

Please Sit at Your Group C Tables

**You will want one question/problem/lesson
from your course to consider during this
workshop**



Building and Leveraging Your Specialized Teaching Expertise

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#2026BLC

The Developing Knowledge Project

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Thanks to our research
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Introduction

What is teaching knowledge and how do we study it?



Application

Exploring generalizable teaching knowledge



Application

Exploring topic-specific teaching knowledge



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GEORGIA

Agenda

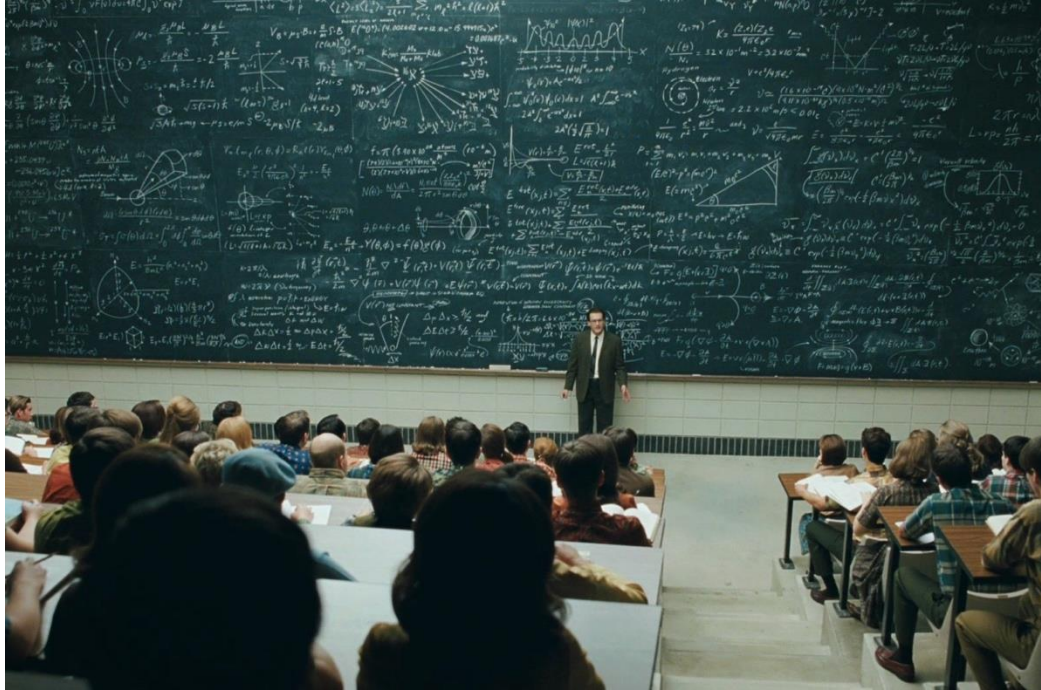


Instructional Practices

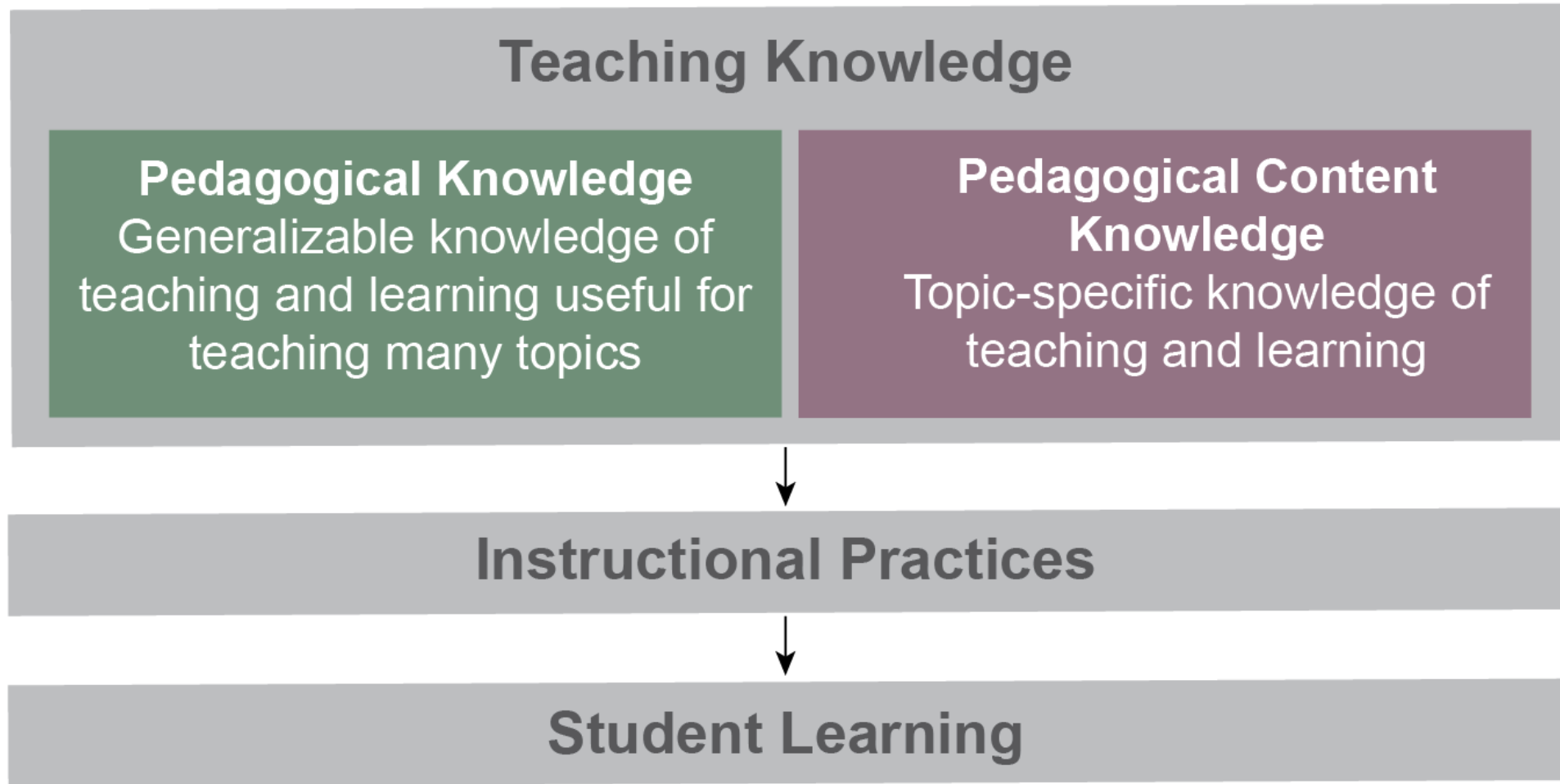


Student Learning

What knowledge DO college instructors need?

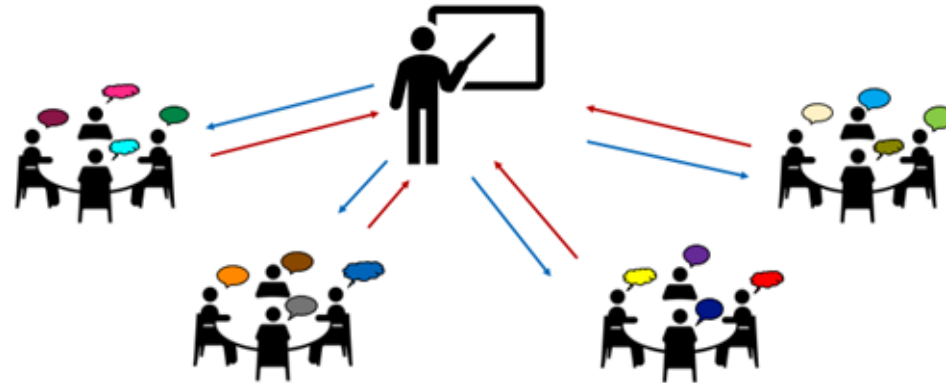


Can you recall a professor who had impressive disciplinary expertise... but was not successful in helping you learn?



The active-learning classroom:

A unique test for an instructor's **pedagogical knowledge (PK)** and **pedagogical content knowledge (PCK)**



How we study teacher knowledge

Study 1: Participants analyze videos of real classrooms



What was effective and why do you think it was effective?

What needs improved and why?
How would you do it differently?

Expert active-learning instructors were more likely than novices to consider...

- if lessons engaged students in generative work & monitored student thinking (**PK**)
- if lessons targeted anticipated student difficulties (**PCK**)

Study 2: In-depth study of teaching knowledge used while...

1. **Planning:** pre-lesson interview (semi-structured)



2. **Enacting:** video-recorded target lesson



3. **Reflecting:** post-lesson interview (semi-structured + stimulated recall)



Compared to active instructors, generative instructors...

- Drew on **PK** to teach lessons that focused on **students generating reasoning**
- Integrated **PK** and **PCK** to design lessons to **target common difficulties**

Study 3: Longitudinal study of knowledge development

Participants (N = 11, with 40 semesters of data total)

- Early-career life science instructors
- Large (>50 students) courses using active-learning

Data Collection:

- Same in-depth elicitation of **PK** & **PCK** via interviews **over 2-7 terms**

Data Analysis:

- Qualitative content analysis of interviews to identify and characterize knowledge.
- Rubrics to quantify knowledge for comparison across time.
- Systematic analysis of teaching practices from video.



Study 4: National study of teacher knowledge and student learning



Teaching knowledge



Instructional Practices



Student learning

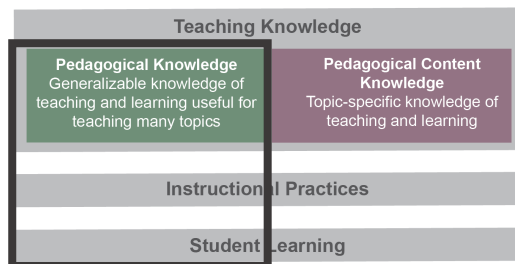
Same **in-depth interviews** and analysis as prior work, N = **57 introductory biology instructors** around the US using active learning in large classes

Systematic analysis of classroom video-recordings

Pre/post-test using research-based concept inventories to determine **how much students learned** about a subset of topics

Exploring Pedagogical Knowledge (PK)

Generalizable knowledge about teaching and learning that is useful for teaching many topics



Pedagogical Knowledge

Generalizable knowledge of teaching and learning useful for teaching many topics

Monitoring thinking

Ideas and reasoning about eliciting student thinking during class

How people learn

Ideas and reasoning about the experiences that foster learning

I prefer that they work on them together with other students because it generates more outward expression of what you are thinking. So, the students, rather than just being an internal dialogue with yourself, as far as what you're doing, when they're working in groups, they have to explain to each other what they're thinking, bounce ideas off of each other.

Allows instructors design tasks that foster learning and implement them in a way that maintains learning opportunities

	Mode	Student behavior	Learning outcomes
GENERATIVE	Interactive	Two or more learners discuss and substantively respond to one another to generate outputs that go beyond the information that has been presented in instructional materials (e.g., explain rationale to peers during group work)	Deepest understanding, potential to innovate new ideas, interpretations, products.
	Constructive	Learners individually generate outputs that go beyond the information that has been presented in instructional materials (e.g., write or draw a representation of one's reasoning)	Deep understanding, potential for transfer to new contexts
NON-GENERATIVE	Active	Learners recall information and/or make physical manipulations without adding new knowledge (e.g., taking verbatim notes, recall questions)	Shallow understanding, potential for transfer to very similar contexts
	Passive	Learners receive information (e.g., listening to explanations)	Minimal understanding, potential for knowledge recalled verbatim and in identical context

ICAP Framework



Task 1: How might an instructor's PK about how people learn influence their design and implementation of in-class activities?

If you prefer a virtual copy of the handout, you can access it here. Make a copy of the google doc and save to your own drive.



See the handout.



What intellectual work is described as facilitating learning?

“Students are all coming with different strengths as far as biology and that stuff goes. So, by giving them a chance to talk to each other, the ones that have more advanced prior knowledge are able to help those other folks along.”



In this quote, the learners are the students **listening to their more knowledgeable peers**. Listening is non-generative work (passive)

“Students can take on a teaching role and that can help their own learning. I think the best way you learn something is by explaining it to somebody else. So, I'm thinking that can help them feel challenged. Like they're being asked to really explain it to somebody else.”



In this quote, the learners are the students **explaining their ideas to peers**. Explaining ideas in your own words is generative work (constructive)

Active rather than passive

Learning occurs when students have opportunities to engage actively with tasks in the classroom rather than passively listening to lecture

“I think I’ve talked for about 5 or 10 minutes here. This [question] is just to **get them engaged**, right? To **break up the time** of me talking and droning on.”

Eric

Underlying assumption = students learn well from lecture but need breaks.

To explain is to learn

Learning occurs when students outwardly express their thinking, often via verbal and/or written explanations

“[Students] can take on a teaching role and that can help their own learning. I think the **best way you learn something is by explaining it to somebody else.**”

Kim

Generative work as a mirror

Learning occurs when students reflect on their own thinking because of engaging in generative work

“I think it's easy to feel like you understand something when you hear it. Often, **you don't realize the things you don't understand until you try to explain it to somebody.** I feel like that all the time where I'll start teaching something and I'll realize like, ‘Oh, there's some nuance to this.’”

June

Refraining from explaining

Learning occurs when instructors keep the onus for intellectual work on students by prompting THEM to explain, rather than explaining to them

“I'm trying to identify how far through this thought process...they're able to navigate on their own and then see how little I can give them to go the rest of the way...If they just need a tiny little push or a tiny little point in a direction, **that's making them use a lot more brain power** and a lot more of these skills we're trying to build **than if I told them they were wrong and then told them the right answer.**”

Amy

How we facilitate a task, not just the task itself, influences the opportunities students have for generative work

Non-Generative

Because I see the issue, I'll give them an explanation to get them started in the right direction.

Generative

Even though I see the issue, I want them to explain their reasoning first, because that will help them realize what they do and do not know.

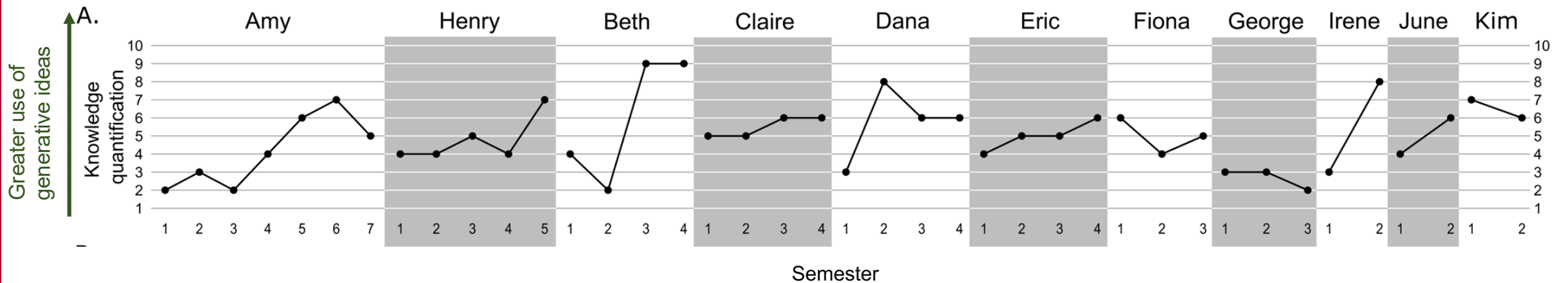
Ah, I see the issue!

Can you help us with question #3?



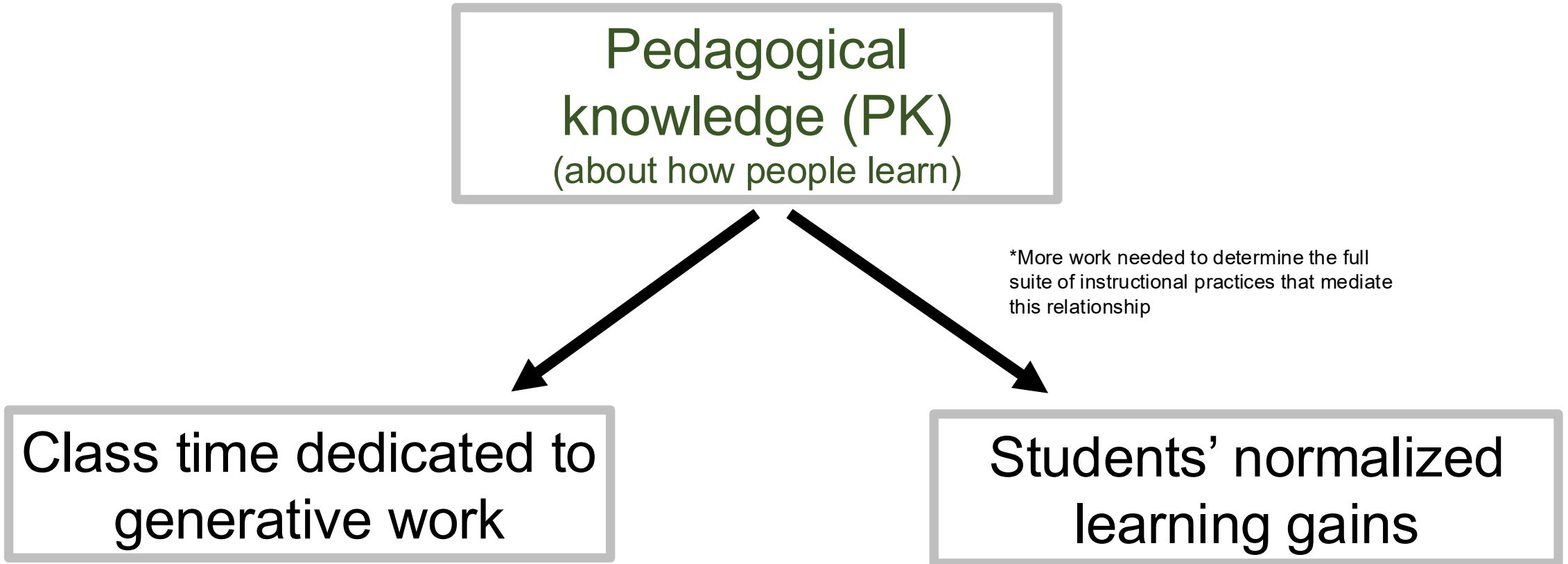
Findings Highlight

Study 3: Early-career instructors had variable starting levels of **PK** and did not consistently develop ideas aligned with generative work from experience alone (or common teaching professional development)



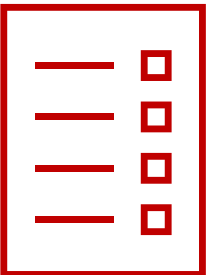
Findings Highlight

Study 4: Pedagogical knowledge (PK) predicted instructional practices AND student learning gains



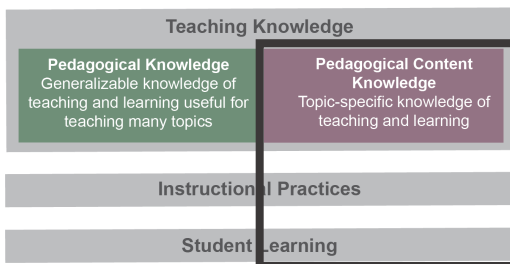
Task 2: Fine-tune a focal task or lesson to create and maintain opportunities for generative work

See the
handout.



Exploring Pedagogical Content Knowledge (PCK)

Topic-specific knowledge of teaching and learning



Two components of PCK



When my students think natural selection, they think 'survival of the fittest'

Allows instructor to anticipate and interpret students' intuitions and reasoning

Pedagogical Content Knowledge

Topic-specific knowledge of teaching and learning

Student thinking

Awareness of common student ideas, difficulties, and development in learning a topic

Instructional strategies

Awareness of effective strategies for supporting learning of a topic



I show examples of natural selection increasing the fitness of an organism at the expense of the organism's survival

Allows instructors to plan strategies tailored to anticipated student thinking and respond with agility

PCK about student thinking varies in the extent to which it is grounded in evidence from students

Evidence-based

- based on observations of students' reasoning about a topic
- evidence comes directly from students (e.g., exams, formative assessments, and interactions with students)

Assumptive

- based on assumptions and guesses about students' reasoning about a topic
- no evidence from students, but not necessarily wrong



Irene

I know **last time [I taught the lesson] they were definitely having a problem** with the concept that plasticity is change within a generation, yet evolution is change between generations and so sort of just getting confused as to what role phenotypic plasticity has played.

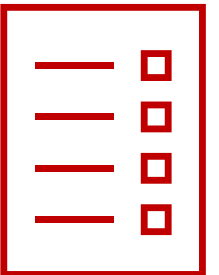


Henry

I imagine they've never talked about before the idea that one gene would completely interfere with another gene.

Task 3: Where does PCK about student thinking come from: evidence or assumption?

See the
handout.



Where does PCK about student thinking come from?

Take Home :

Evidence-based PCK may provide a more **reliable** and **actionable** basis for instructional design than assumptions or guesses.

E or A	Instructor Quote Demonstrating Knowledge of Student Thinking	
E	"I only have a small handful of pre-class assessments. A lot of students think about pluripotent stem cells meaning the ones that can become all the types of the adult body. So, when they answer, 'What is a stem cell?' they almost never know that there are different kinds." (topic: stem cells)	1
E A → E	"Over time, I've been saying, 'Oh, from what I understand this is what students think dopamine is mainly involved in.' And so then I said, 'You know what? I should actually assess this instead of making some assumptions from some students that I've heard from.' So, I finally made it an actual clicker, and the results were pretty much what we had expected... I wanted to see if there was any evidence to this kind of hunch that I had about their initial ideas" (topic: dopamine in neuroscience of motivated behavior)	2
A	"I don't know if they have many ideas. I don't know how many of these concepts are really introduced. In terms of broad tuning and fine tuning the misconception may be that a neuron fires because it fires regardless of when and what signal is. I don't know if they have that because of misinformation but more likely just not having been told before. I have no idea honestly how much the high school biology curriculum has changed since I went through but I don't remember ever being taught differences in cell firing as contributing to sensing things in the environment. So, this could be a new principle for some." (topic: combinatorial coding in neurons)	3

Task 4: Reflect on your **PCK about student thinking** for your focal lesson/activity.

PCK about student thinking includes a teacher's awareness of **both productive and unproductive** intuitions students use during an activity

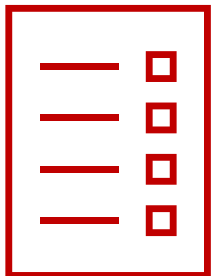
When my students think natural selection, they think **survival of the fittest**.

Potentially productive




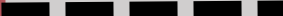
However, they tend to think of fitness in terms of **survival, not reproductive output**.

Unproductive

See the
handout.



PCK about instructional strategies varies in the extent to which it relies on insights about student thinking

Type of PCK about instructional strategies		
<p>PCK about instructional strategies linked to PCK about student thinking</p>	<p>Custom-Tailored</p> 	<p>Students tend to confuse gene by environment & gene + environment interactions.</p>  <p>So, I deliberately included both of those as answer choices.</p>
	<p>Broad-Strokes</p> 	<p>There was some confusion about this last one on carrying capacity.</p>  <p>That gave me a clue that I should at least talk about this last one more than the others.</p>
<p>No link to PCK about student thinking</p>		<p>I chose these answer choices because I wanted to add another level of interpretation. It will get them to think a little more big picture.</p>

Task 5: What does it look like when PCK about student thinking informs the design of in-class activities?

See the
handout.



PCK about instructional strategies

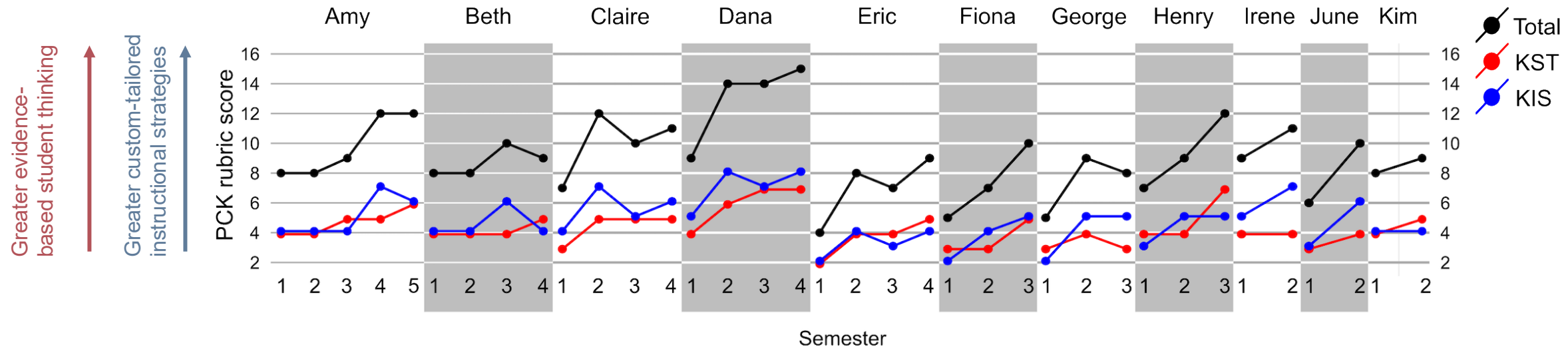
Take Home Message:

Custom-tailored PCK about instructional strategies may provide more **targeted** support for student learning.

C, B, or O	Knowledge of Instructional Strategies Quote	
C	<i>Instructor's rationale behind a specific prompting question they posed to a group of students.</i>	1
	"It was that little detail of well okay so yes, embryo is not making anything. We all agree on that, but is there something else that can feed into this? So, I think that that piece, that is one where, you know, for some students the second I say, 'Well, this embryo is human. We're developing within a maternal environment, you can just see the light bulb and they're just like, 'Oh. And that's why that is.'"	
B	<i>Instructor's rationale for slowing down and spending more time explaining a topic.</i>	2
	"Knowing students have a misconception about dopamine makes me slow down because then I can realize like, 'Okay, this is what we need to spend more time on, and that's why I'm going to spend that one slide from the last lecture, to go over just a little bit more of that'. But yeah, so I spend more time explaining, and I try to come up with different examples or different ways to explain it if my original explanation maybe wasn't as clear or didn't really resonate with them."	
O	<i>Instructor's rationale for simplifying, using examples, and gradually introducing complexity.</i>	3
	"It's kind of a balance between wanting to be transparent about the uncertainty around this idea and like the ambiguity around carrying capacity, while also simplifying it to a level that's applicable across some number of examples. So, I think I try to keep it simple. I'll teach it as a simple concept and straightforward without too much nuance initially, and then kind of add in at the end that, 'There's lots of complicating factors.'"	

Findings Highlight

Study 3: Early-career instructors had variable starting levels of **PCK** and generally developed **PCK** with variable efficiency.



Findings Highlight:

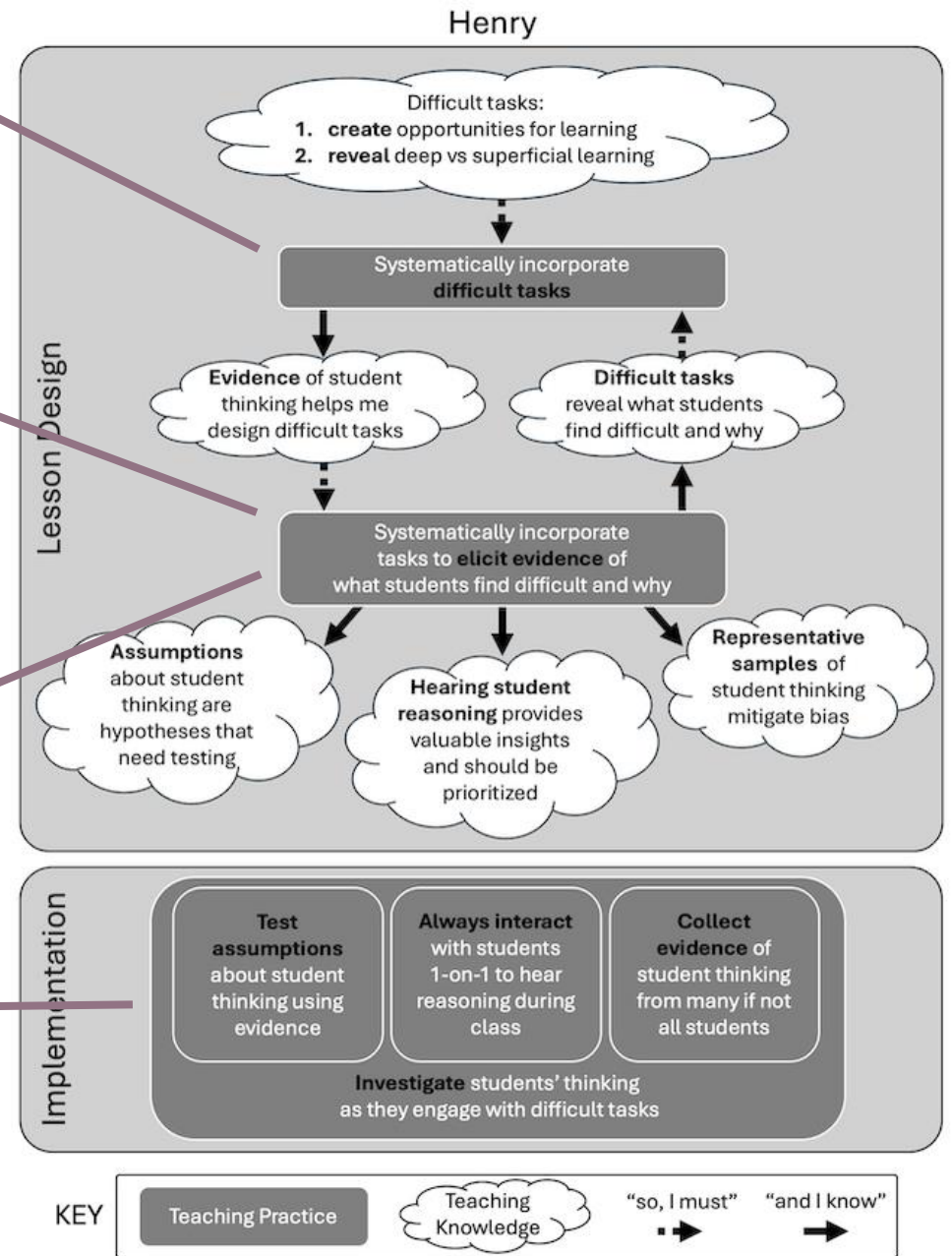
Certain behaviors and ways of thinking contribute to PCK development


Engage students in difficult tasks

Seek access to student thinking

Aim to understand (not just evaluate)

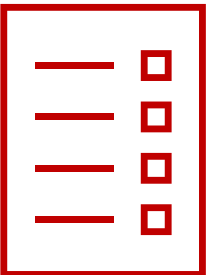
Use a scientific mindset





Task 6: Reflect on your PCK about instructional strategies for your focal lesson/activity.

See the
handout.



REALISE Videos

Repository for Envisioning Active-Learning Instruction in Science Education

Immerse yourself in active-learning lessons



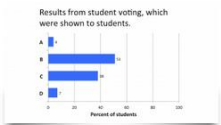
An uninterrupted glimpse into a large active learning classroom

The Thinking Behind the Teaching



Watch expert teaching and then hear the instructor's reasoning

Why should I use active-learning strategies?



Testimonials and evidence regarding the benefits of active learning

How do I implement active learning?



Step-by-step instructions for active learning strategies

Other opportunities to reflect on your teaching:



The Thinking Behind The Teaching (New in 2025)

These **interactive videos** reveal the thinking behind expert active-learning instruction, and are **grounded in research about teacher expertise**. You'll see **footage of large active-learning courses** interwoven with **expert commentary**, and you will have the **chance to reflect** on your own teaching.

Using questions in an active-learning class



Time: 11:56

Created by REALISE Originals

This video shares an expert instructor's thoughts about why he chooses to ask questions during class and how he manages to balance lecture time and active learning.

Writing productive questions



Time: 7:34

Created by REALISE Originals

This video shares an expert instructor's thoughts about the features of in-class questions that make them worth class time, and how she writes these productive questions.

The brain that does the work does the learning



Time: 9:25

Created by REALISE Originals

This video shares an expert instructor's thoughts on why active learning supports student learning in college courses.

Interacting with students as they work in class



Time: 11:32

Created by REALISE Originals

This video shares an expert instructor's thoughts about interacting with students during small-group work.

I asked a question and students were silent



Time: 4:50

Created by REALISE Originals

This video shares an expert instructor's thoughts on what you do when you pose a question to the class and students do not respond.



Thank you to our amazing research participants, who invest deeply in their students, and were willing to share some of their time and expertise with us.

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Link to a doc with resources about teaching knowledge, including new videos

