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Peer-Led Team Learning (PLTL): Effect on student performance, student talk during sessions, and peer-leader facilitation

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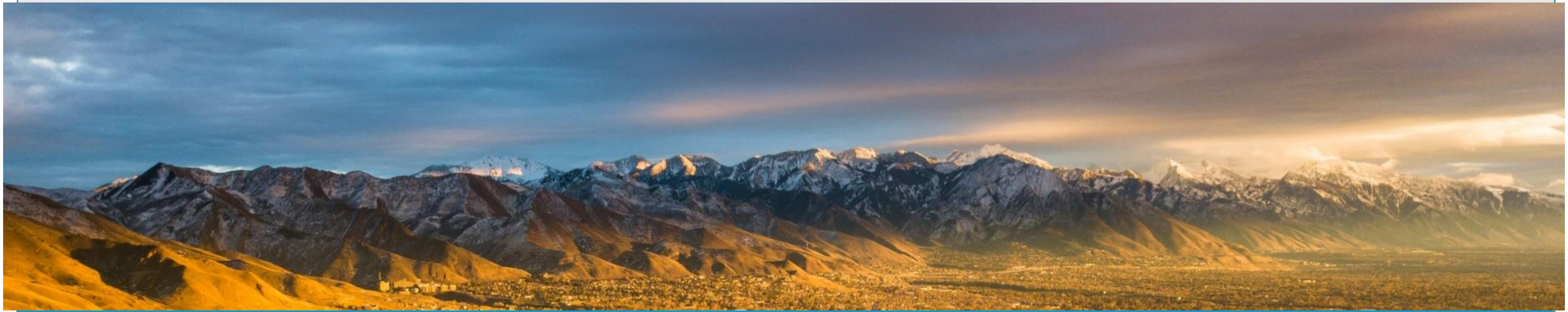


Peer-led Team Learning (PLTL) Program

Why Are We Using PLTL?

Effectively use group study

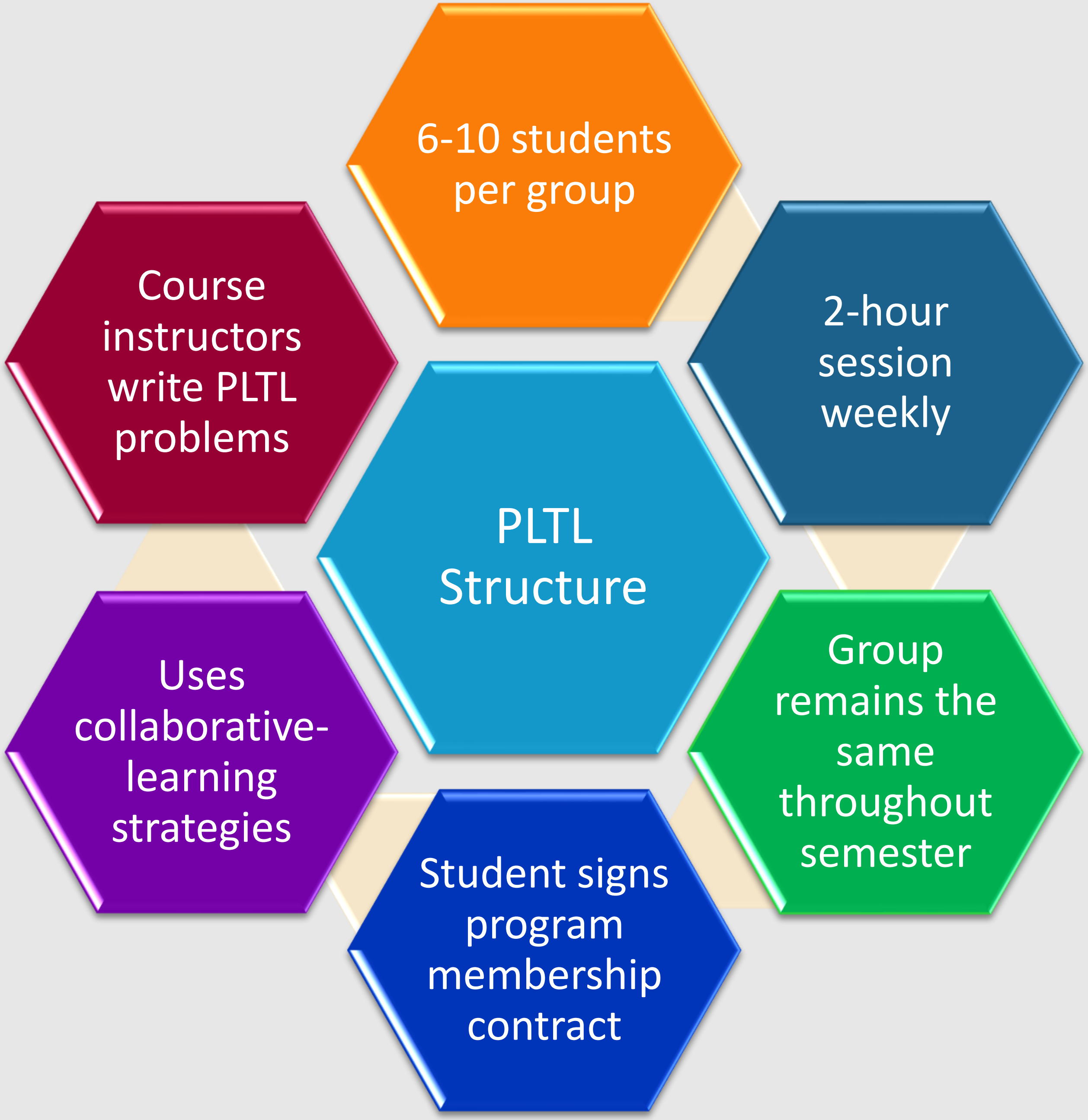
Improve problem-solving skills

Active-Learning Environment

Improve professional skills

Overview

- PLTL has been implemented in many STEM undergraduate disciplines (e.g., biology, chemistry, mathematics, physics, psychology, and computer science), and some graduate studies
- PLTL has been implemented in varying institution types (e.g., two-year, four year liberal-arts, regional institutions, R-1 institutions; private and public)
- PLTL approach has been associated with gains in learning (e.g., course performance and retention, and DWF rates) and promoting positive student affect (e.g., motivation and attitude)


6-10 students per group
Course instructors write PLTL problems
2-hour session weekly
PLTL Structure
Uses collaborative-learning strategies
Group remains the same throughout semester
Student signs program membership contract

PLTL Membership Contract

As a member of a PLTL study group, I agree to:

- Attend every meeting
- Arrive prepared for meetings
- Be willing to study cooperatively in a group
- Participate in new activities with an open mind
- Inform my group leader ahead of time if I must be absent
    - I understand that, if it is necessary, I will be allowed two excused absences and that more than two absences will end my involvement in the PLTL study group
- Not discuss PLTL problems outside of my PLTL group before 9 p.m. on Sunday night


Not remedial
Develops student learning community
Supplements course instruction
PLTL Philosophy
Uses collaborative -learning strategies
Peer leader only facilitates
No answer key

PLTL Materials

- Carefully designed by instructor to reinforce and deepen understanding of concepts from lecture

- Proceed through challenging concept questions as a group
  - Challenging enough to benefit from groups
  - Increase in difficulty through session
  - Ask students to think in different ways: graphically, quantitatively, descriptively
  - Emphasis on logic processes
  - Group-consensus answers put on board

Current PLTL Problem Set Design

Student-driven review of week's topics, concepts, relationships

↓

Warm-up conceptual questions

↓

Warm-up problem-solving questions

↓

Challenging questions


Not an Expert
Coach (not a tutor or teaching assistant)
Responsible for the Process
Peer Leader Role
Student Role Model
Encourages Problem Discussion
Sets the tone for the Session

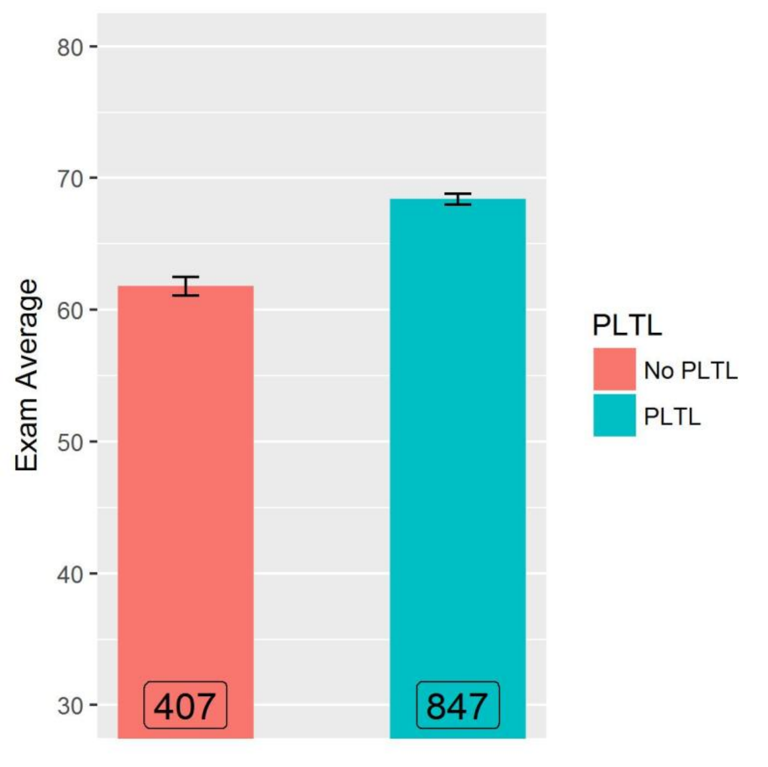
Collaborative Learning Techniques

Activity	Key Idea
Small group/Large group	• Students work in groups of 2-3 • Then present and discuss their work as a whole group
Round Robin	• Entire group works together • Each student provides one piece of information
Recorder	• One student is recorder • Group tells the student what to write • The group must clearly communicate their ideas.

Evaluation of PLTL in General Chemistry 1

Reference: Frey, R. F., Fink, A., Cahill, M. J., McDaniel, M. A., & Solomon, E. D. (2018). Peer-led team learning in general chemistry I: Interactions with identity, academic preparation, and a course-based intervention. *Journal of Chemical Education*, *95*(12), 2103-2113.

PLTL improves performance 2012-1016

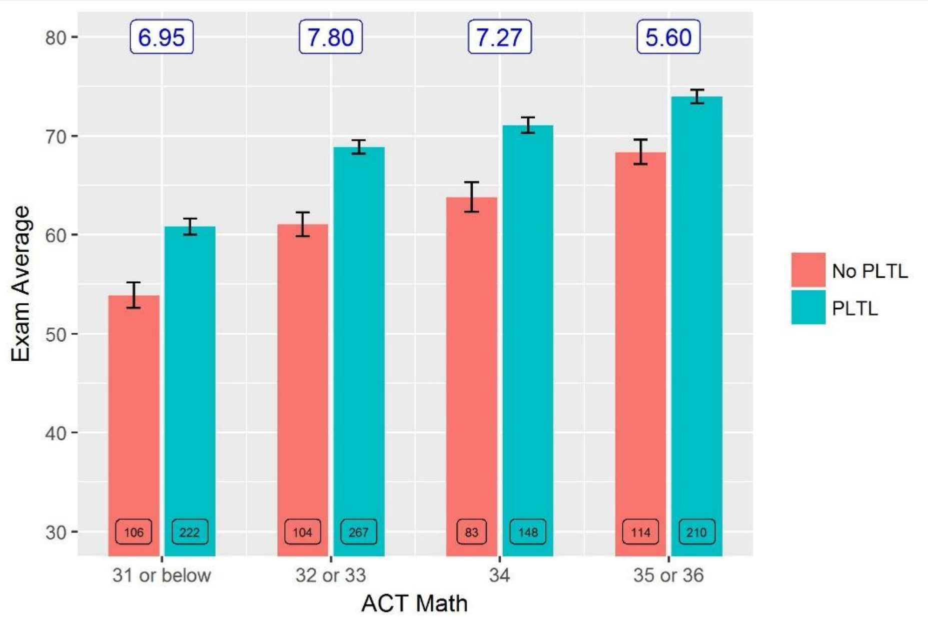


Note: showing unadjusted exam means

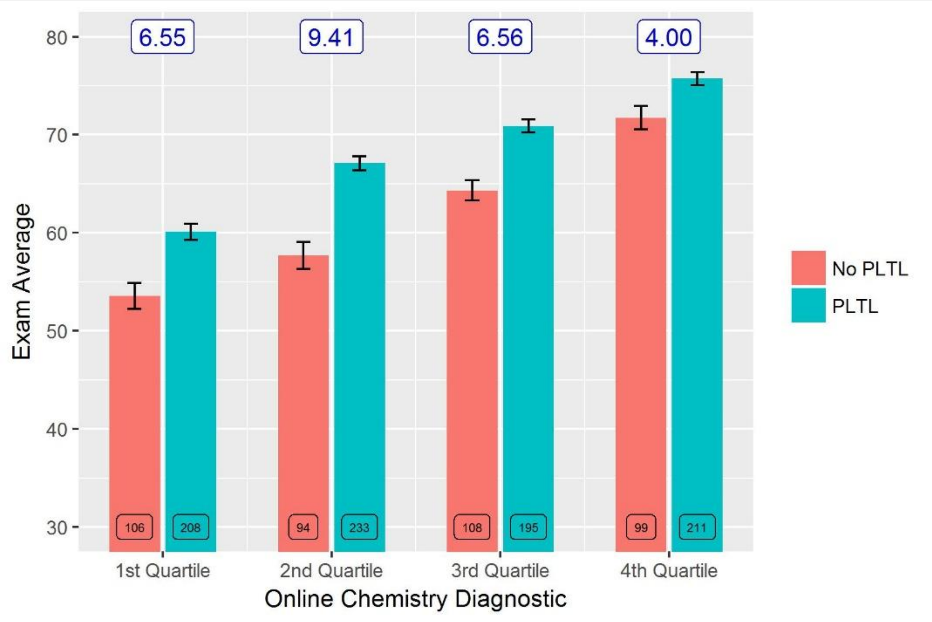
- Difference in Exam averages for PLTL and no PLTL is approximately 6.6 percentage points and is significant.
- Calculations take into account AP STEM, ACT math, and the prior chemistry-knowledge diagnostic exam.

PLTL Improves Performance of Students with Different ACT Math or Incoming Chemistry Knowledge Equally

PLTL Effect Grouped by ACT Math



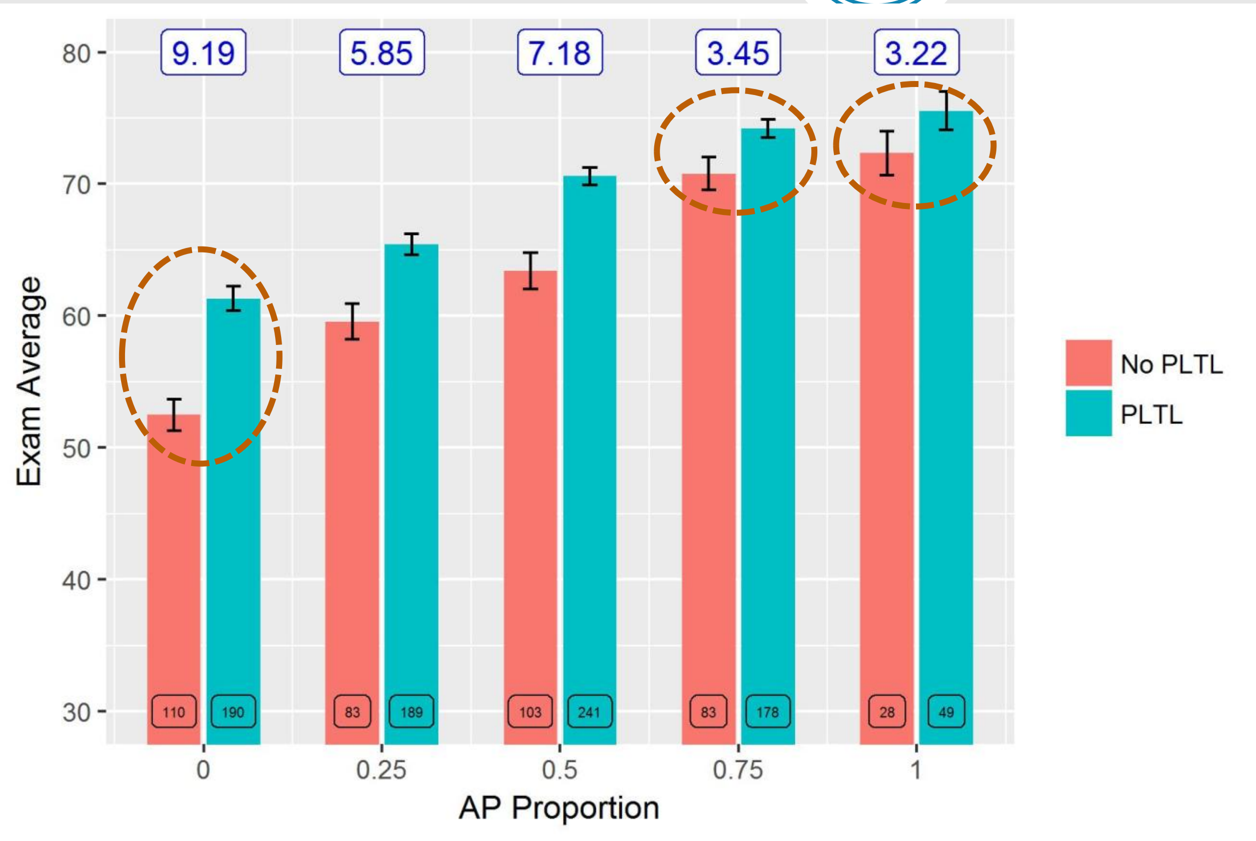
PLTL Effect Grouped by Incoming Chemistry Knowledge



- Differences in Exam averages for PLTL and no PLTL across ACT Math Quartiles and across Chemistry Diagnostics Quartiles are approximately 7 percentage points and are significant.

PLTL benefits do not differ significantly across levels of incoming math or chemistry knowledge

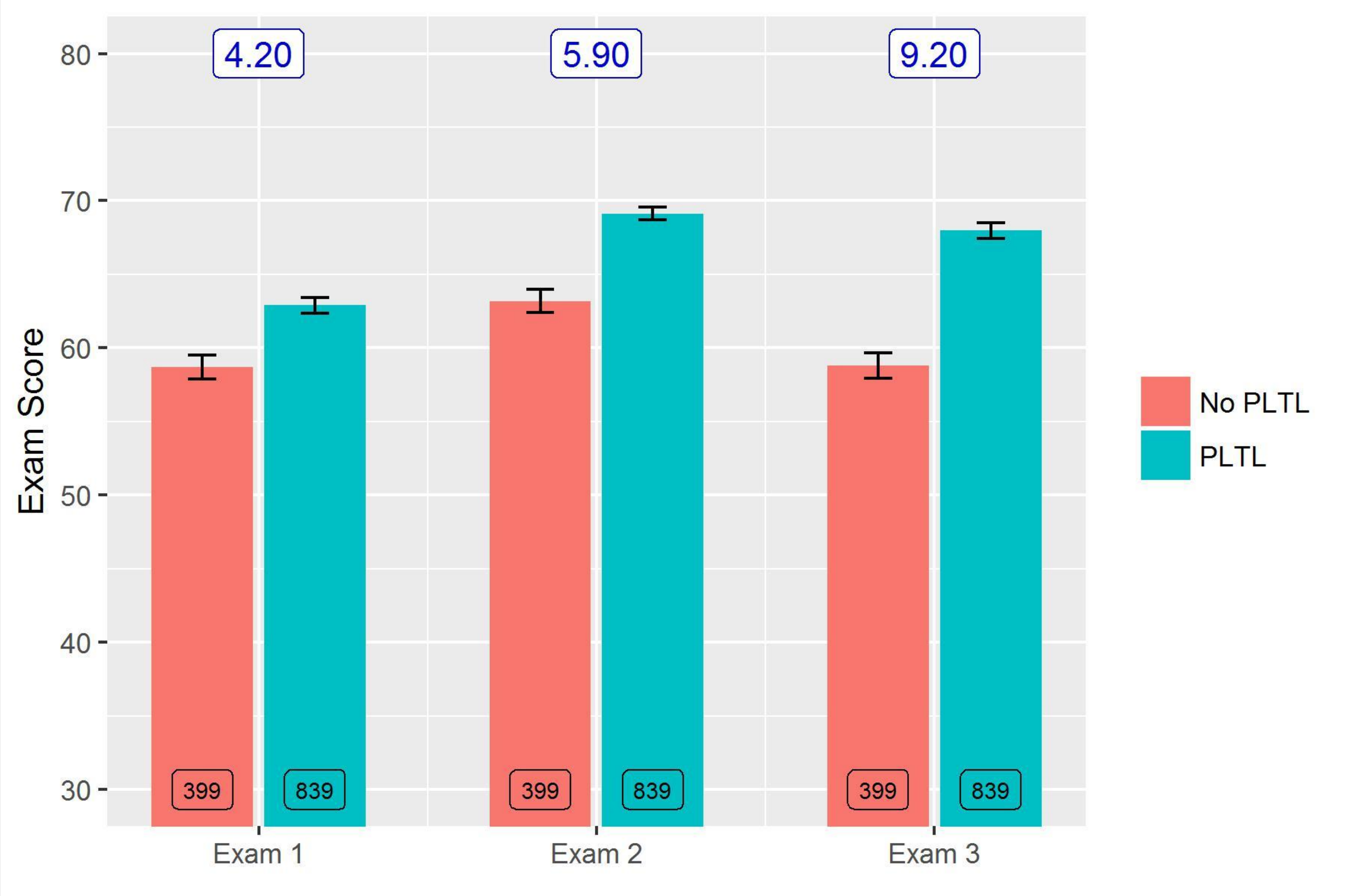
PLTL improves performance of students with lower AP STEM more than higher AP STEM scores



Benefits especially pronounced for students with no AP STEM experience

- Difference in Exam averages for PLTL and no PLTL across AP STEM is significant
- Interaction is significant. That is, PLTL improves students with lower AP STEM scores more than students with higher AP STEM scores.

PLTL Benefit on Exam Performance Grows Across the Semester



How do students talk while solving the problems?

Reference: Repice, M. D., Sawyer, R. K., Hogrebe, M. C., Brown, P. L., Luesse, S. B., Gealy, D. J., & Frey, R. F. (2016). Talking through the problems: A study of discourse in peer-led small groups. *Chemistry Education Research and Practice*, *17*(3), 555-568.

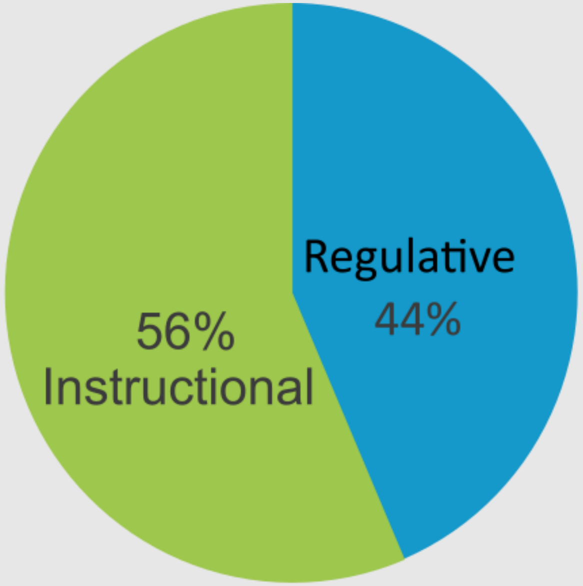
Primary Discourse Categories

Regulative – language that works to:

- Establish behaviors among participants
- Promote discussion
- Keep students on task and moving through problems
- Create community

Instructional – language that contains chemistry content and works to:

- Exchange factual information
- Make procedural suggestions about problem solving
- Explain concepts behind questions
- Question the group



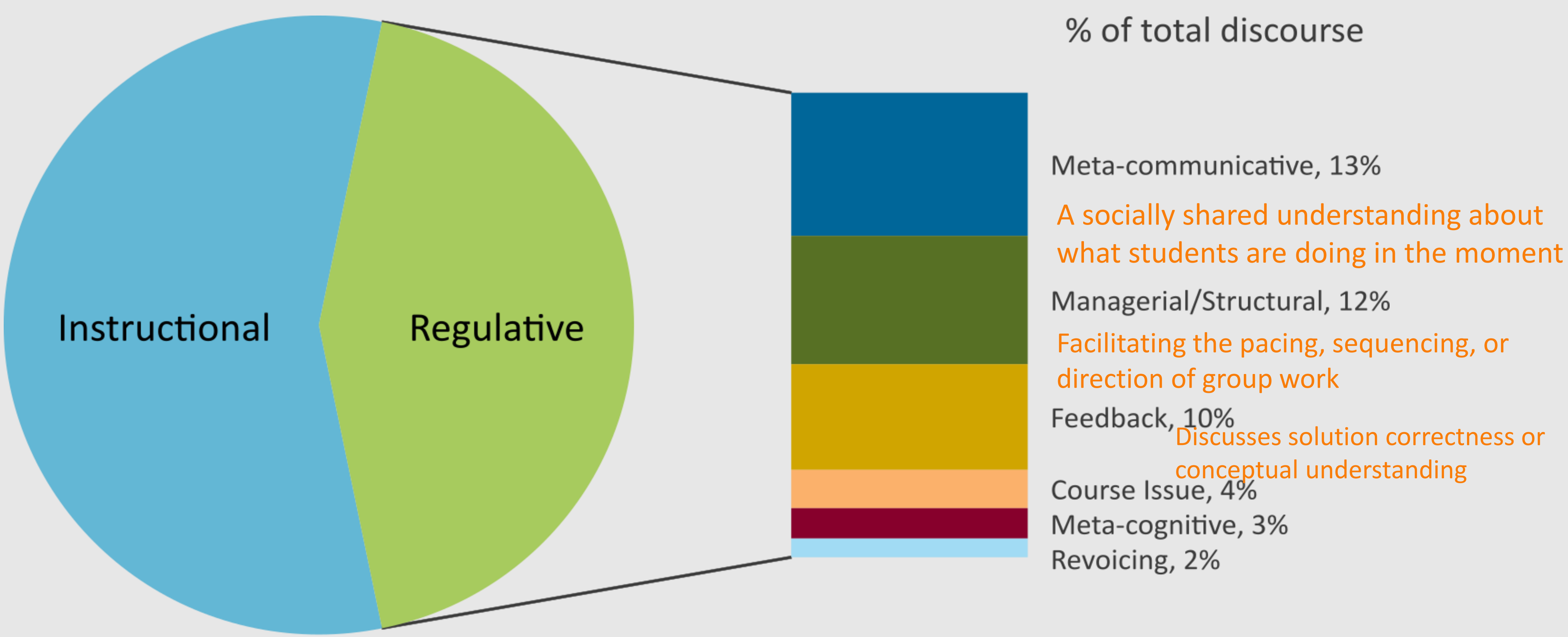


Figure 3: Breakdown of Regulative Discourse Codes

Meta-Communicative example of a student saying what they are doing (from the calculational problem):

F4: *Ep* minus the work function. So *7.92 x 10-19* minus *6.6 x 10-19* joules. And those are all joules. What did you get for *Ep*?

F2: Did you get *92* or *95*?

F4: I didn't do it. I will though. I just like to get everything [written] down.

Managerial/structural example of students working together to make decisions about next steps (from the model-building problem):

F2: *We can do one with some lone pairs, or something.*
F4: *Can you pass me more of the toothpicks?*
PL: Yeah. That enough?
F4: *Thank you. All right. Yeah, that should be cool.*
F3: *Trigonal bipyramidal?*
F4: *All right, which one do we want to do? We have to do one of the … Should we do, like, the see saw?*
F3: *Sure.*

Finding 1

Students use regulative language in groups to promote discussion, exchange information, and manage their own learning and that of their peer group members.

Students facilitate group learning by:

- Pacing, sequencing, and keeping the group on track
- Forming a community of learners
- Commenting on learning process (metacognition)

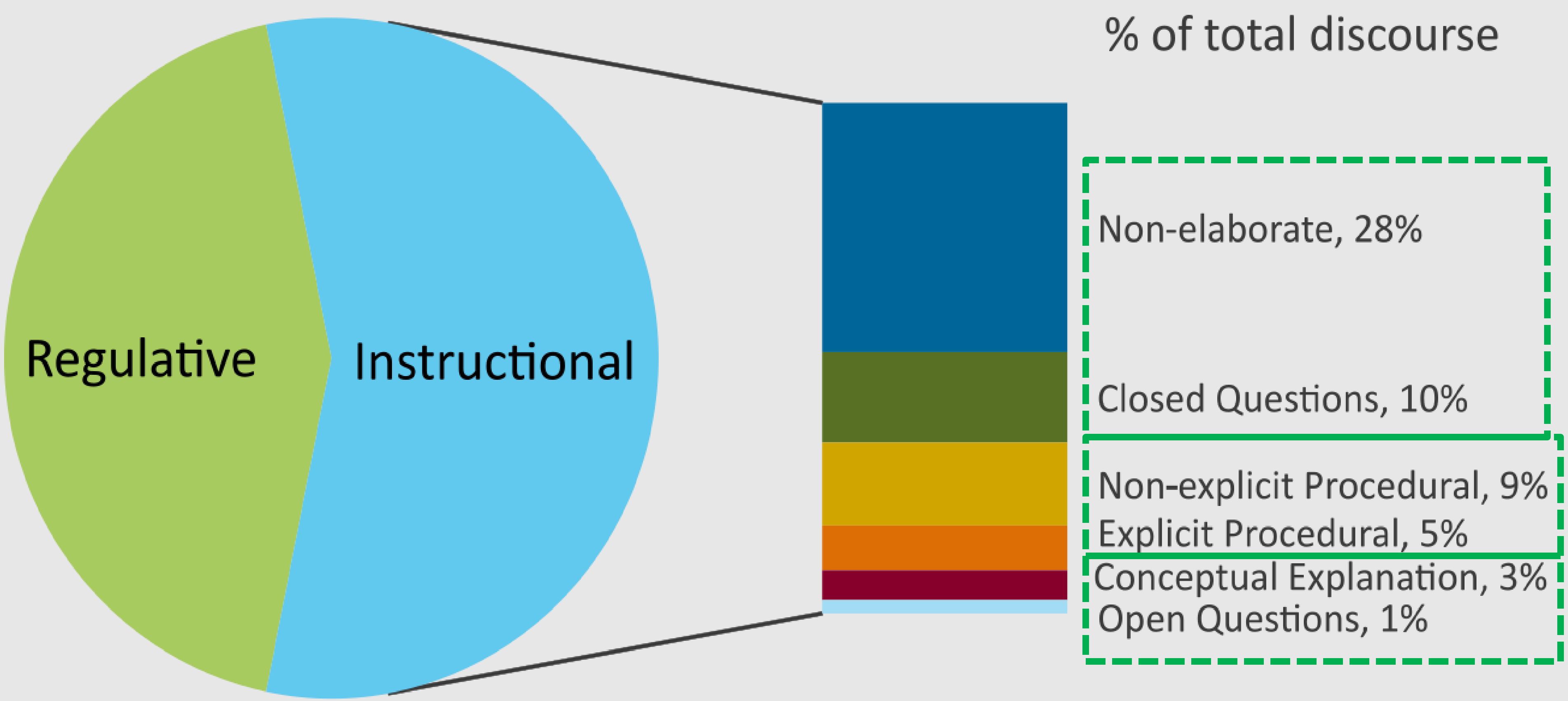


Figure 4: Breakdown of Instructional Discourse Codes

Non-explicit procedural example of students building on one another's explanation (from the calculational problem):

F3: But we want it to be ejected right? So we want to set those two equal to each other.
We don't know E.

F2: *But if we find E.*
We could find it. They give you wavelength.

F3: *They give you wavelength and the work function, and then we can find the other kind of wavelength.*

Finding 2

Student instructional discourse patterns suggest that participants in small peer-led learning groups practice “talking science” to each other in ways that reveal the development of a shared understanding of chemistry knowledge and vocabulary.

“Talking Science” looked like:

- Fact-based comments and questions
- Gathering and exchanging information needed to solve the problems

Finding 3

Students communicate in ways that reveal a focus on the *process* of complex problem-solving to move through the problems together.

Procedural language showed:

- Development of problem-solving process skills
- Turn-taking behavior and joint decision making

Open-question example of students leading to conceptual explanation (from the data analysis problem):

F4: But here, they have the same number of electrons, 'cause this has two extra and this has one extra. So, we have to figure out which one's gonna be smaller.

F4: *This has two extra things added to it. This has more protons, right. So I would think, that F would be smaller*, I don't know if it's right, but that's what I'm guessing. Meg, what do you think?

F3: That's what I was thinking too.

M6: Why?

F4: *Because there are more protons to pull in the same number of electrons.*

M6: Oh.

F4: *Because, adding two to this and adding one to this gives them the same number of electrons, but this still has one more proton.*

F3: *So then all that matters is the positive charge in the middle. Whichever one's stronger is gonna pull them in tighter.*

Finding 4

Students engaged in little of the deeper meaning-making discourse, but an identifiable pattern emerged between open questions and conceptual explanations, suggesting that more open prompting by students may encourage deeper conceptual understanding.

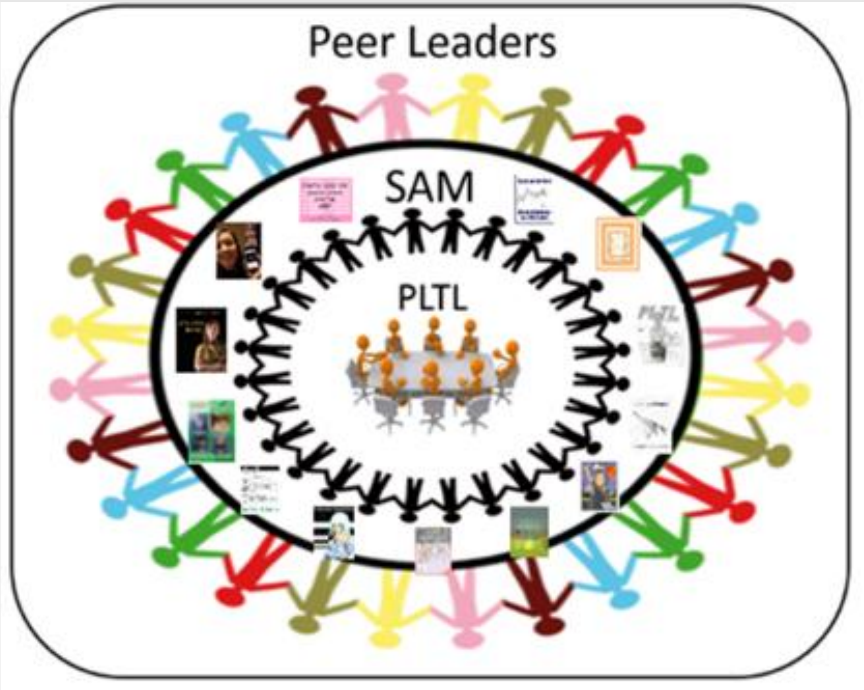
Why so little?

- Students rarely explained concepts without prompting from other students or peer leaders

Implications of Collaborative Group Work

- Students develop social and communicative skills in an academic setting
- Students engage in the process of solving complex problems – not just getting the right answer
- Students discuss ideas and practice disciplinary ways of thinking and talking - the small-group setting provided a social space to build a science vocabulary and practice communicating in the language of the course.
- Students develop skills to monitor and learn about their own learning

What do Peer Leaders say about leading groups effectively?



Reference: Szteinberg, G., Repice, M. D., Hendrick, C., Meyerink, S., & Frey, R. F. (2020). Peer leader reflections on promoting discussion in peer group-learning sessions: Reflective and practiced advice through collaborative annual peer-advice books. *CBE—Life Sciences Education*, *19*(1), ar2.

Finding 1 – Setting the Stage (Environment) for effective Problem-solving discussions

- Setting the stage for effective problem-solving discussions in collaborative peer groups by creating a social and intellectual environment that is community-oriented, positive, and conducive for risk-taking.

Category	Sub-category
Leader Attitude	Show positivity
	Prepare for session
	Display professionalism
	Show confidence
Social Environment	Develop community
	Communicate with students
	Know your students
Physical Environment	Bring food
	Arrange space
Group Expectations	Introduce PLTL philosophy

Finding 2 – Groups that work:

- Peer leaders reported on promoting positive collaborative group functioning and full participation by knowing their students, monitoring group interaction unobtrusively, and using strategies to ensure participation in discussion.

Category	Sub-category
Group Functioning	Use strategic grouping
	Actively Monitor
	Remind about philosophy
Balancing Personalities	Reign in dominant students
	Encourage quiet students
	Strategically pair students
Promoting Equal Participation	Call on students
	Use turn-taking
	Get students talking

Finding 3 – Facilitating learning:

- Peer leaders reported they keep students moving forward together encouraging collaborative knowledge building without giving answers by pacing sessions and questioning strategies and changing-up the session structure.

Category	Sub-category
Pacing Sessions	Move together
	Take breaks
	Move forward
	Get back on track
	Use wait time
Questioning Strategically	Use redirection
	Guide via questions
	Encourage student explanations
Motivating Student Learning	Promote preparation
	Provide incentives
Structuring Sessions	Add variety
	Vary working order
	Review material
Promoting Group Independence	Allow student struggle
	Encourage self-reliance

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Questions/Comments?