design **guidelines** (e.g., animations, text and graphic usage) and **practicing implementation** with the hands-on activity.
3. Students found the workshop **useful for building** their slides and getting **feedback**, though some felt it was too soon to focus on slide specifics.
4. Students were **frustrated** by critiquing one key slide because it led to **irrelevant feedback** built on **incorrect assumptions** about the broader presentation. Addressing criticisms in Sp26 using storytelling led to indifference.
5. Students embraced the speaking challenge as **initially scary but very helpful**. Some requested more feedback and exposure to further build confidence.

In Physics Seminar, presentation quality remained roughly constant throughout semesters regardless of intervention.

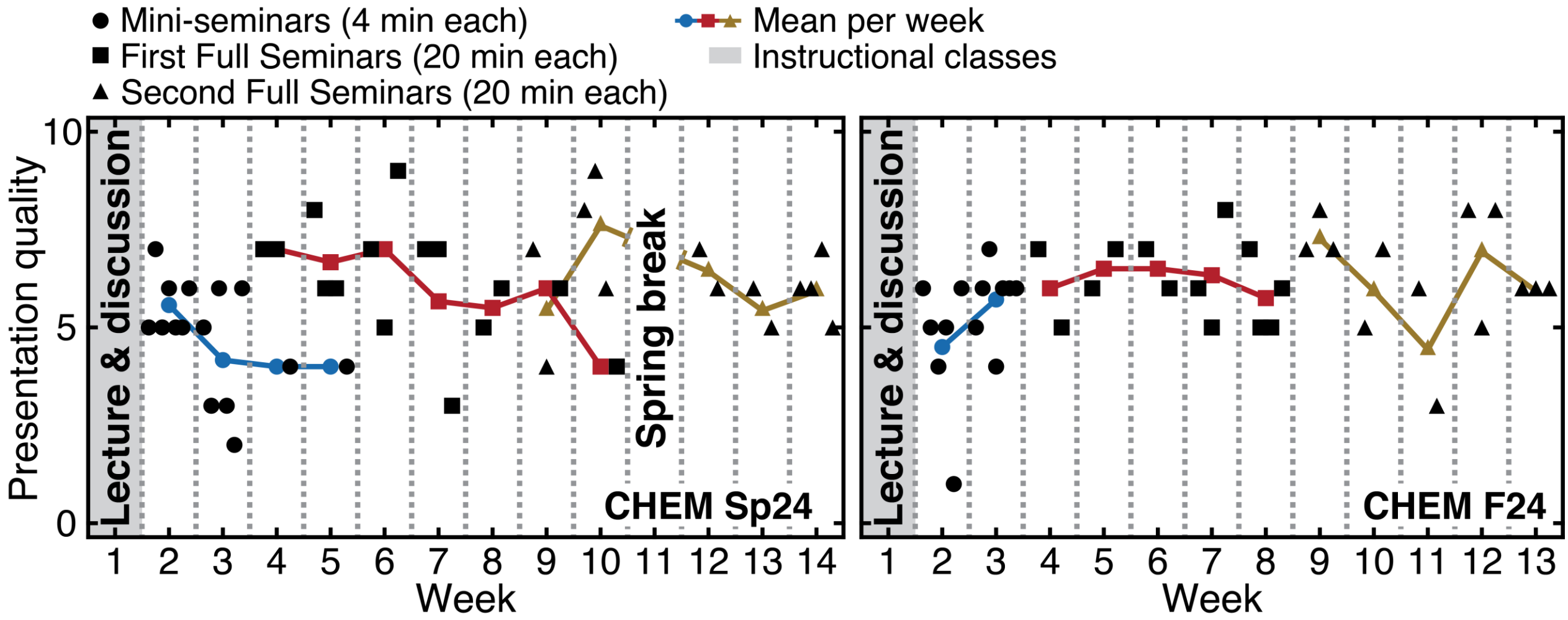


Research-based instruction helped Physics Seminar students significantly outperform earlier students.

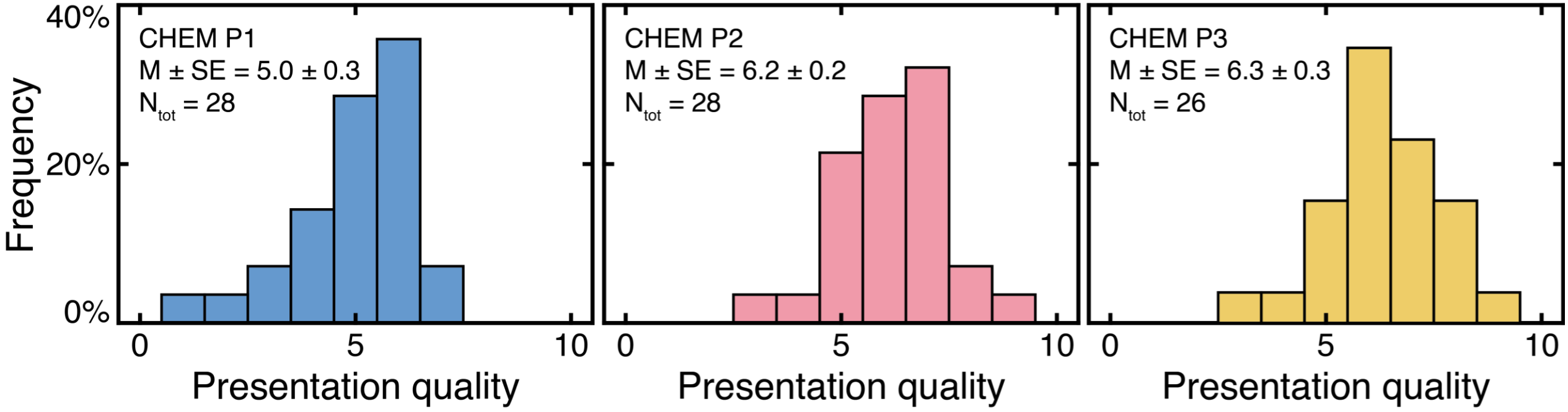


The new curriculum had a **medium-large effect size** on student presentation quality ($\delta = 0.39 \pm 0.09, p < 0.001$).

In Chemistry Seminar, presentation quality stays roughly constant per presentation type.

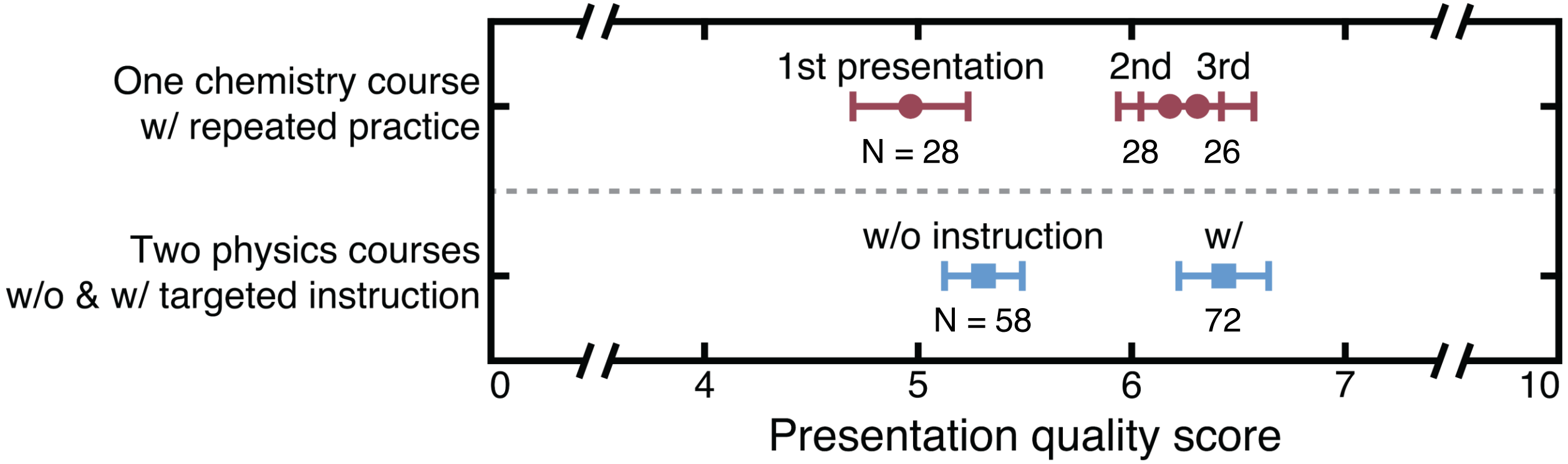


In Chemistry Seminar, student presentation quality improved significantly after the Mini-seminar.



Repeated practice had a **very large initial effect size,** $(r_C = 0.84, [0.54, 1.00], \quad p < 0.01)$
but no significant effect afterward. $(r_C = 0.02, [-0.49, 0.54], \; p = 0.48)$

There are a variety of methods that teachers can use to help significantly improve student presentation skills.



Research-based instruction in Physics Seminar helped students deliver presentations with **comparable quality** to those by students with **multiple rounds of practice & feedback** in Chemistry Seminar.

Instructional frequency alone does not account for which principles increased in usage.

- Increased presentation quality suggests increased usage of **individual CTML principles.**
- Though never explicitly "CTML," **preplanned instruction often aligned** with specific principles.
- Whether observing changes in individual students or changes between curricula, **frequency of instruction does not explain** changes in student usage of **specific principles.**

Chemistry Seminar (within semesters)		**Frequency of students' use**		
		Increased	Same	Decreased
Instruction per principle	Any	1	4	0
	None	2	2	1

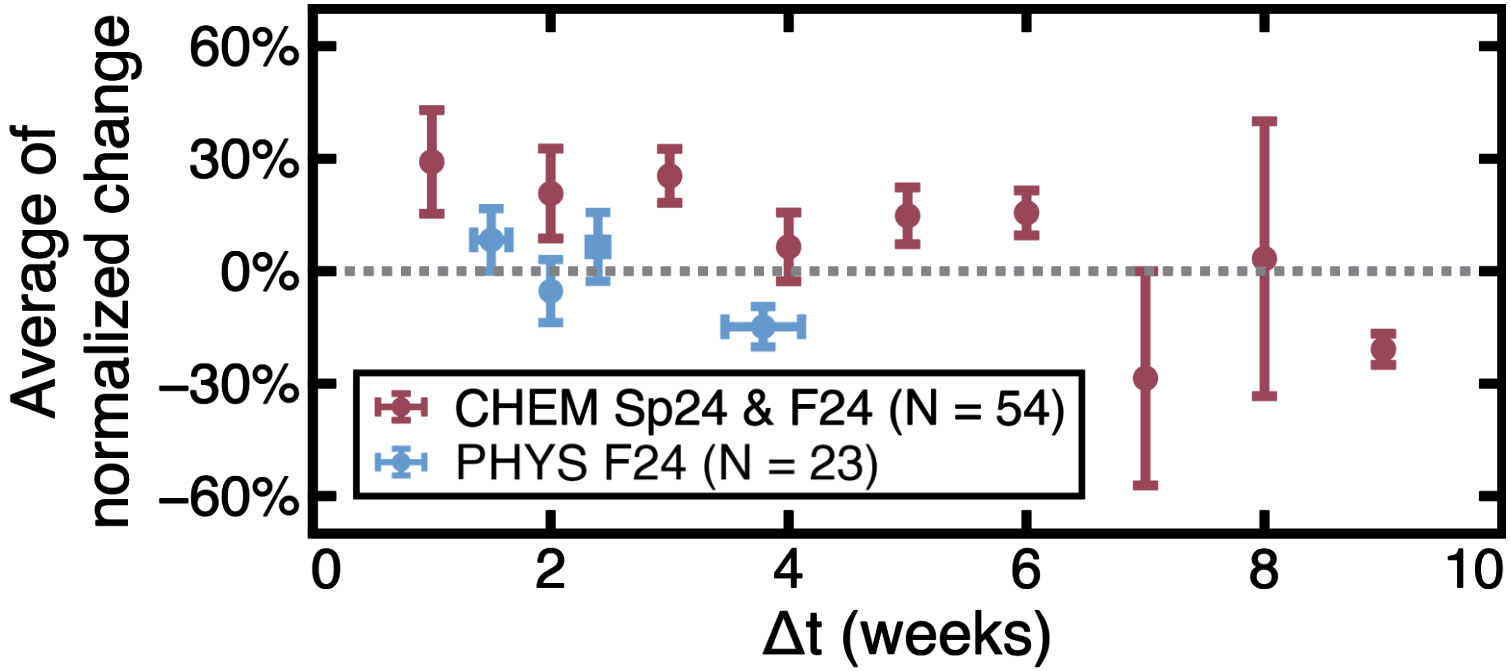
Physics Seminar (between semesters)		**Frequency of students' use**		
		Increased	Same	Decreased
Instruction per principle	Increased	2	4	1
	Same (none)	1	2	0

Random assignment of presentation dates may disadvantage students who receive large gaps between presentations.

- (CHEM Seminar) Personal growth between presentations **decreases** with **preparation time.**

- (PHYS Seminar F24) Recorded presentation redo **due within 2 weeks** of in-class presentation
  - Often minimal change in quality
  - Inconclusive trend in time

- Model fit may **improve by including** elements of personalized **feedback.**



$$\text{Normalized change} = \begin{cases} \dfrac{\text{post} - \text{pre}}{100\% - \text{pre}}; & \text{post} > \text{pre} \\ \dfrac{\text{post} - \text{pre}}{\text{pre}}; & \text{post} < \text{pre} \\ \text{omit the data}; & \text{post} = \text{pre} = 100\% \text{ or } 0\% \end{cases}$$

Marx & Cummings, *Am. J. Phys.* (2007)

Audience achievement of presenter's learning goals is a tangible measure of communication "success."

- (PHYS Seminar)
  Presenters submitted questions an attentive audience member could answer, which we compiled into **daily quizzes** for attendance.
  - **Grading scheme for research only:** No attempt (0), fully incorrect (0), partially correct (0.5), fully correct (1)

- Expected results provide sanity check for study protocol.
  - Higher scores with two types of **prior exposure**
  - Higher scores for **last presentations per day**

Category	**Subgroup**	N_a	***M*±*SE***	**Sig. level**
Prior exposure (before Seminar)	No exposure	1481	0.40±0.01	$p < 0.001$
	Any exposure	1234	0.51±0.01	
Workshopped with speaker	Never	1290	0.44±0.01	$p < 0.01$
	At least once	199	0.53±0.03	

Category	**Subgroup**	N_a	***M*±*SE***	**Sig. level**
Presentations left until quiz	3	104	0.39±0.04	$p < 0.01$
	2	610	0.40±0.02	
	1	831	0.48±0.01	
	0	889	0.48±0.01	

Research environments may explain substantial differences in effects of CTML principles on quizzes.

- Of the eight CTML principles without overwhelming usage bias:
  - Four had much smaller significant effects,
  - Three had much smaller insignificant effects,
  - One had a **significant, reversed** effect.

- CTML studies **rarely** occurred **in the classroom.**
  - Prerecorded, **heavily scripted** presentations
  - Presentations **under 2 min;** 8–10 s per slide
  - Psychology **Subject Pool** at UCSB

Muted ($p < 0.05$):
- Personalization (36% expected effect size)
- Temporal Contiguity (15%)
- Signaling (10%)
- Coherence (8%)

Silenced ($p > 0.05$):
- Embodiment (10%)
- Spatial Contiguity (7%)
- Modality (3%)

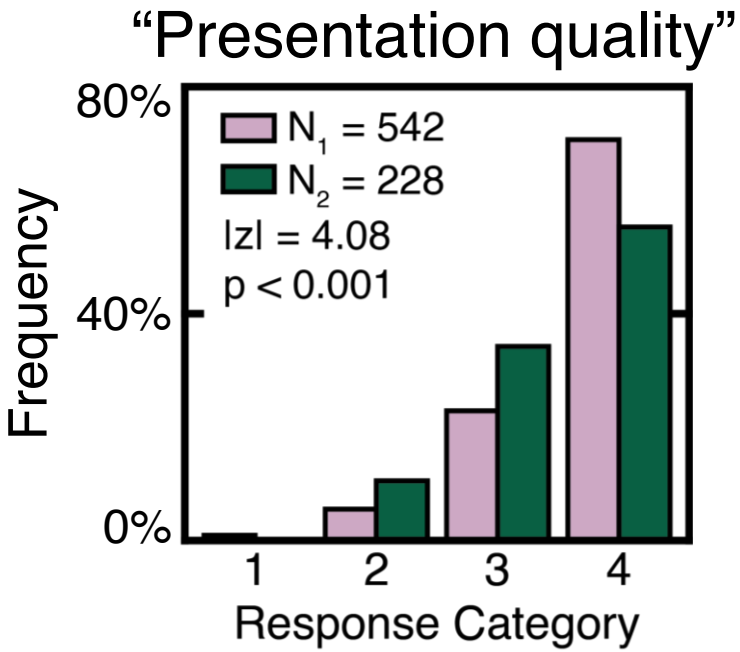
Reversed ($p < 0.05$ & negative effect):
- Redundancy (–25%)

Hypothesis: Seminar-style sessions provide **high intrinsic cognitive load**, which **dulls** the effects of **CTML** on learning and turns **redundancy into reinforcement** rather than the expected extraneous cognitive load.

Joint peer evaluation and reflection activities failed to affect learning outcomes.

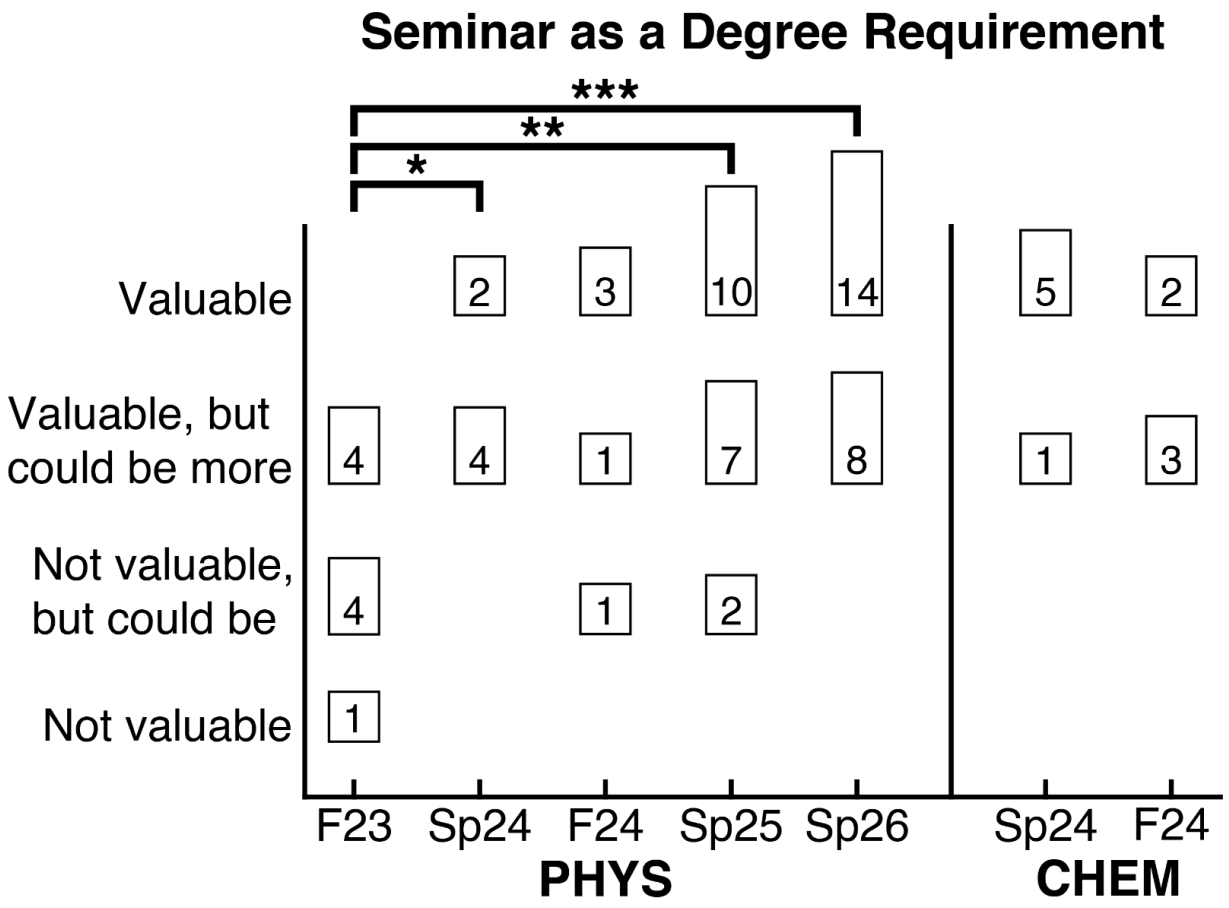
- Randomly distributed forms, each with multiple-choice and free-response questions updated every other semester
  - **Treatment:** reflection activity [Girard et al., 2011]
  - **Control:** assess engagement; distract from reflection

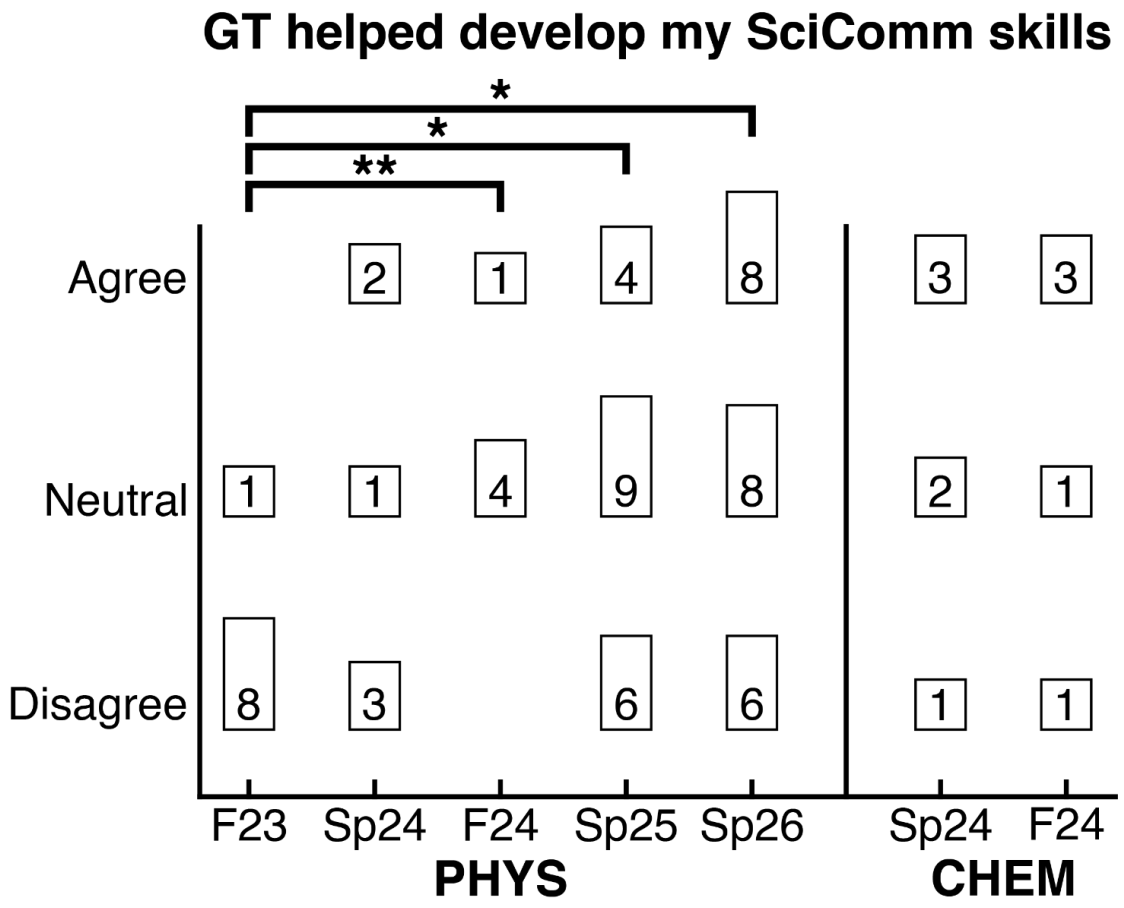
- Largely dysfunctional aside from provoking attention with an attendance grade.
  - Quantitative responses fail from **social desirability bias** and high **sensitivity to category labels.**
  - Qualitative responses regularly perceived as **non-actionable platitudes regardless of prompt.**
  - **No clear correlations** with content learned or quality of subsequent presentation.



Resp. Cat.	Version 1	Version 2
1	Needs improvement	Clear opportunity for substantial improvement
2	Just okay	Fair
3	Good	Good
4	Excellent	Very impressive

Revising Physics Seminar had cascading positive effects on students' beliefs about their time at Georgia Tech as a whole.





$$^{*}p < 0.05;\ ^{**}p < 0.01;\ ^{***}p < 0.001$$

Would you ask your students to compute the currents in a circuit without teaching them Kirchhoff's Rules?

- **Oral presentations** (often without deliberate instruction) are ubiquitous as summative end-of-term assessments in science courses and are **likely soon to skyrocket in usage.**

- **Established presentation norms** facilitate significantly **less learning** in seminar-style/conference-style environments and sometimes even hinder learning.

- **Peer observations, reflections, and feedback are wholly insufficient** at enabling student growth into skilled presenters or audience members.

- Multiple rounds of practice and feedback are not always feasible. **Research-based pedagogy closes the gap,** and in less time!

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For group information,
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