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Socio-Scientific Issues Based Teaching, Learning & Assessment

Troy D. Sadler

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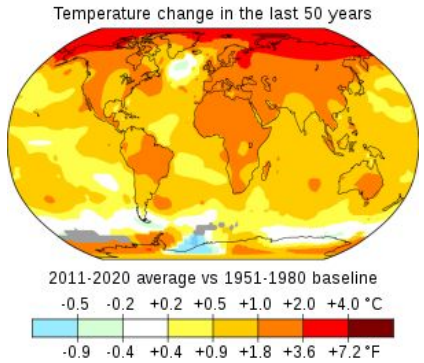
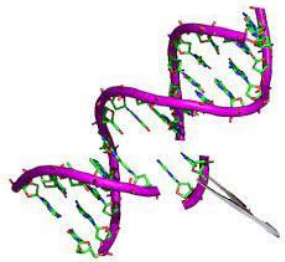
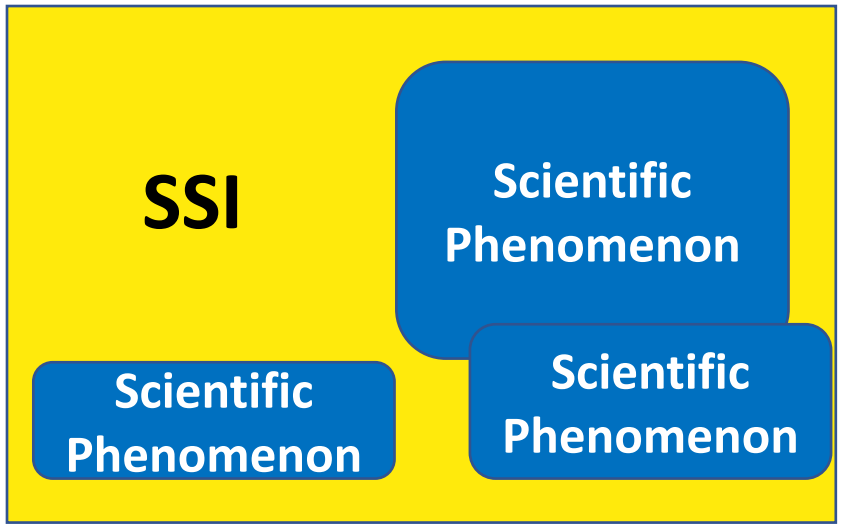
Socio-Scientific Issues (SSI)





- Societal issues or problems that can be informed by science
- Solutions under-determined by scientific data
- Open-ended, ill-structured problems
- Have political, ethical, and/or economic implications
- Problems that matter for learners and their communities



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IMAGES: https://en.wikipedia.org/wiki/Climate_change https://en.wikipedia.org/wiki/Genetic_engineering
https://www.sentinelassam.com/editorial/biodiversity-loss-is-loss-for-humanity-478126

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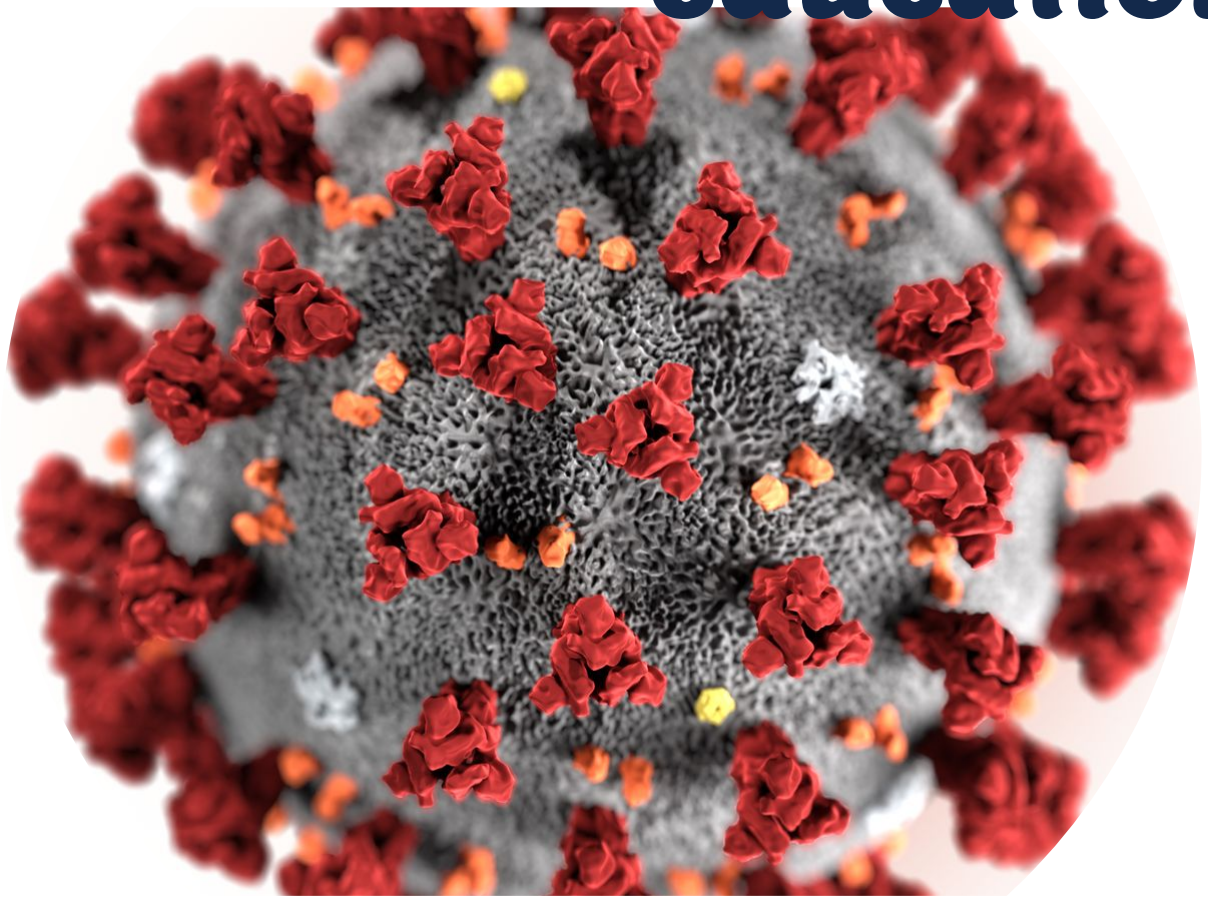
Why SSI for Science education?



The COVID-19 pandemic offers an example of why *SSI-based teaching* is so critical.

Classrooms should be spaces in which learners explore complex issues, like pandemics, and how disciplinary ideas can be used to inform societal solutions and personal decision-making.

However, issues-based teaching is challenging. Teachers often struggle with the emerging nature of the issues, limited curriculum materials, and the interdisciplinarity of these issues.

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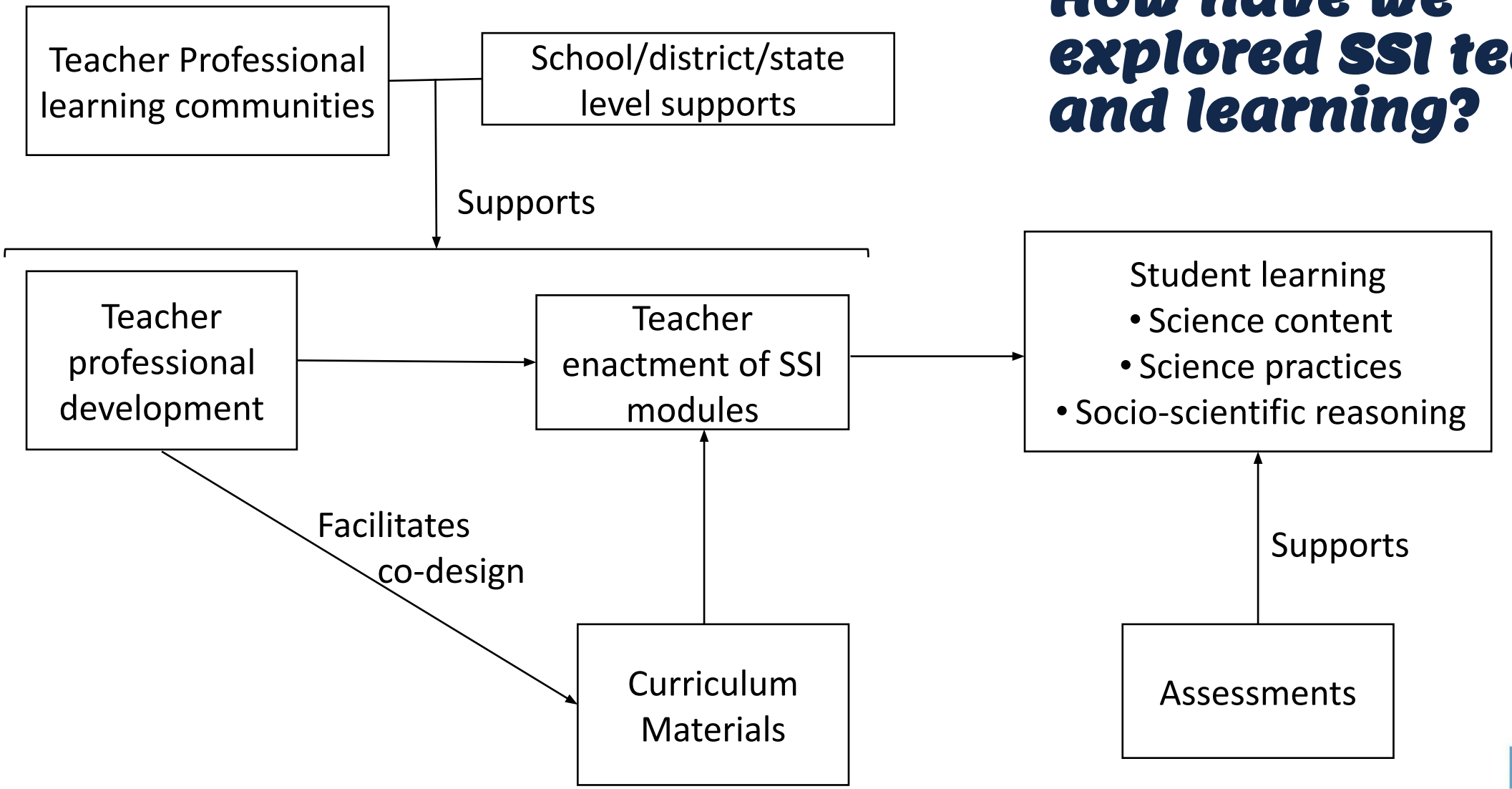
How have we explored SSI teaching and learning?



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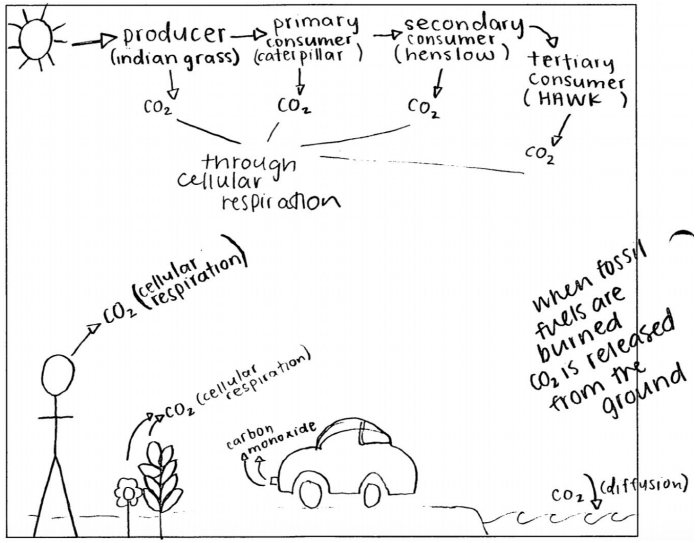

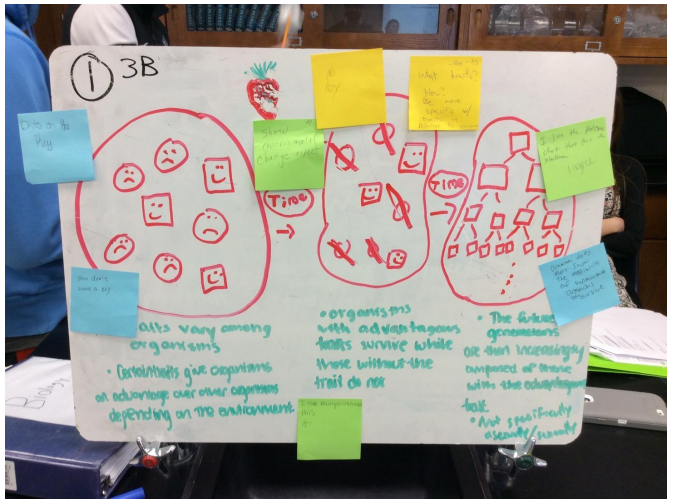

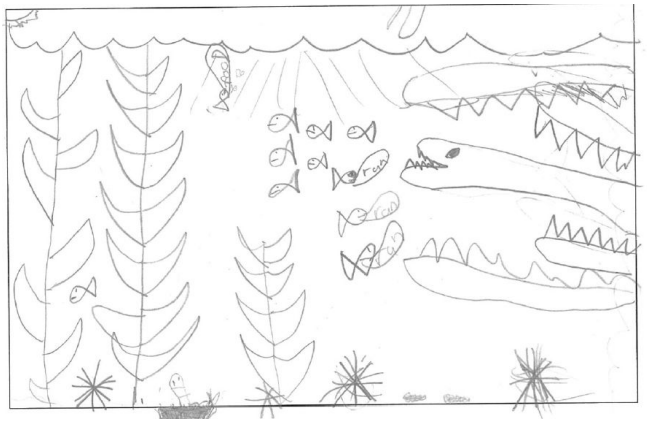

Student learning
- Science content
- Science practices
- Socio-scientific reasoning

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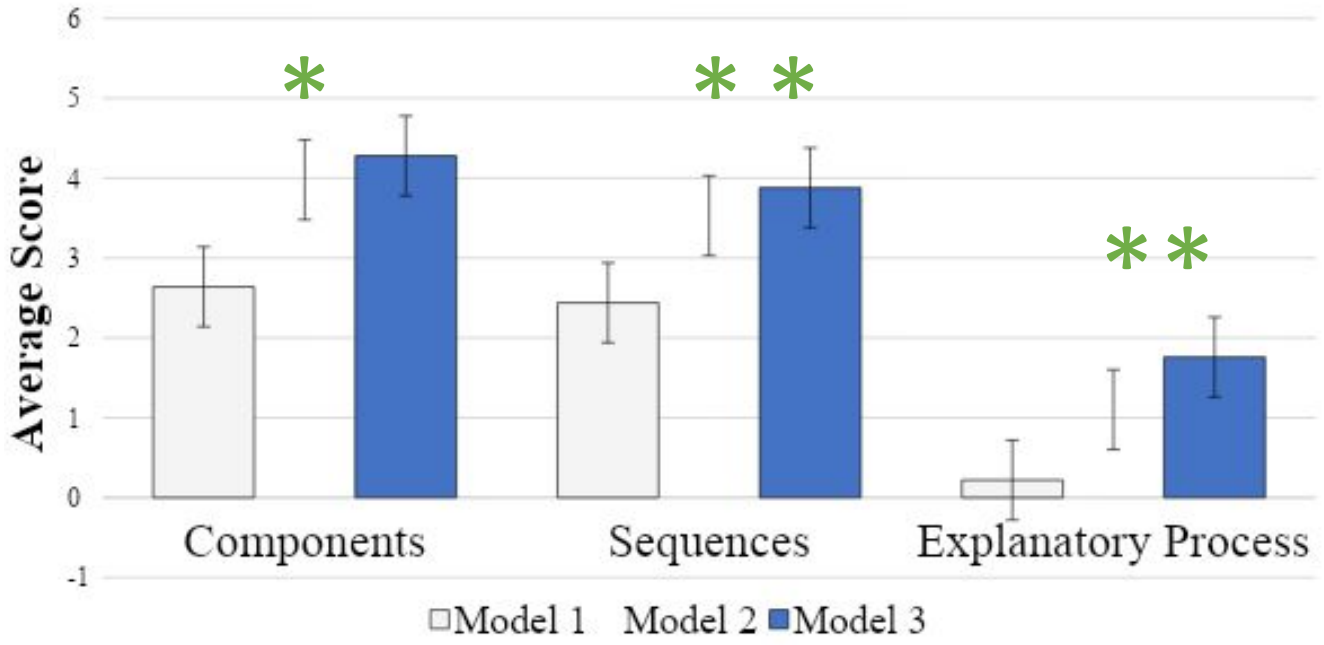
Modeling Performance over Time



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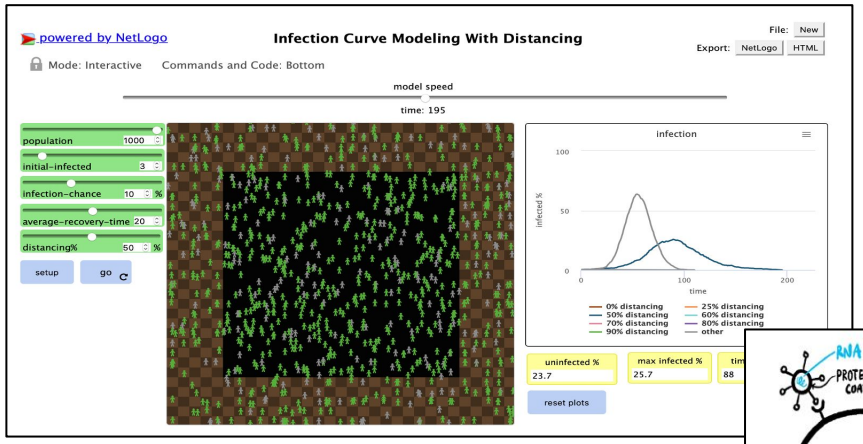

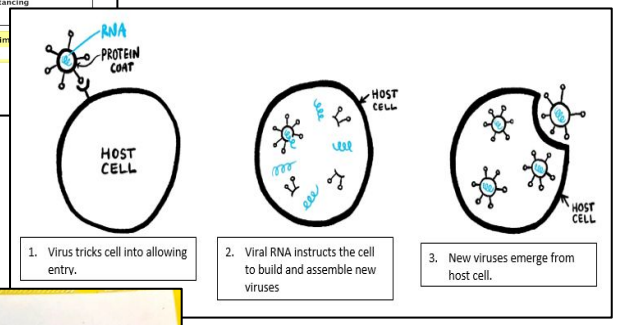

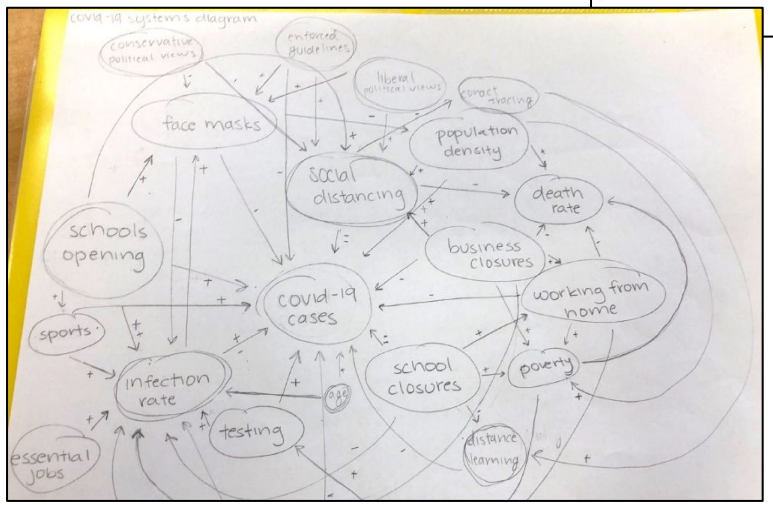

New Work: How do learners coordinate ideas across different kinds of models?

Student learning
- Science content
- Science practices
- Socio-scientific reasoning

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What are the unique affordances of SSI teaching and learning?

Transfer?

Socio-Scientific Reasoning (SSR)

Reasoning skills essential for informed negotiation of complex issues.

- Recognizing the inherent **complexity** of the issue.
- Analyzing the issue from **multiple perspectives**.
- Employing **skepticism** when presented with potentially biased information.
- Engaging in **inquiry** to identify missing information.
- Recognizing the **affordances and limitations of science** for the issue.

SSR: Construct for informing instruction & Assessment

Assessment development research

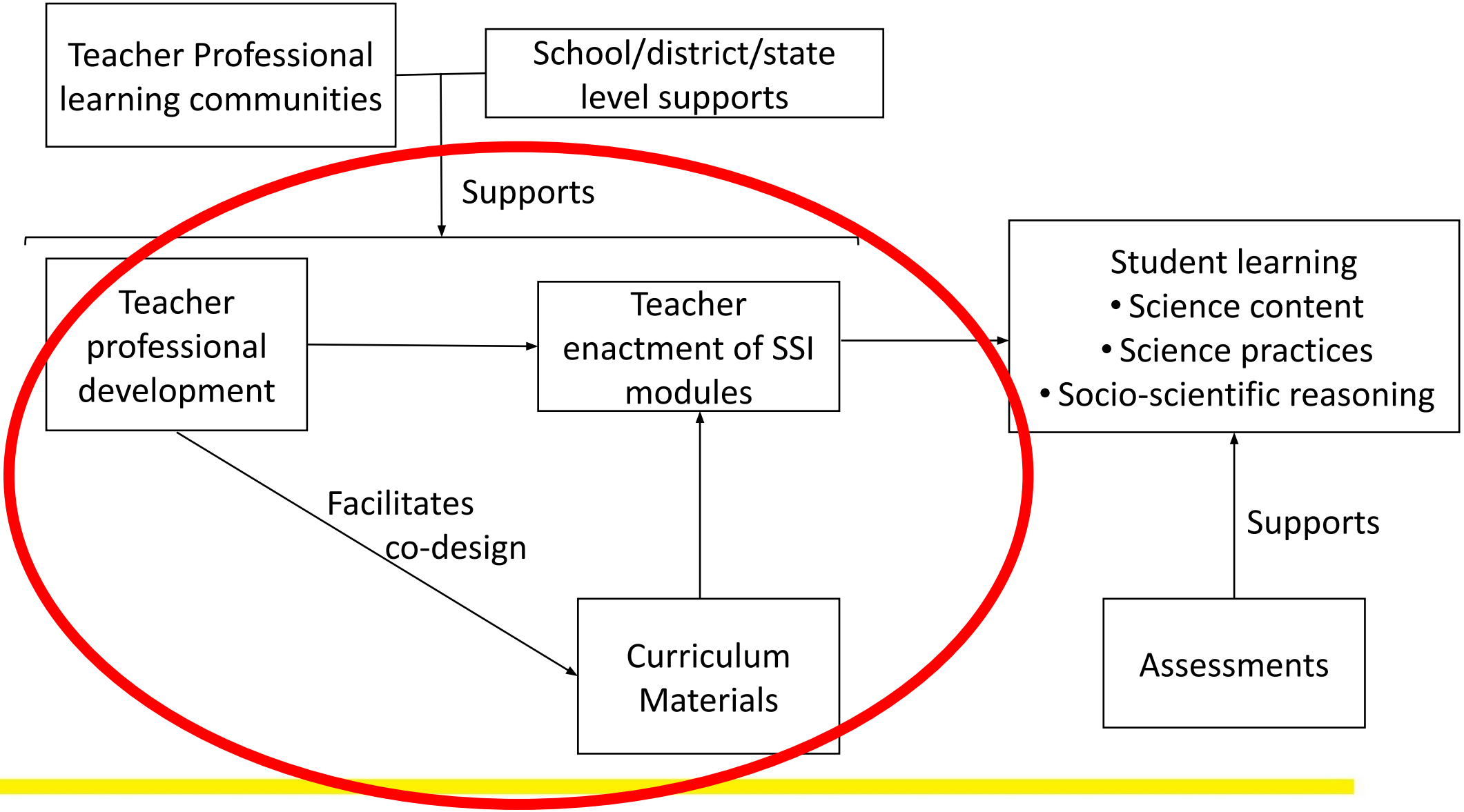
- Identification of SSR dimensions & levels of performance-Interviews
- Open-ended surveys
- Ordered multiple choice:

  QUantitative Assessment of Socio-Scientific Reasoning (QUASSR)

  - Socio-scientific scenarios (multiple forms)
  - Multiple items that target each SSR sub-dimension

QUASSR Findings

- Item Response Theory evidence for validity & reliability
- Different scenarios provide similar results
- Short interventions (1-3 weeks) do not produce measurable gains
- Longer interventions (6 weeks; multiple SSI units) produce significant gains
- SSR sub-dimension relationships
  - Complexity□Perspective taking□ Skepticism & Inquiry


Teacher Professional learning communities
School/district/state level supports
Supports
Teacher professional development
Teacher enactment of SSI modules
Student learning
• Science content
• Science practices
• Socio-scientific reasoning
Facilitates co-design
Curriculum Materials
Supports
Assessments

Rationale

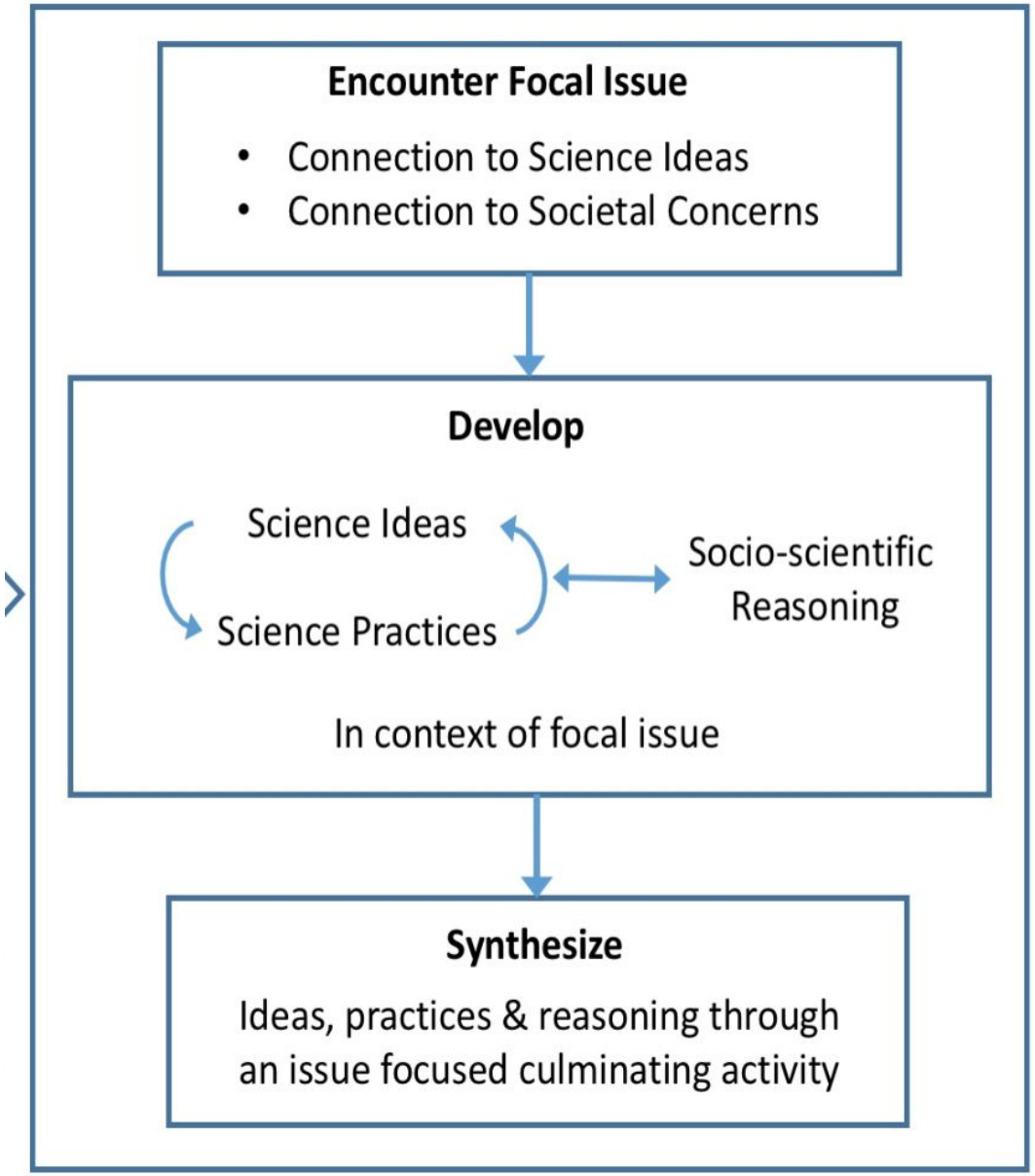
SSI teaching is challenging for teachers: (Bossér et al., 2015; Lee & Yang, 2019)

- Selecting a good socio-scientific issue (Hancock et al., 2019)
- Lack of comfort with non-scientific dimensions (Lazarowitz & Bloch, 2005)
- Lack of instructional time (Cross & Price,1996)
- Pressure of high stakes assessments (Lee & Yang, 2019)
- Lack of readily available SSI curriculum (Ekborg et al., 2013)

We know little about effective ways to support teachers in using SSIs.

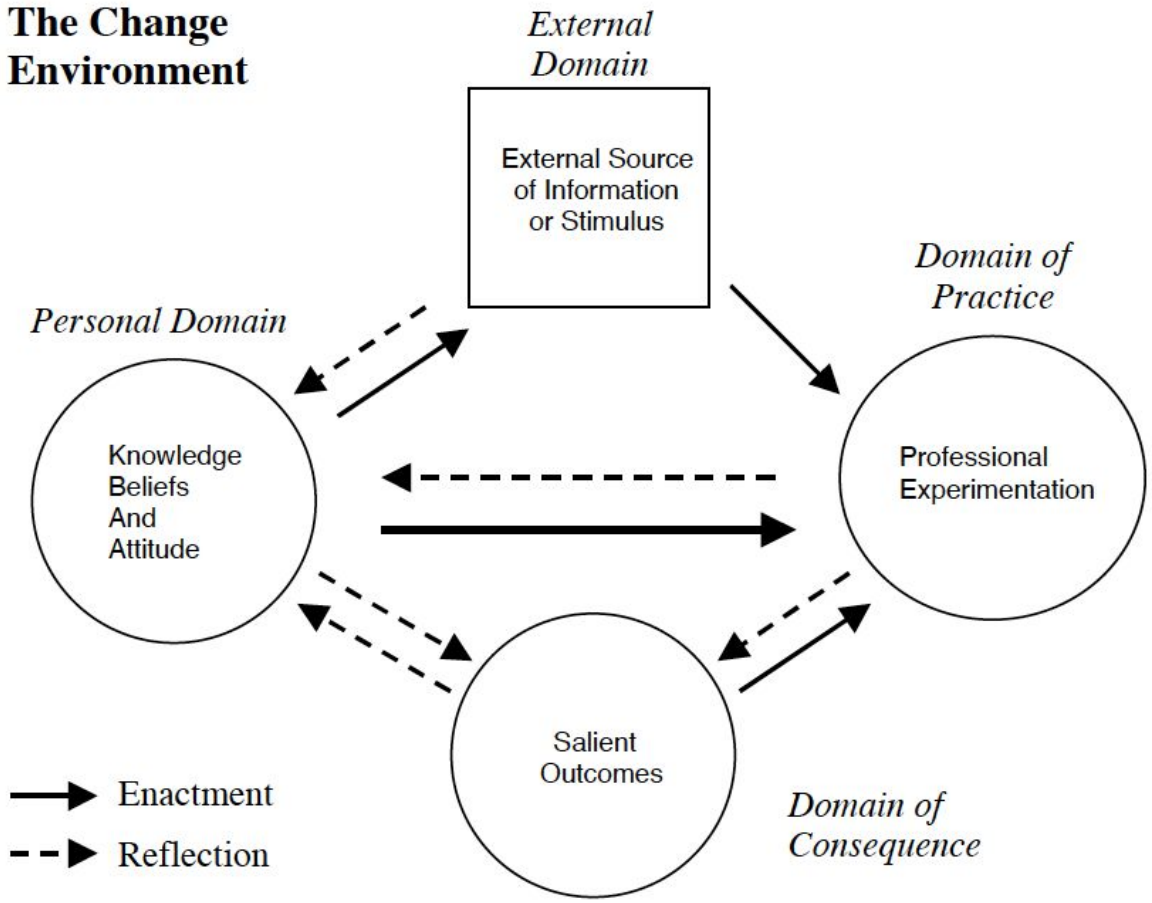
Context: Collaborative Curriculum Design PD

- PD Participants: 18 HS teachers of biology, chemistry, and environmental science
- 35-hour workshop in 2 sessions
  - Spring workshop (2 days): SSI framework, sample SSI units, curriculum design scaffolds; Team Selection & initial design
  - Summer workshop (3 days): NGSS support; Design time with support
- Implementation of units following school year



SSI Teaching & Learning Framework

Theoretical Framework: Clarke & Hollingsworth's (2005) Interconnected Model of Professional Growth (IMPG)



Research Questions

1) Which elements of SSI do the PD participants enact in their classrooms? (*Domain of Practice*)

2) What do participants identify as salient outcomes when they enact their SSI units? (*Domain of Consequences*)

3) What is the nature of participants' beliefs about teaching and learning? (*Personal Domain*)

4) What do participants learn in the PD? (*External Domain*)

Participants: 8 teachers implemented SSI units and agreed to participate in the study

Pseudonym	SSI Unit
Harry	Performance Enhancing Drugs
Margaret	Performance Enhancing Drugs
Jess	Clean Air
Tonya	Clean Air
Jemma	Diabetes
Judith	Mars Colonization
Rebecca	Junk Food Tax
Suzanne	Flood Control

Methods

Multiple case study (Yin, 1994) of teacher learning about SSI-based teaching.

Bounded by the PD and teachers' enactment of their SSI unit.

Data Sources

Primary

- Individual interviews (~1hr)
- Design team interviews (~1hr)
- Follow-up Implementation interviews (~1hr)

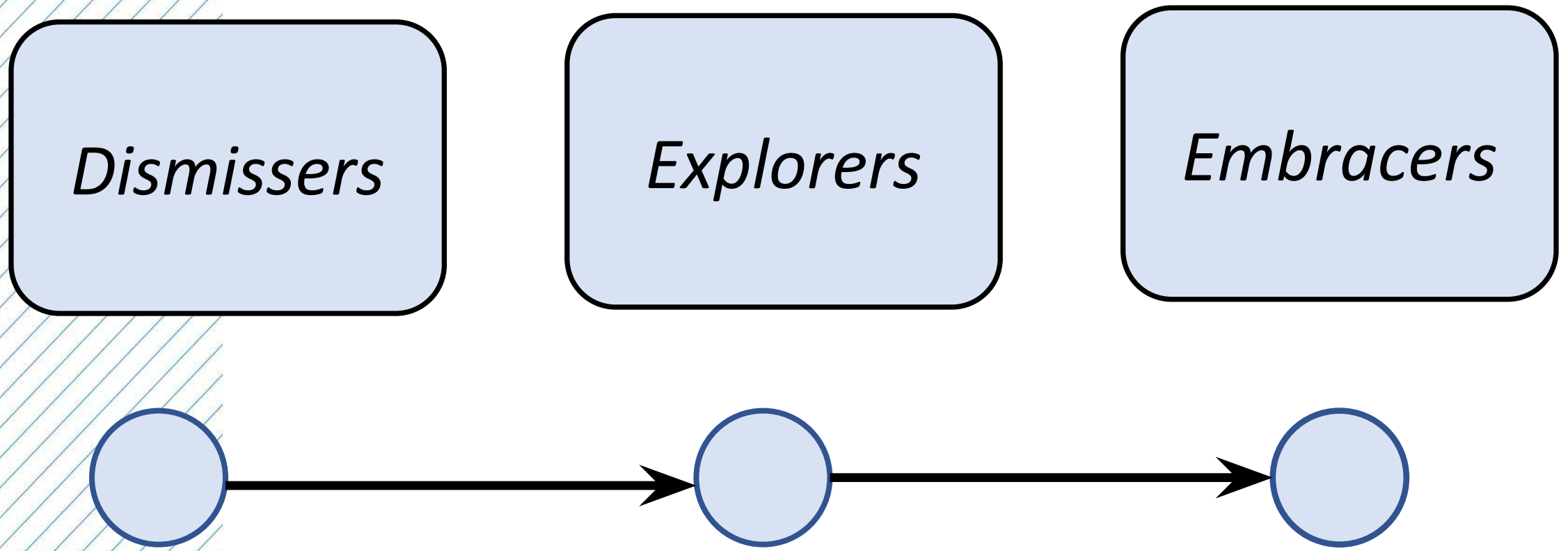
Secondary

- PD field notes
- SSI Curriculum Materials

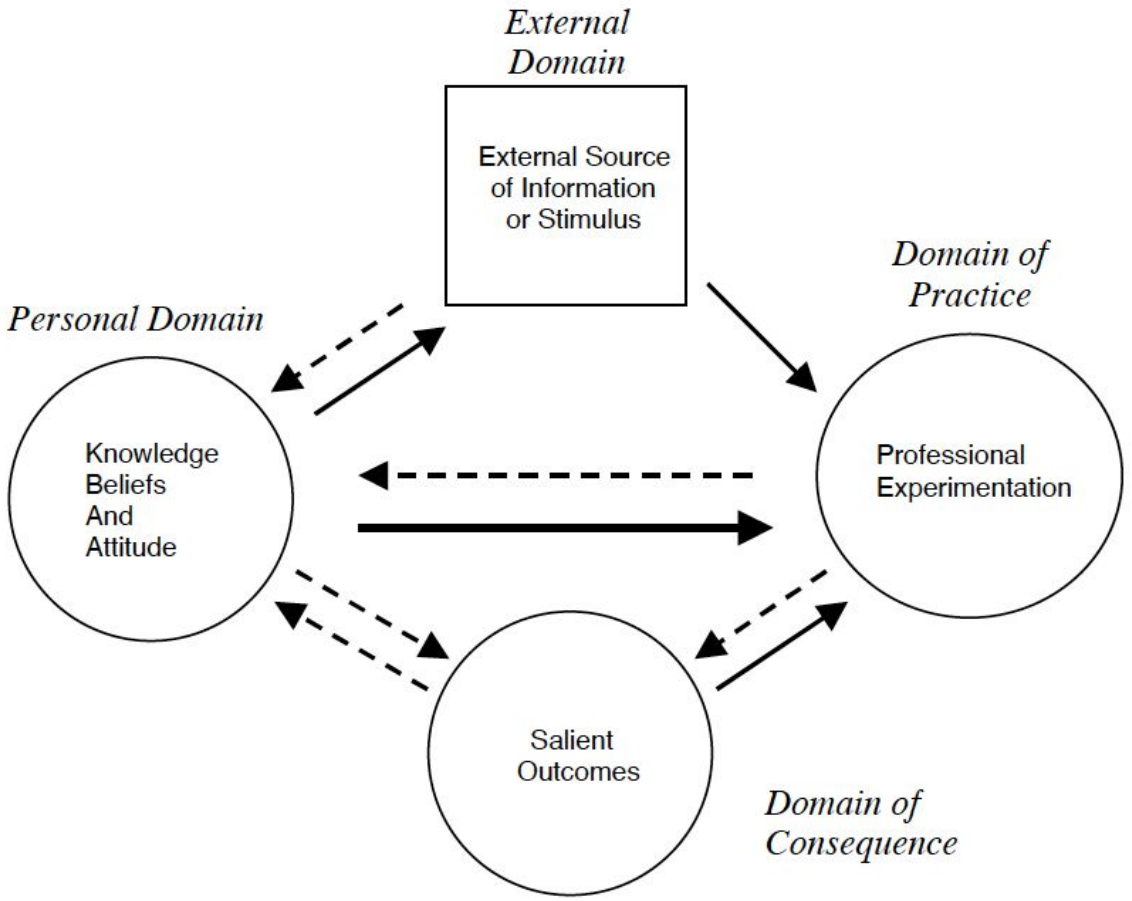
Data Analysis

- Multiple coding rounds
- 1st Round: Deductive coding using IMPG Domains: Practice, Consequences, Personal, and External
- 2nd Round: Inductive coding within IMPG Domains
- Multiple participants shared same inductive codes Profile analysis
- Created in-depth profiles using inductive codes

Findings: Implementation Profiles Continuum



The Explorers



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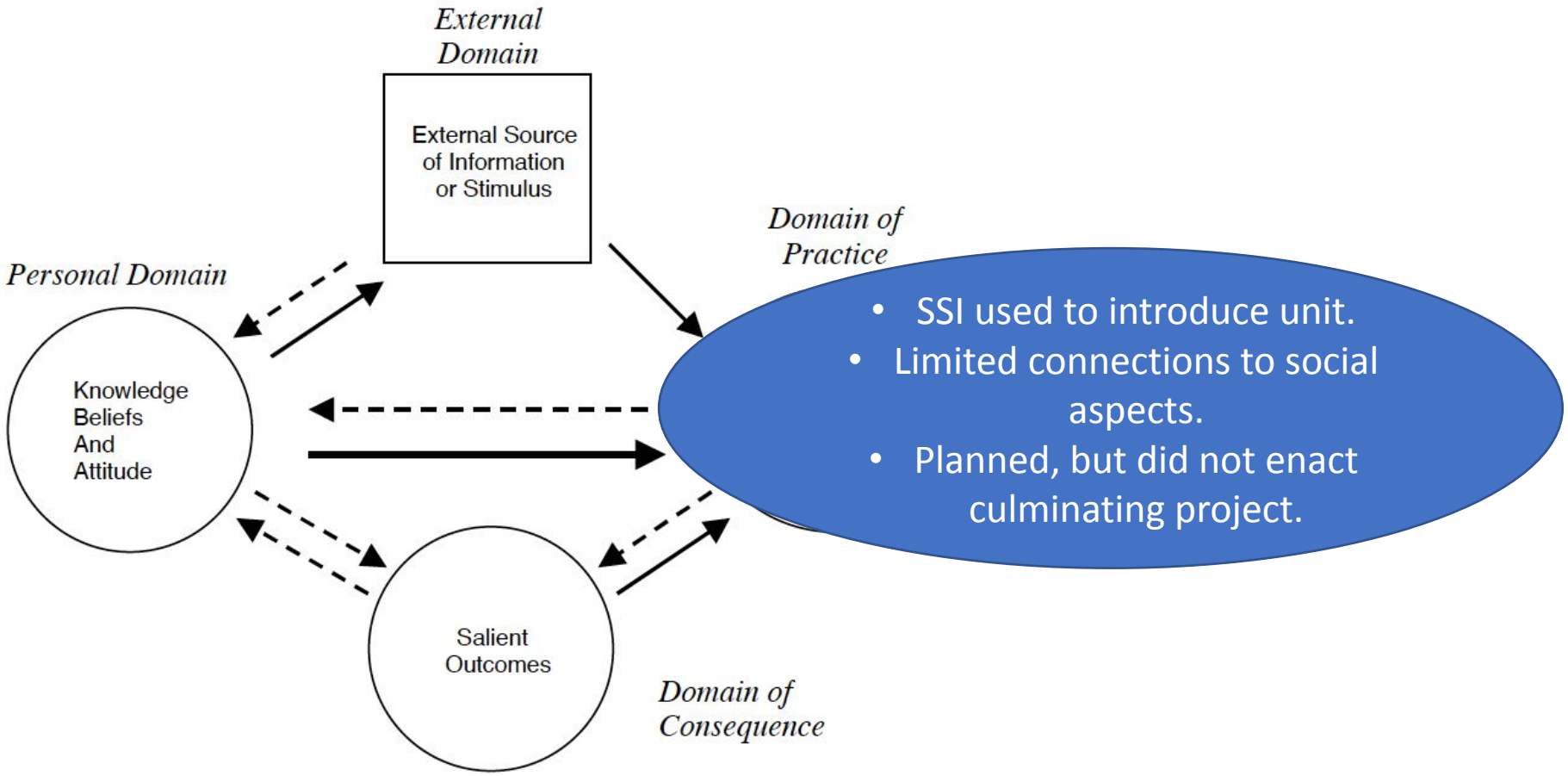
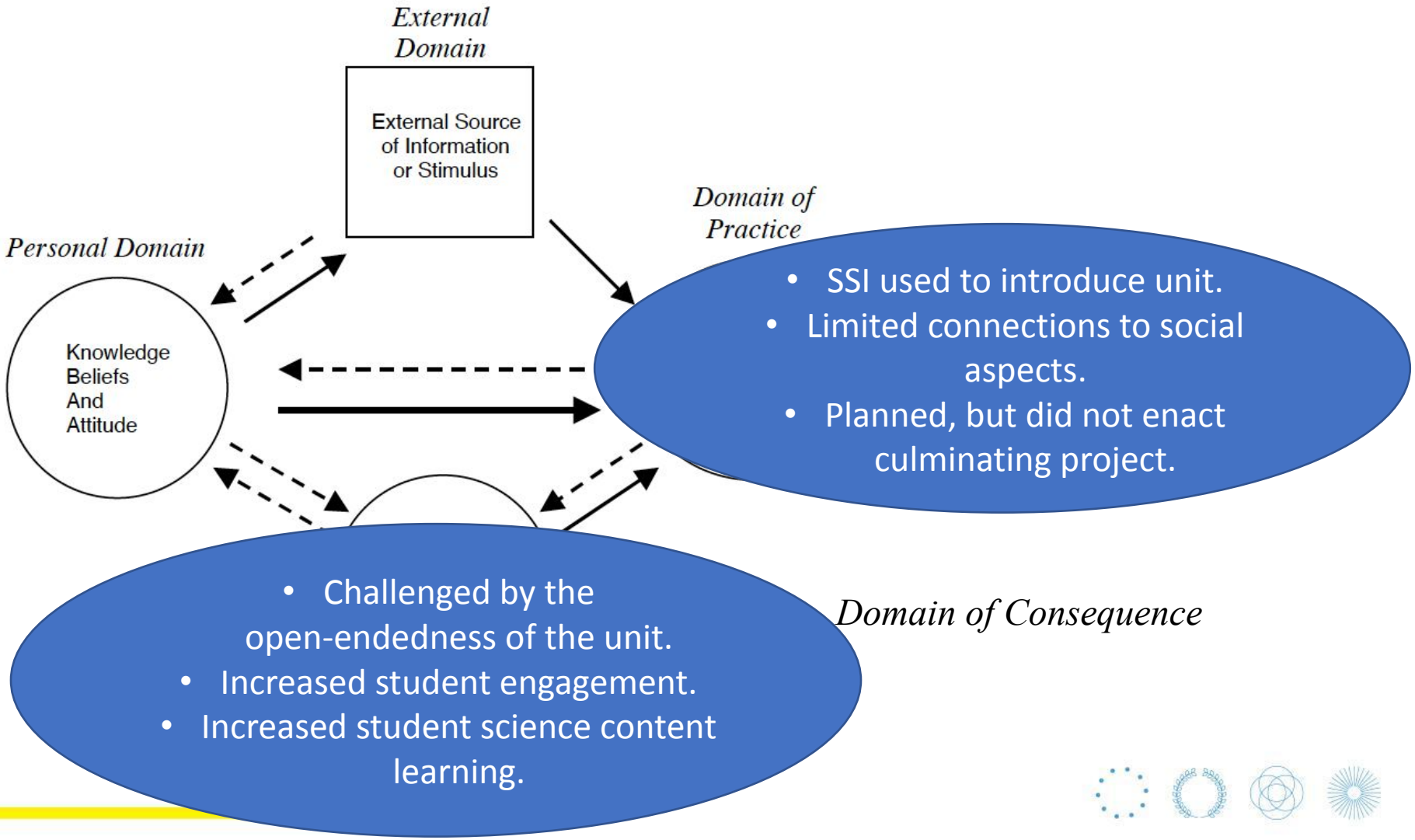


- SSI used to introduce unit.
- Limited connections to social aspects.
- Planned, but did not enact culminating project.

The Explorers



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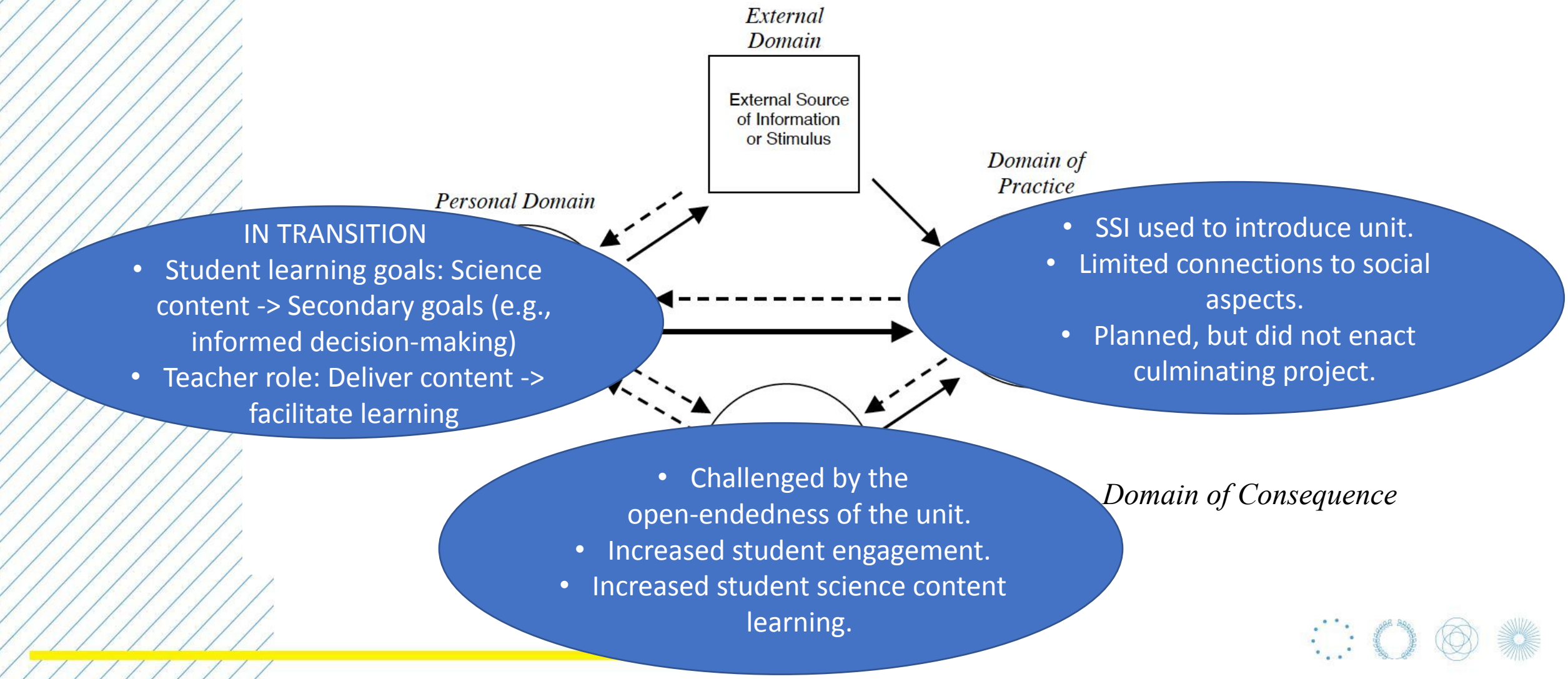

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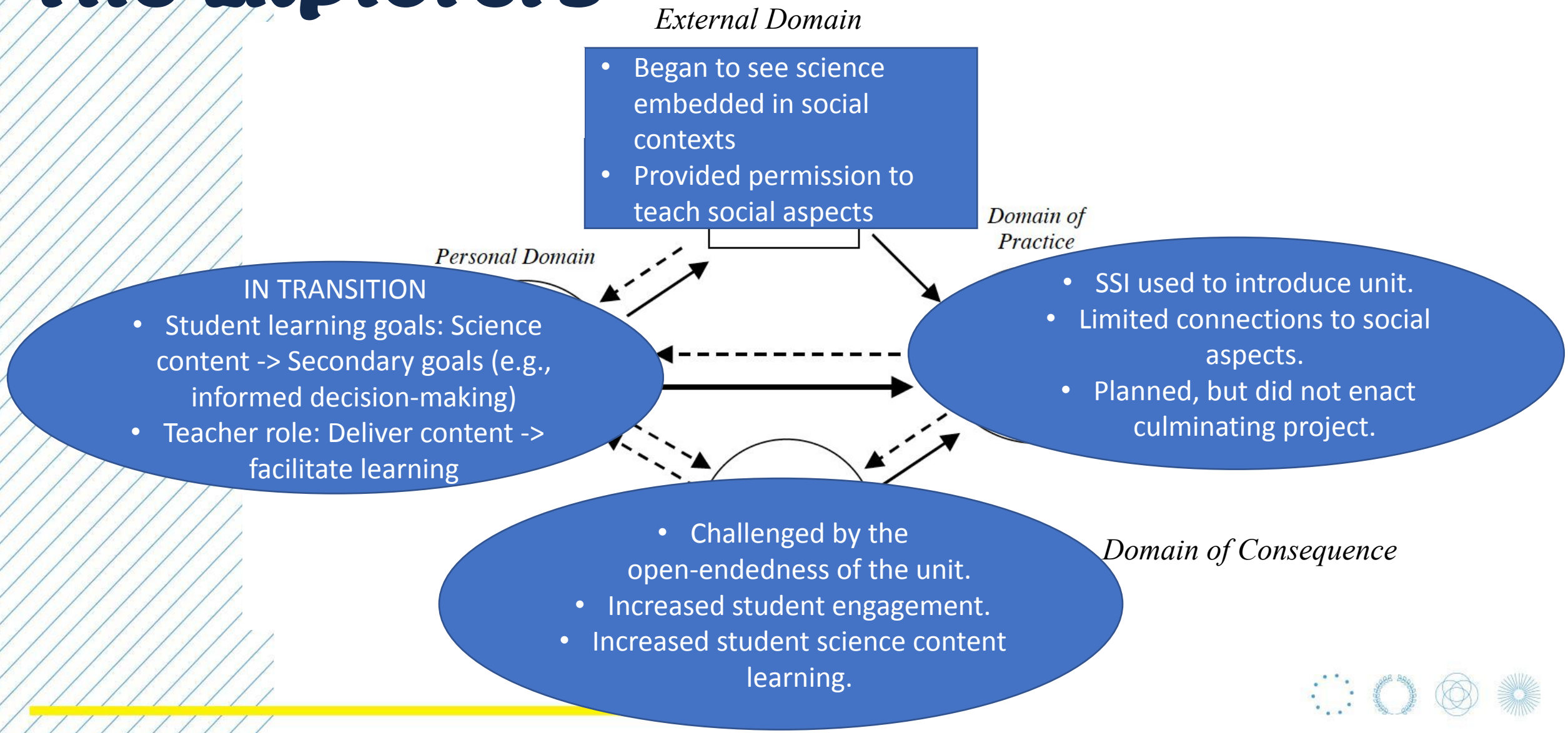


External Domain across Profiles

External Domain

- Began to see science embedded in social contexts
- Provided permission to teach social aspects

Dismissers

Explorers

Embracers

External Domain across Profiles

External Domain

Dismissers	*Explorers*	*Embracers*
• SSI is something we already do—nothing new here • Design teams struggled to collaborate	• Began to see science embedded in social contexts • Provided permission to teach social aspects	• Drew on PD activities to design coherent units • Provided tools to achieve SSI aligned goals

Key Inferences

Dismissers: Misalignment between Personal and External domains was a significant barrier

Explorers: SSI (External Domain) was seen as a way to support motivating & engaging students (Personal Domain). Experience supported their transitional process.

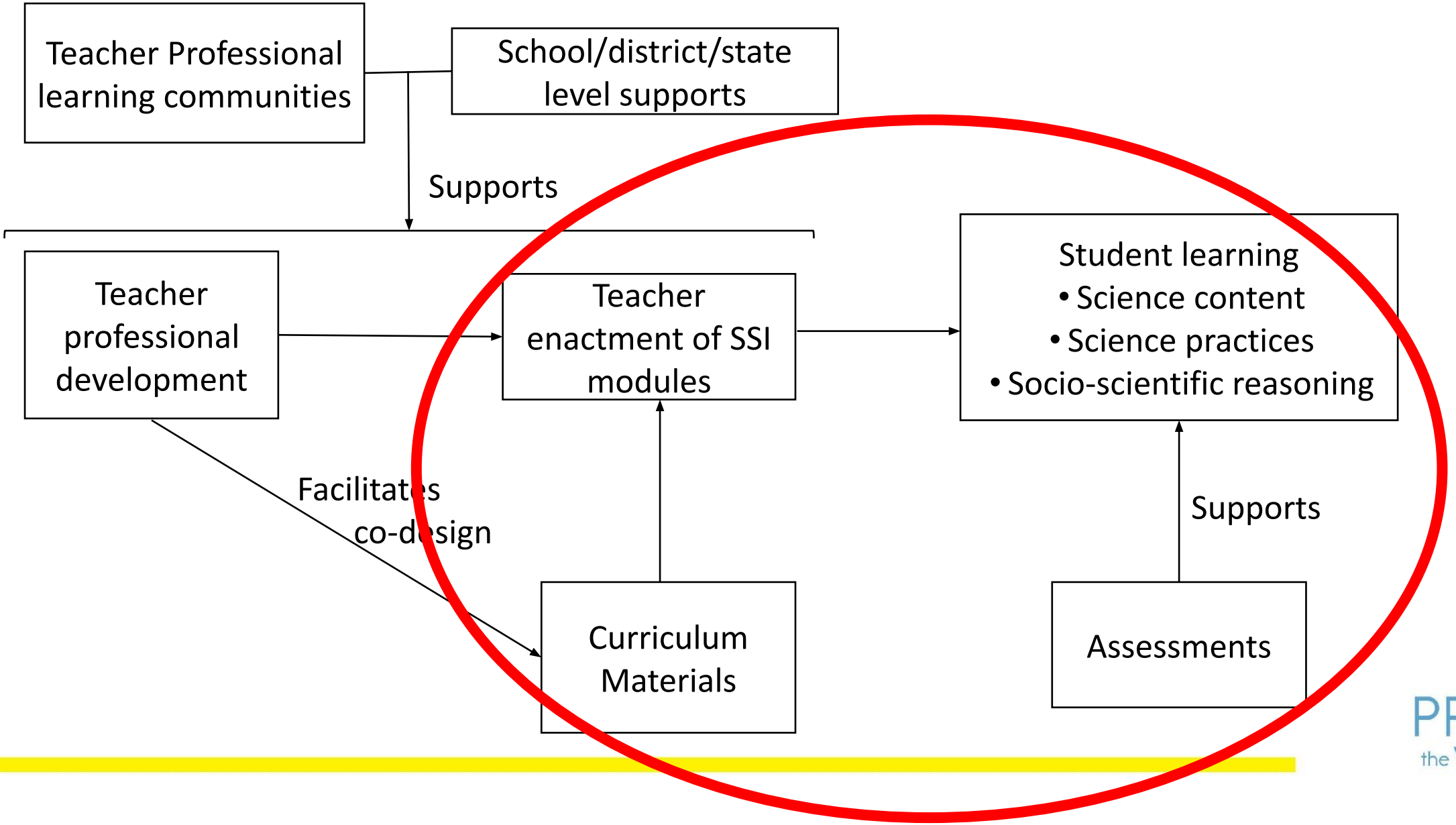
Embracers: Strong alignment across IMPG domains

PD Implications

Profiles	PD Implications
Dismissers	- Member of larger design teams - More PD support for struggling design teams - Critical feedback on SSI unit design
Explorers	- Need for facilitator support during implementation - Need for more SSI instructional and assessment tools - Need to work with PLCs
Embracers	- Experienced SSI teachers and exemplary SSI units were useful resources

Implications for Research

- Investigation of PD supports that help teachers move across the continuum
- Investigation of supports during SSI enactment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SSI & Modeling

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Peel et al. (2018). *Innovations in Science Teacher Education, 3*(3). Retrieved from http://innovations.aste.org/?p=3026

SSI Framework

Sadler et al. (2019). *Educação e Fronteiras/Education and Borders, 9* (25), 8-26.

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Thank you.

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Framework Tools: Essential Features