Beyond PCK: Science Teachers Building Critical Historical Knowledge for Environmental Justice

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Youth Participatory Science (YPS) to Address Urban Heavy Metal Contamination

- “Heavy” metals are toxic elements like lead, mercury, arsenic
- These naturally occurring elements have been concentrated in urban environments both through the intentional use of their properties in industry and consumer products and because they exist as natural impurities in coal.
- Our collaboration supports YPS projects about this issue in Chicago classrooms.

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Research Question Shaped by Participation

- **Preliminary Question:** What do secondary science teachers need to learn to support youth participatory science (YPS) projects about urban heavy metal contamination?
- **Refined Questions:**
  - What forms of **contextual historical knowledge** do teachers need to support youth participatory science (YPS) projects about urban heavy metal contamination?
  - How did we collectively come to understand the importance of these forms of knowledge for supporting YPS projects in secondary science classes?

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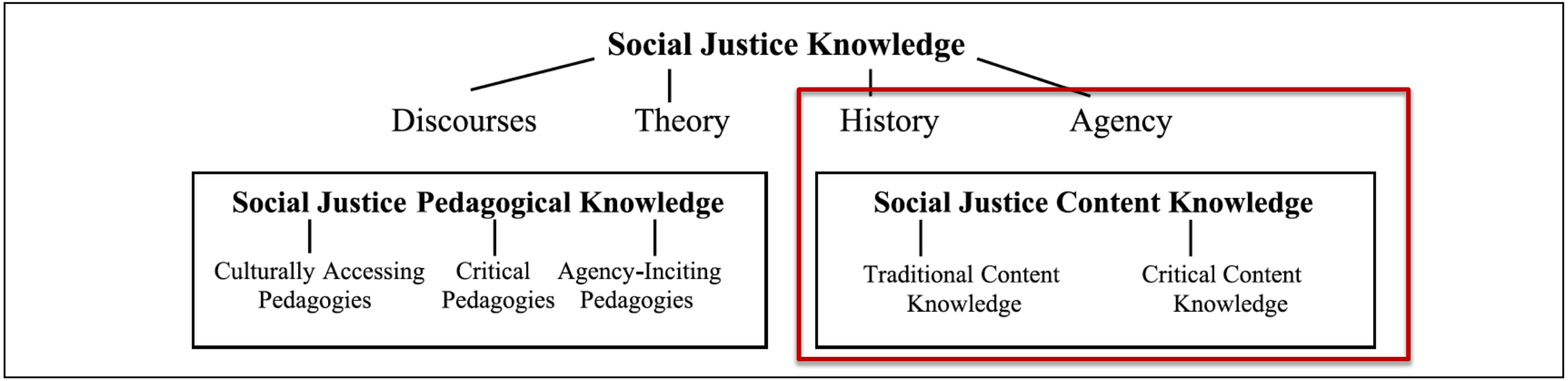
Beyond PCK

- **PCK:** Pedagogical Content Knowledge (Shulman 1986)
- **SJ PACK:** Social Justice and Pedagogical Content Knowledge (Dyches & Boyd, 2017, p. 479)



Community-based Design Research (Bang, Faber, Gurneau, Marin, & Soto, 2016)

Inquiry Cycle Overview

- Planning Institute, Winter 2018
- Teaching & Conducting YPS Projects, Spring 2018
- Institute 2, Summer 2018

  Part A: Reflection

Data Sources

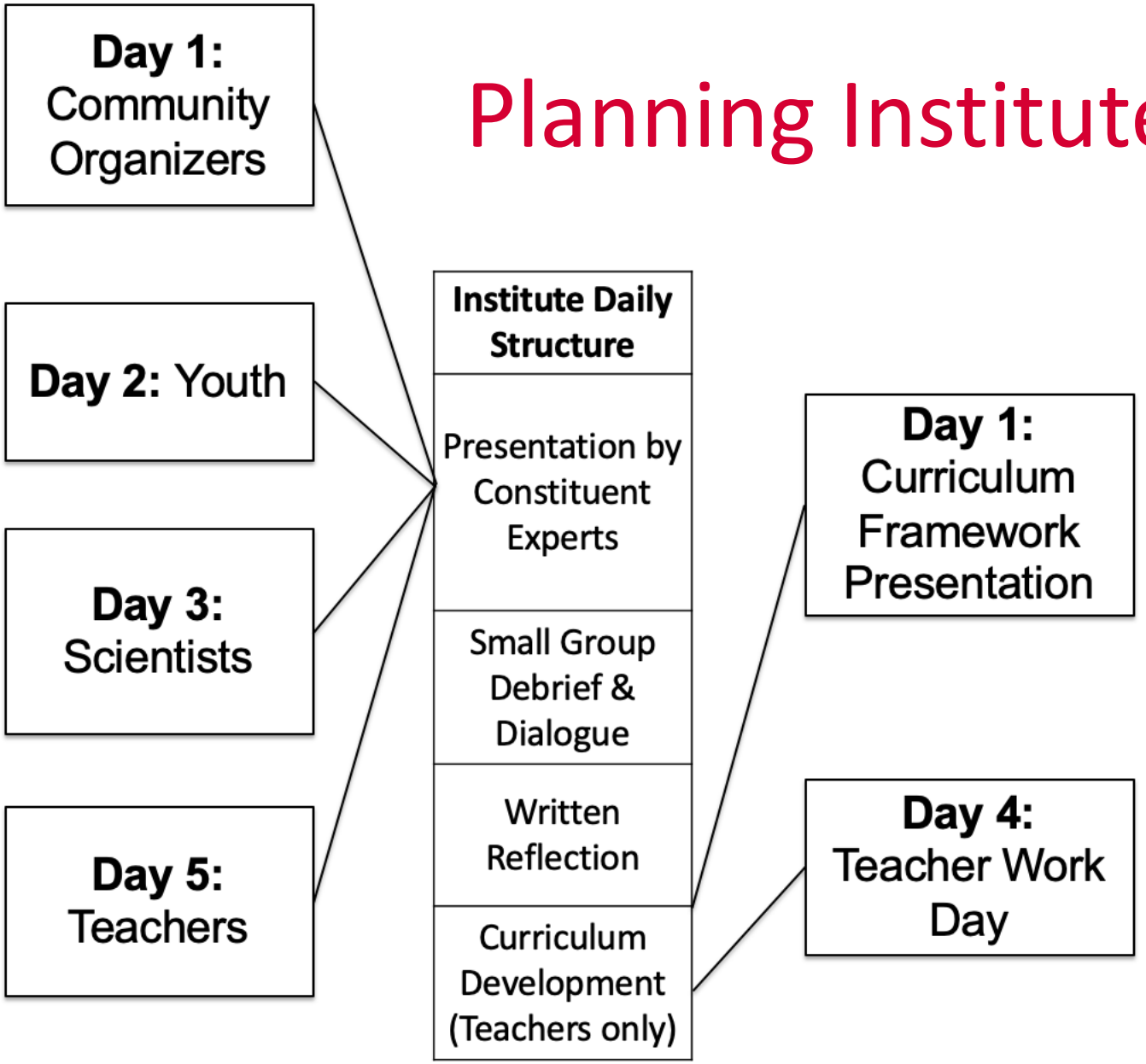
- 2 Teacher interviews (before and after teaching)
- Advisory Board Report

<u>Data from Institute:</u>

- Daily reflections written by teachers
- Audio and video
- Reflective Partnership Presentations

What we learned and how we learned it (methods, context, and findings) are intertwined throughout the presentation in order be true to our Design-based/PAR approach.

Planning Institute, Winter 2018



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Teaching & Conducting YPS Projects, Spring 2018

Phase 1:	**Seven** teachers led activities to define the social justice science issue.
Phase 2:	**Seven** teachers led activities about understanding heavy metal contamination using chemistry concepts.
Phase 3:	**Four** teachers led students in collecting soil samples.
Phase 4:	**Two** teachers facilitated data analysis based on results of soil testing.
Phase 5:	**One** teacher engaged students in dissemination or action beyond the classroom walls.

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Institute 2: Part A, Summer 2018

- During the first morning, collaborators were organized into school-university partnership groups.
- The lead teacher modeled a **reflective presentation** about **successes** and **challenges** of teaching YPS and **envisioning** for the following year's curriculum & projects.
- Using the model and 11 prompts, the 3 partnership groups prepared a presentation with the same elements.
- During the second morning, collaborators presented to each other and to the 3-person advisory board composed of a geochemist, a science educator, and a YPAR expert.

Partnership Group Composition

- **Loyola University Group:**
  3 teachers, 1 HS student, 1 scientist
- **University of Illinois in Chicago Group:**
  3 teachers, 2 HS students, 1 science education faculty
- **Northwestern University Group:**
  2 teachers, 2 HS students, 1 scientist, 1 community organizer

Clear Consensus Emerged → Research Question Refined

- All three groups clearly identified **the need to know more history** as a challenge for their YPS projects
- **Refined Questions:**
  - What forms of **contextual historical knowledge** do teachers need to support youth participatory science (YPS) projects about urban heavy metal contamination?
  - How did we come to understand, collectively, the importance of these forms of knowledge for supporting YPS projects in secondary science classes?

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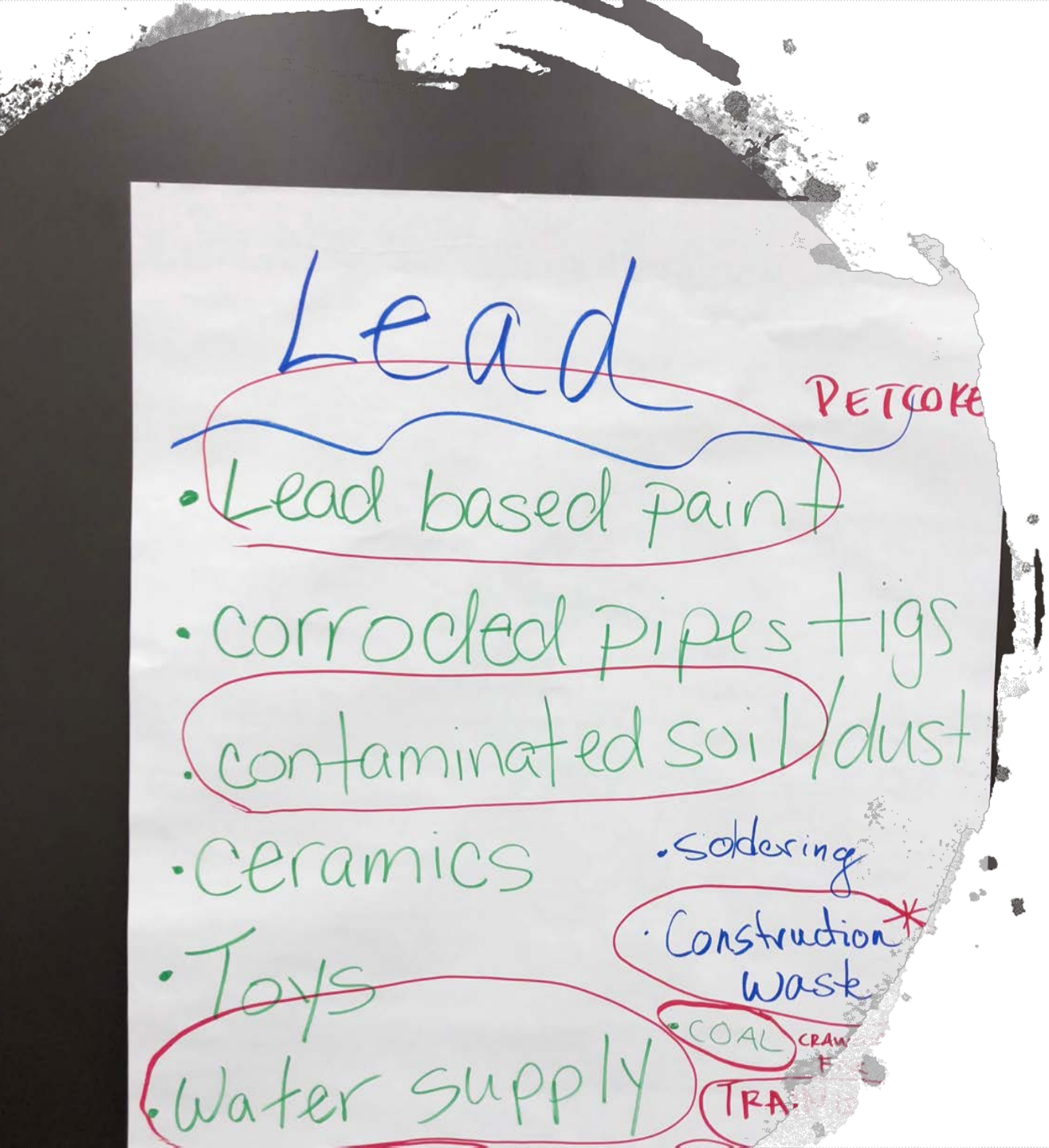
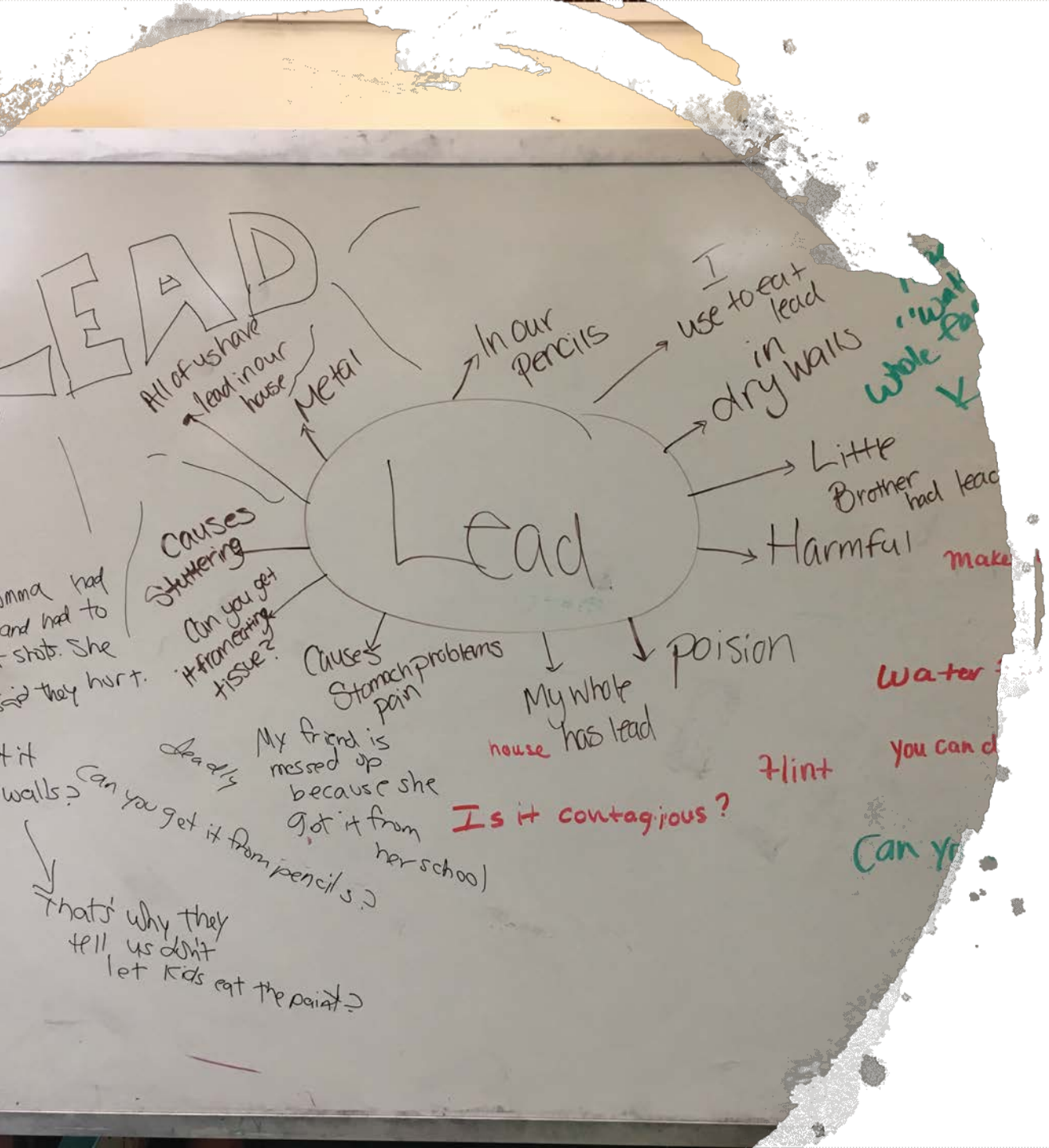


"I think something that is really important as we are expanding community impact is **knowing the history of the neighborhood** ...we need to know like what was there before there was housing or how old those houses are or what kind of history did these roads have or transportation did they have because a lot of that helps us with planning which areas should we see areas of high concern where we should probably sample but I think it also helps students to understand where they are coming from and understand the impact that the history of their neighborhood has had on where they are living today."

- Tomasz

(Institute 2 Reflective Presentation)



"My neighborhood is very political. Actually Dr. King lived there when he launched his anti-slum housing campaigns. Students come from very political families and so they want to know who decided to put lead in gasoline. Because they are too young to remember that but I remember going to Detroit gas stations and my grandfather asking for like leaded or unleaded. **And students when they came to understand that history, had all kinds of questions** about who decided that, who put lead in paint in the first place? And so it seems a little unnatural not to address these issues of who has the power to determine what kind of resources we have and use, products, what's manufactured."

- Tiffany

(Institute 2 Reflective Presentation)

“So I think another challenge that people kind of mentioned in the other two presentations is kind of like what do we do next?...**maybe we need to learn about the history of what caused this**, what may be causing it still. So it was kind of like this end mark of I don't know what to necessarily do with these results or how to create an explanation. And also, now what do we do with this information? What do we do to help?”

- Amy

(Institute 2 Reflection Presentation)

Clear Consensus Emerged

- All three groups clearly identified **the need to know more history** as a challenge for their YPS projects
- We planned Part B of Institute 2 based on this consensus
- Participation in Part B of Institute 2 led to a refined consensus about three themes in the requisite historical knowledge:

Historical Theme	Institute Learning Activity
History of the Neighborhood	History research time in library
History of Relationships Between Science & Industry	Four readings & discussion
History of Environmental Justice (EJ) Victories	Videoconference with EJ Activist & Community Asset Toxic Tour

What forms of **contextual historical knowledge** do teachers need to support youth participatory science (YPS) projects about urban heavy metal contamination?

Theme 1: History of the Neighborhood

"I think something that is really important as we are expanding community impact is **knowing the history of the neighborhood**...**we need to know like what was there before there was housing or how old those houses are or what kind of history did these roads have or transportation did they have because a lot of that helps us with planning which areas should we see areas of high concern where we should probably sample** but I think it also helps students to understand where they are coming from and **understand the impact that the history of their neighborhood has had on where they are living today.**"

- Tomasz
- (Institute 2 Reflective Presentation)

What forms of **contextual historical knowledge** do teachers need to support youth participatory science (YPS) projects about urban heavy metal contamination?

Theme 2: History of Relationships Between Science & Industry

My neighborhood is very political. Actually Dr. King lived there when he launched his anti-slum housing campaigns. **Students come from very political families and so they want to know who decided to put lead in gasoline.** Because they are too young to remember that but I remember going to Detroit gas stations and my grandfather asking for like leaded or unleaded. **And students when they came to understand that history, had all kinds of questions** about **who decided that, who put lead in paint in the first place**? And so it seems a little unnatural not to address these issues of **who has the power to determine what kind of resources we have and use, products, what's manufactured**.

- Tiffany (Institute 2 Reflective Presentation)

What forms of **contextual historical knowledge** do teachers need to support youth participatory science (YPS) projects about urban heavy metal contamination?

Theme 3: History of Environmental Justice Victories

"So I think another challenge that people kind of mentioned in the other two presentations is kind of like **what do we do next?**...**maybe we need to learn about the history of what caused this**, what may be causing it still. So it was kind of like this end mark of I don't know what to necessarily do with these results or how to create an explanation**. And also, now what do we do with this information? What do we do to help?**"

- Amy

(Institute 2 Reflection Presentation)

How did we come to understand, collectively, the importance of these forms of knowledge for supporting YPS projects in secondary science classes?

- We revisited our data sources and coded them for the three themes of historical knowledge to try to reconstruct and understand our long consensus-building process.
  - 5 initial interviews, and 3 subsequent interviews
  - Teacher and youth written reflections from both institutes
  - Institute 1, Day 3 Small Group Audio Recordings
  - Institute 2, Day 2 Reflective Partnership Presentations Video Recordings

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How did we come to understand, collectively, the importance of these forms of knowledge for supporting YPS projects in secondary science classes?

1. **The Role of Teachers:** Different teachers came to recognize the role of neighborhood history at different times and in different ways, based on their relationship with the neighborhood.
2. **The Role of Teaching:** Teaching through YPS was an important epistemological component of our participatory design-based approach.

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The Role of Teachers: Different teachers came to recognize the role of neighborhood history at different times and in different ways, based on their relationship with the neighborhood.

Mindy (initial interview)	**Tiffany** (reflective presentation)	**Maribel** (initial interview)
"I'm not from Chicago so my historical background is not as in depth. I've been working with the history department because I found those maps about smoke abatement. So figuring out what actually was there in the area so that I can help students connect that piece to, not necessarily who's responsible, but how did it [possible contamination] get here...I found out our school was built on a brownfield...but it did go through remediation."	"My school, just so you know the context of my school, I've worked at for the last 12 years. Its also my neighborhood school, it's a neighborhood my husband and I live in and we are raising our two sons in. The…neighborhood which has a really interesting political past and history. It also was a manufacturing hub many years ago when the population was mostly Eastern European."	"I was born in South Chicago, but I was one when we moved to the house that we just moved out of. So, yeah I've been there my entire life."

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The Role of Teaching: Teaching YPS was an important epistemological component of our participatory design-based approach.

Mindy (Institute 1 Reflection)	**Tiffany** (reflective presentation)	**Maribel** (initial interview)
"I need to find/create out a map of historical industrial make up of the area surrounding my school. This is crucial in order for us to be able to connect to the social justice aspect of the project."	"And students when they came to understand that history, had all kinds of questions…it feels irresponsible for me as an educator not to address these issues."	"I didn't want to leave them with that whole sense of deception, like OK. So, we did talk about how the southeast side has always been a very industrialized community with the steel companies being there before and then now this. So, I did talk a little bit about the history of the East side, but I didn't really go into like well, why they didn't just put them somewhere else? Because I didn't want to leave them with that."
Reflecting on teaching helped build consensus in our group.	Questions that students raised helped us understand the importance of historical knowledge.	The experience of teaching underscored the importance of a pedagogy of hope.

Discussion

- Leading authentic YPS projects, necessarily extends science teachers beyond the boundaries of their disciplines and thus traditional PCK is inadequate.
- In our case, the History component of SJ PACK emerged as central and connected to the Agency component and critical content knowledge. But the specific SJ PACK required by a particular project may be difficult to predict.
- Our model of Community-based Design Research provides a way for teachers to identify the forms of SJ PACK that are necessary and to develop them collectively with other constituency groups (youth, scientists, community organizers). Even with these structures, the act of teaching was epistemologically important in this process.

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Questions for further study

- How is knowledge being constructed during teaching?
- How is knowledge constructed collectively during interactions between participants in the institutes?
- What specific forms of traditional and critical content knowledge emerged as important?

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