Using Analysis-of-Practice PD to Improve Science and Mathematics Teaching:

Ways to Support and Study Teacher Learning

DRK-12 PI Meeting

June, 2012

BSCS

A SCIENCE EDUCATION CURRICULUM STUDY

Session Focus Questions

- How are we engaging teachers in analysis-of-practice PD?

- How are we studying/assessing the impact of such work, and what are we learning?

Overview of the Session

- Introduction to the session (10 min)
- Presentations: How four projects are using and assessing analysis-of-practice PD (12-15 min each)
- Discussion about promise and challenges of leading and studying analysis-of-practice PD (45 min)
- Presenter summaries of key take-away ideas and questions (5-10 min)

Discussion questions

1) What do these and other approaches to analysis-of-practice PD have in common? What are important differences?
2) How are these and other projects contributing to our knowledge about how to assess the impact of analysis-of-practice professional development?
3) What can our collective projects contribute to understanding analysis-of-practice PD as a mechanism for improving mathematics and science education? What other research is going on in this area? What are gaps in our knowledge?

The Projects

- *Science Teachers Learning from Lesson Analysis* (Kathleen Roth, BSCS)
- *Mathematics Discourse in Secondary Classrooms (*Beth Herbel-Eisenmann, Michigan State University)
- *Virtual Learning Communities: An Online PD Resource for STEM Teachers* (David Beer, University of Chicago)
- *Energy-A Multidisciplinary Approach for Teachers* (Sue Kowalski, BSCS)

Caveat About the Projects

- Each project is at a different stage, and all are incomplete.
- As a group, we will have more to say about what we hope to learn than about what we have already learned.

What is analysis-of-practice PD?

- There is widespread consensus that effective PD engages teachers in inquiry into their own practice.
- Analysis-of-practice PD is one form of teacher inquiry into practice which engages teachers in using artifacts of teaching (such as videos, student work) to analyze and improve teaching and learning.
- Each presenter will highlight one approach to analysis-of-practice PD.

Science Teachers Learning from Lesson Analysis (STeLLA)

Kathleen Roth
BSCS

How are we engaging teachers in analysis-of-practice PD?

- One-year PD program for 4^{th}, 5^{th} and 6^{th} grade inservice teachers
- Analysis-of-practice PD using videocases in facilitated, study groups
- Focused on specific science content in teachers' curriculum
- Conceptual framework focuses on two lenses for analysis of science teaching practice

Videocases…

- Are content specific, focusing on a targeted set of key science ideas
- Include:
  - Videos of science lessons
  - Videos of pre-post student interviews
  - Videos of pre-post teacher interviews
  - Student pre-post written tests
  - Other student work
  - Lesson plans
  - Any written materials used during the videotaped lessons (curriculum materials, worksheets, etc.)

Analysis of practice is guided by The STeLLA Conceptual Framework

Student Thinking

Science Content Storyline

Strategies for Effective Science Teaching: Using the Student Thinking and Science Content Storyline Lenses

STeLLA Conceptual Framework

Student Thinking — Learning to analyze science teaching through two lenses — **Science Content Storyline**

allows you to learn and use strategies for more effective science teaching

Science Teaching

Strategies to Reveal, Support, and Challenge Student Thinking

1. Ask questions to elicit student ideas and predictions
2. Ask questions to probe student ideas and predictions
3. Ask questions to challenge student thinking
4. Engage students in interpreting and reasoning about data and observations
5. Engage students in using and applying new science ideas in a variety of ways and contexts
6. Engage students in making connections by synthesizing and summarizing key science ideas
7. Engage students in communicating in scientific ways

Strategies to Create a Coherent Science Content Storyline

A. Identify one main learning goal

B. Set the purpose with a focus question or goal statement

C. Select activities that are matched to the learning goal

D. Select content representations matched to the learning goal and engage students in their use

E. Sequence key science ideas and activities appropriately

F. Make explicit links between science ideas and activities

G. Link science ideas to other science ideas

H. Highlight key science ideas and focus question throughout

I. Summarize key science ideas

Lesson Analysis during the Summer Institute

Learn about each STeLLA strategy:

- **Read and discuss** description and examples of STeLLA strategy
- **Identify the strategy**: Watch video of other teachers teaching the target content ideas
- **Analyze videocases** where the strategy is used (or not used)
- **Practice using** the strategy

Lesson Analysis Process

Observation
Make an observation, question or judgment

Claim
Turn your observation, question or judgment into a claim

Evidence and Reasoning
Provide specific evidence to support or develop the claim

Alternatives
Consider alternative explanations and teaching strategies

Focus on Student Thinking & Science Content Storyline

Lesson Analysis During Fall Study Groups

- Teachers teach STeLLA lesson plans that highlight the strategies

- Each study group session focuses on analysis of video from participants' teaching of these lessons
  - PD Leader selects video clips for analysis that highlight particular STeLLA strategies
  - Group uses STeLLA analysis protocol

Lesson Analysis Protocol

1. Identify the Lens & Strategy

What Student Thinking or Science Content Storyline strategy(s) is highlighted in this lesson?

2. Analyze the Focus Question(s)

What do we learn about student thinking when the highlighted strategy(s) is used?
How does the identified strategy contribute to making student thinking visible or to developing the Science Content Storyline?
How does the "visible student thinking" related to the intended storyline?

Lesson Analysis Step	To Do	Example
Claim	Turn an observation, question or judgment into a specific claim that responds to the focus question.	Claim: I think Maria is confused about water vapor. She links the term "water vapor" to the droplets of liquid water she sees on the mirror.
Evidence and Reasoning	Point to a specific place in the video transcript, lesson plan, or student work that supports your claim. Also look for evidence that challenges your claim.	When Maria is breathing onto the cool mirror and seeing the water droplets form she says (14:34) "I can see my breath on the mirror!" Another student in her group says, "We have to use science words to describe what we see." Maria says, "Oh yeah, the science word is 'water vapor'". Water vapor cannot be seen; what Maria sees is liquid water that has condensed on the mirror.
Alternatives	Consider an alternative interpretation or explanation.	Maria may know that water vapor is in her breath, which might explain why she calls the water droplets on the mirror water vapor.
	Consider new questions this might raise.	How does Maria think about other instances of condensation, like "a fogged up mirror after a shower", or "moisture on the outside of a cold glass"?
	Consider alternative question(s), activity(s), or strategies.	Probe and challenge questions would clarify what Maria was thinking. For example, "Can you point to where you think water vapor is?" "Is there water vapor anywhere else?" "What if you breathed on a mirror that was hot? Would that make a difference?

3. Reflect

Videotaped teacher shares reflections on the analysis discussion.

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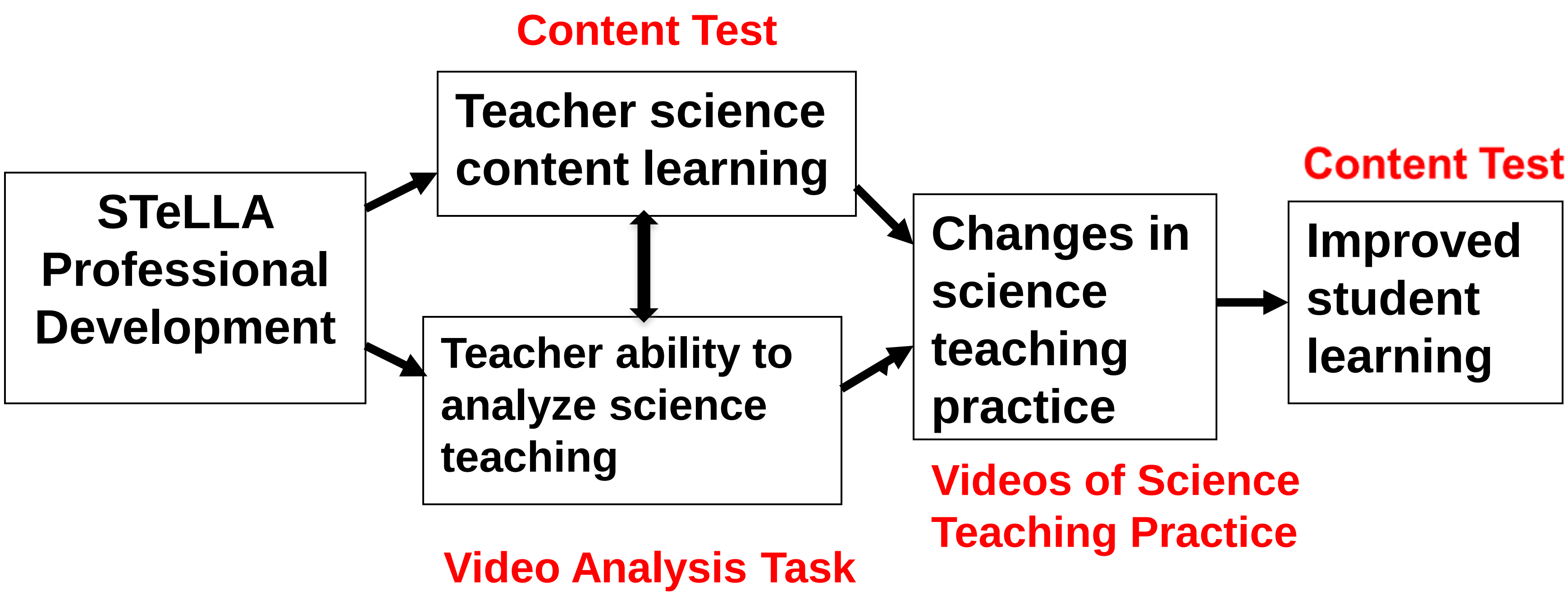
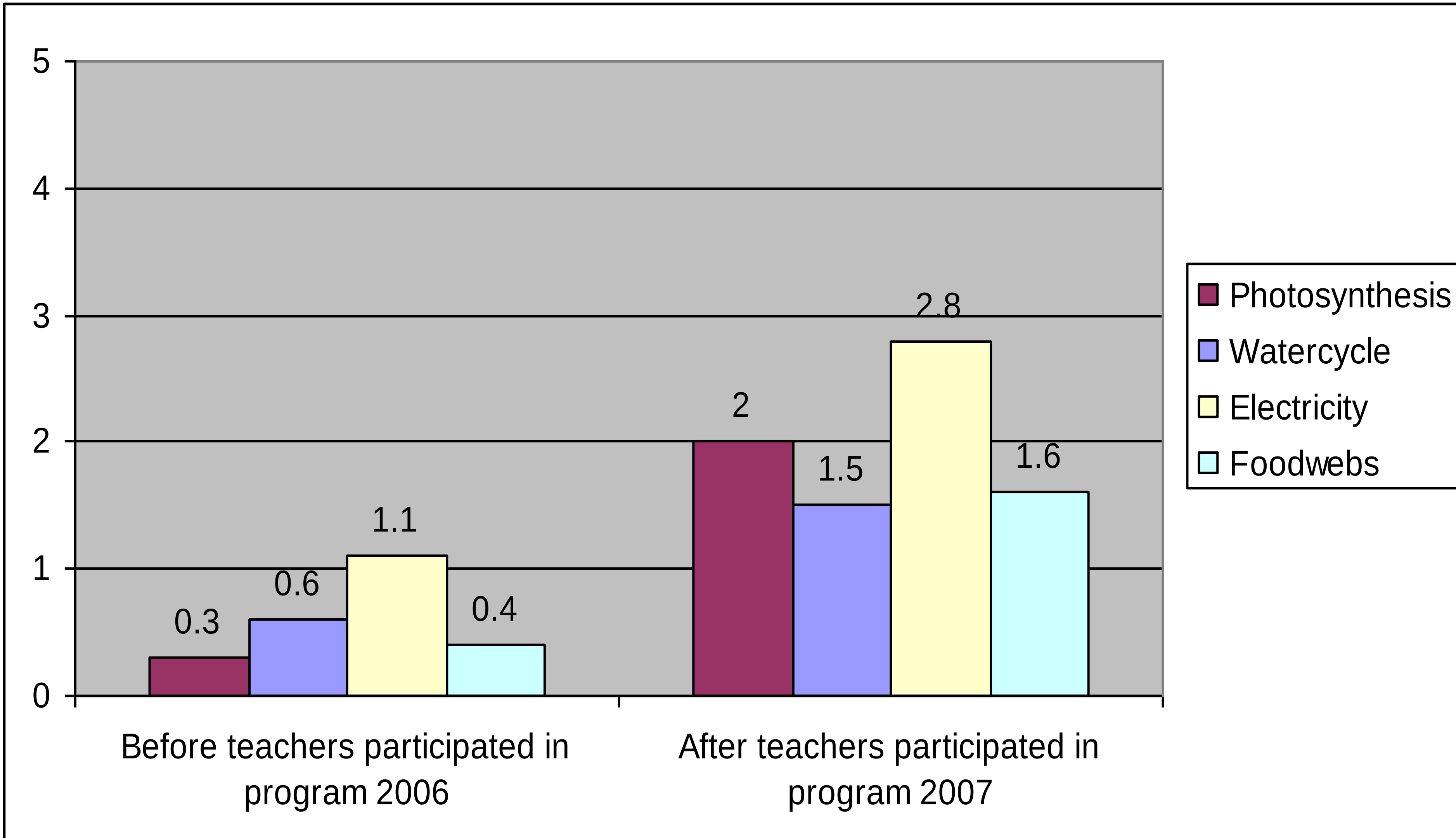
How are we studying/assessing the impact of analysis of practice PD, and what are we learning?

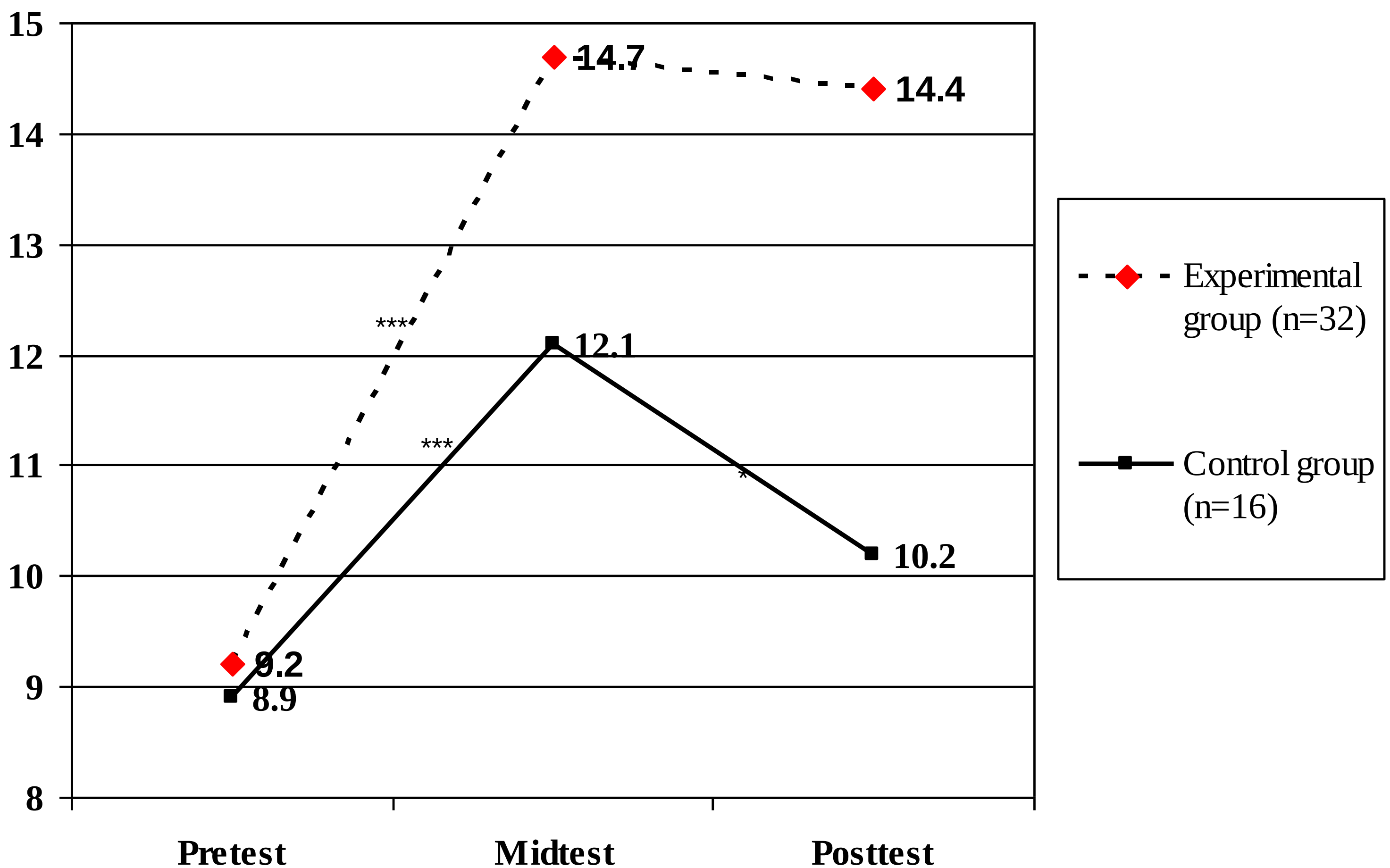
How are we assessing impact?



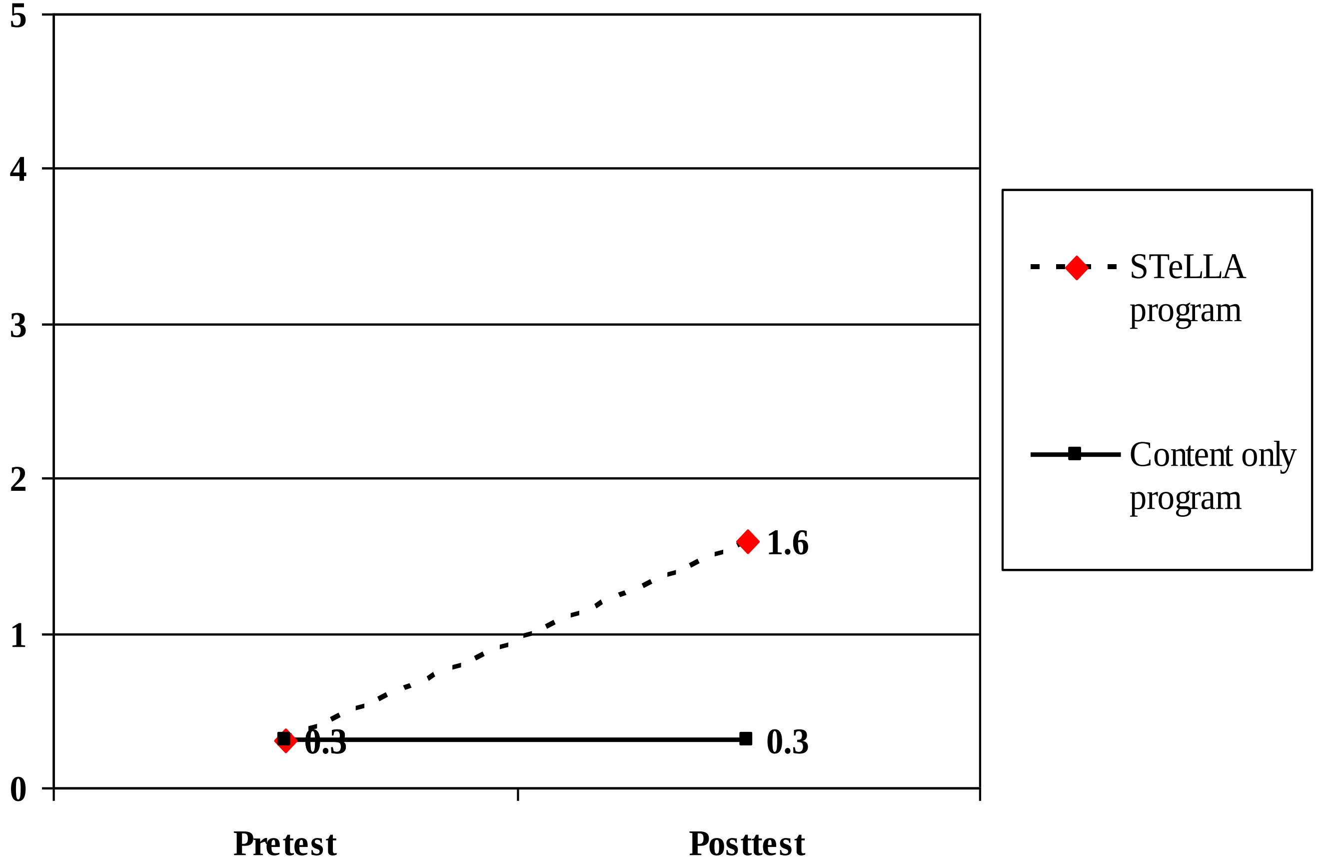
Improved Students' Science Content Learning



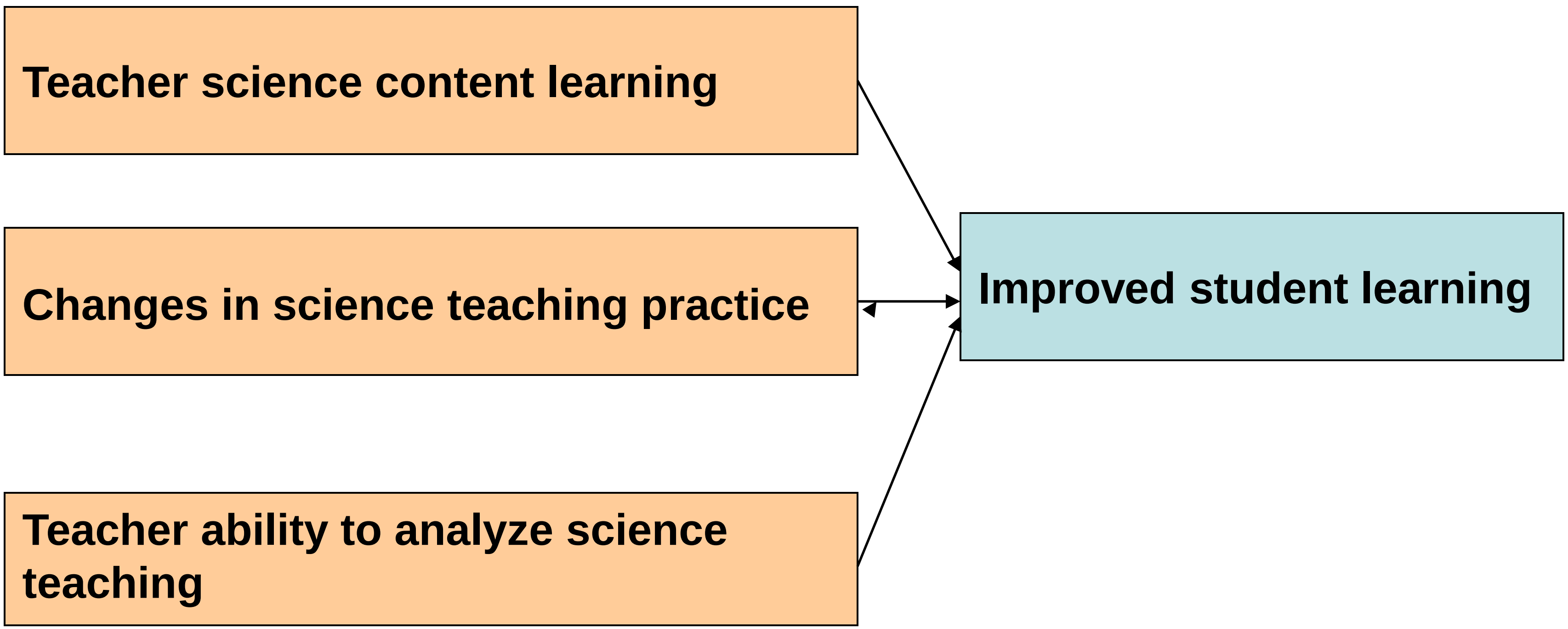
Improved Teachers' Science Content Learning



Change in Ability to Analyze Teaching



Student Learning was Predicted by…



Strategies that Predicted Student Learning

Science Content Storyline Strategies

- One main learning goal
- Set purpose with goal statement or focus question
- Select activities matched to learning goal
- **Link science content ideas and activities**
- **Link content ideas to other content ideas**
- **Content representations matched to learning goal**
- Summarize and synthesize
- Sequence key ideas and activities appropriately

Student Science Learning

Student Thinking Strategies

- Elicit student ideas
- Ask probing/challenge questions
- Engage students in interpreting and reasoning about data and observations
- Engage students in using and applying new ideas in a variety of ways and contexts
- Engage students in making connections through synthesizing and summarizing work

Next Steps: STeLLA Analysis of Practice PD

- Scale-up study with randomized assignment to two groups: Lesson analysis and content deepening
- Study of STeLLA lesson analysis approach with preservice teachers and into first year of teaching

Mathematics Discourse in Secondary Classrooms (MDISC)

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National Science Foundation WHERE DISCOVERIES BEGIN

UNIVERSITY OF DELAWARE

Overview of presentation

- Bigger picture descriptions
- Core discourse ideas included in the materials
- Description of some of the analytic activities we ask participants to do
- Overview of the evaluation data sources
- Share some preliminary ‘noticings’ from the internal pilot this year

MDISC Timeline

Project Timeline

Design & Internal Review

External Review & Revision

Field Testing & Revision

Large-Scale Pilot & Revision

Publication & Dissemination

Phase I
Phase V

Phase II

Phase III

Phase IV

2009-2010

2010-2011

2011-2012

2012-2013

2013-2014

Structure of materials

- **Introduction**
- **Constellation 1**: Explanations, Evidence, & Tacit Expectations (focus on students)
- **Constellation 2**: Interaction Patterns & Teacher Discourse Moves (focus on teachers)
- **Constellation 3**: Planning for Rich Discourse
- **Constellation 4**: Setting Up & Gathering Evidence of Student Work
- **Constellation 5**: Concluding & Contemplating Evidence
- **Capstone**

Each Constellation includes…

- A high-level mathematical task
- A written or video case of a secondary mathematics teacher teaching that task
- Other artifacts related to the task
- Short readings or summaries of readings
- One or more Connecting to Practice activities

Key discourse concepts underlying materials

<u>Stop and notice</u>: Teacher Discourse Moves

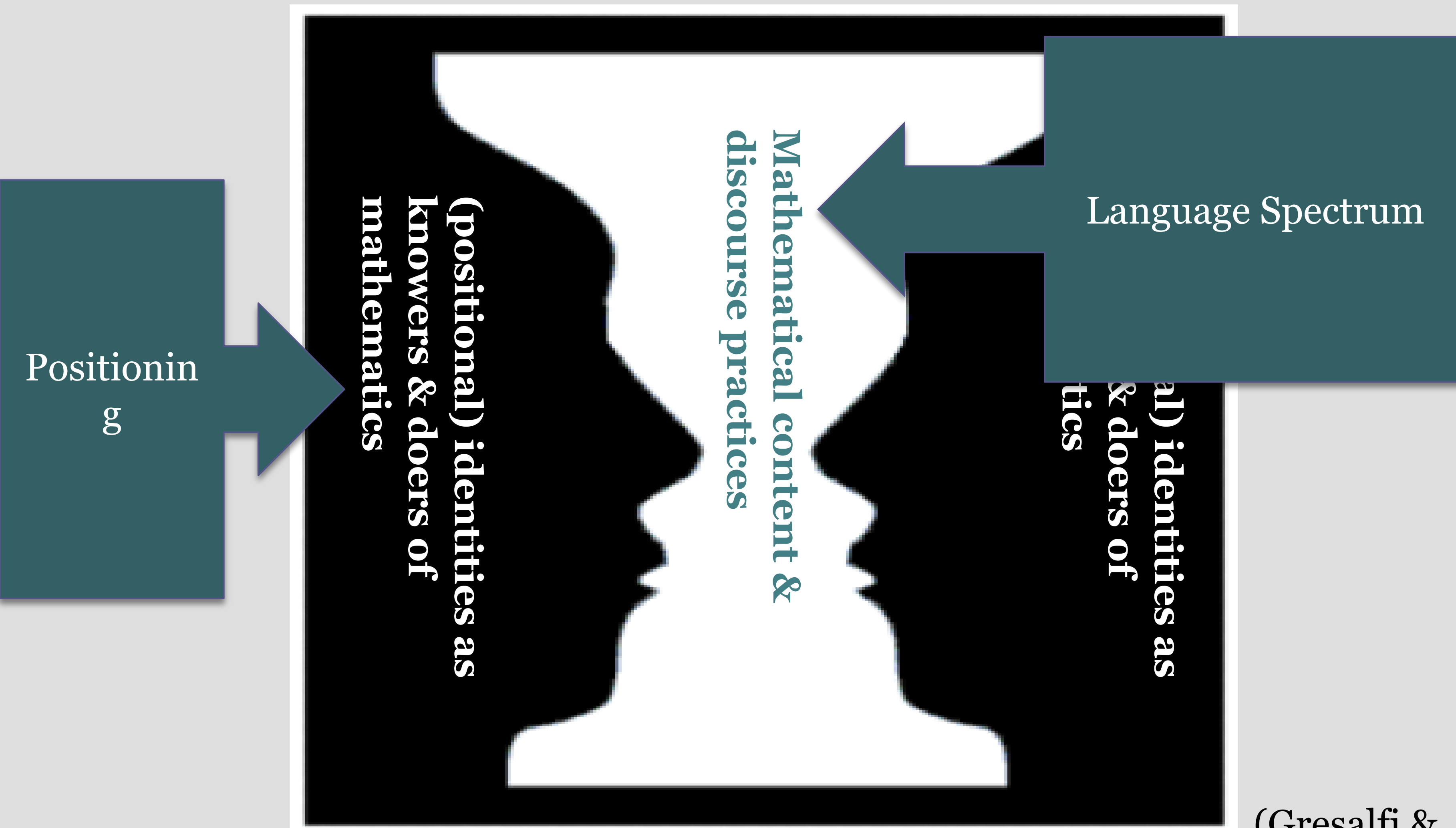
<u>Interpretive discourse lenses</u>:

- Language Spectrum (& Math Register)
- Positioning

Teacher Discourse Moves (TDMs) (based on modified "talk moves" proposed by Chapin, O'Connor & Anderson, 2003)

- *Inviting* student participation
- *Waiting*
- *Revoicing*
- *Asking* students to revoice
- *Probing* a student's thinking
- *Creating* opportunities to engage with another's reasoning

Opportunities to learn: access to…



(Gresalfi & Cobb, 2006)

Language Spectrum (based on the mode continuum described by Gibbons (2003, 2004, 2006, 2008, 2009))

- Focuses on "communication context" (how language changes based on various contexts)
- Describes movement from context-dependent language to more abstract and discipline-based use of language

Consider how language changes as…

- a small group of students work at their desks to try to solve a mathematical task;
- one student from that group is asked to report out their solution to other students after the groups worked on the task;
- a student might write up a formal explanation; and
- textbook explanation

Communication Context	Type of Text Typically Produced	Some Common Characteristics of the Text
Small group work		
Whole class reporting out		
Student written solution		
Textbook		

Communication Context	Type of Text Typically Produced	Some Common Characteristics of the Text
Small group work	**Language of Interaction**	**Pointing, contextual language, vague references**
Whole class reporting out		
Student written solution		
Textbook		

Communication Context	Type of Text Typically Produced	Some Common Characteristics of the Text
Small group work	Language of Interaction	Pointing, contextual language, vague references
Whole class reporting out	**Language of Recounting Experience**	**More specific, more mathematical terms, some logical connectors but also chronology, usually past tense, human actors (I, we) and action verbs**
Student written solution		
Textbook		

Communication Context	**Type of Text Typically Produced**	**Some Common Characteristics of the Text**
Small group work	Language of Interaction	Pointing, contextual language, vague references
Whole class reporting out	Language of Recounting Experience	More specific, more mathematical terms, some logical connectors but also time connectors, usually past tense, human actors (I, we) and action verbs
Student written solution	**Language of Generalizing Experience**	**Explain and justify what did, "you" or mathematical objects as actors, logical connectors, more mathematically dense, timeless present tense**
Textbook		

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Small group work	Language of Interaction	Pointing, contextual language, vague references
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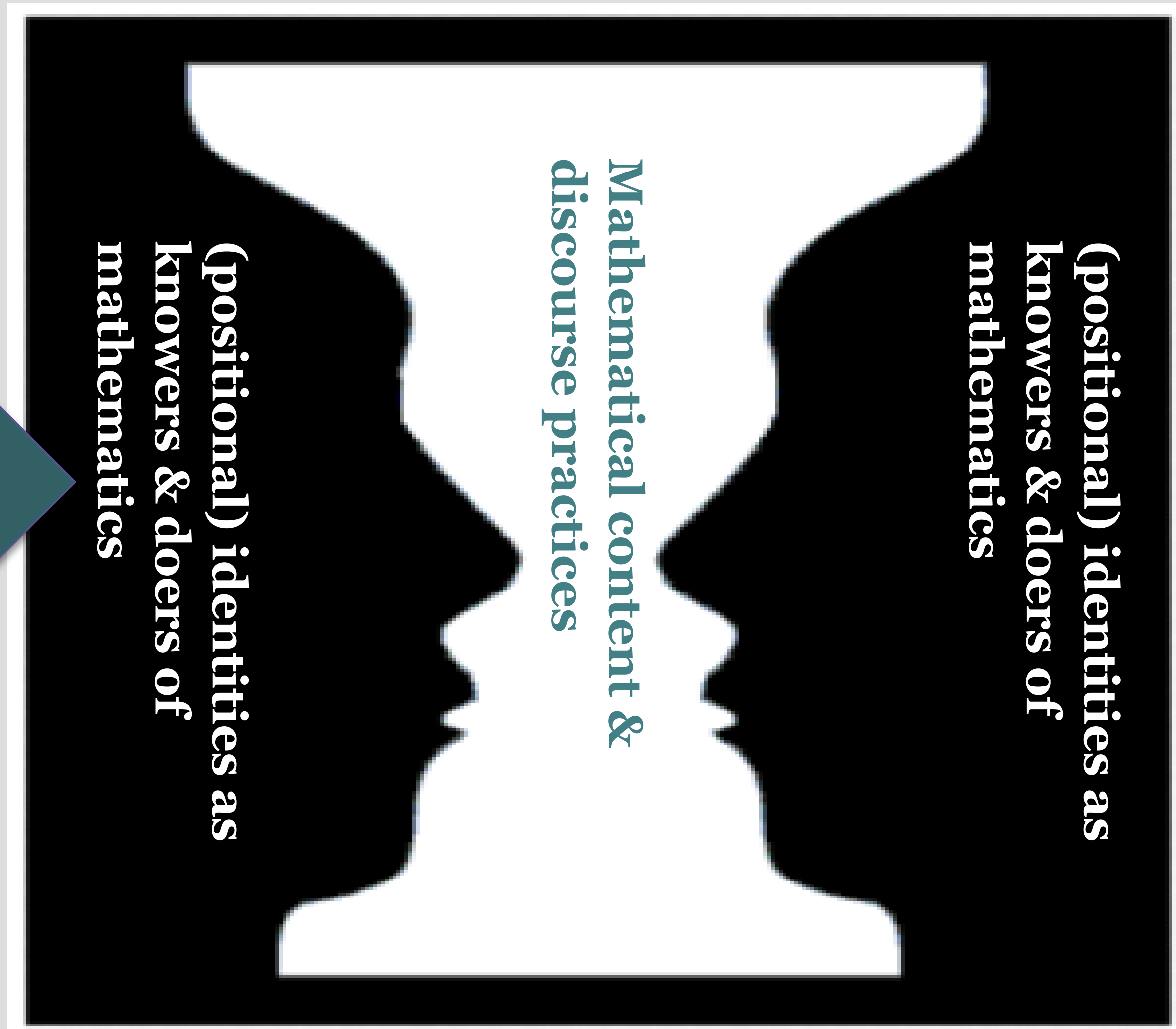
Student written solution	Language of Generalizing Experience	Explain and justify what did, "you" or mathematical objects as actors, logical connectors, more mathematically dense, timeless present tense
Textbook	**Similar to the Mathematics Register**	**Dense noun phrases, no human actors, nominalizations, logical connectors, symbols, relational verbs**

Opportunities to learn: access to…

Positionin
g



(Gresalfi & Cobb, 2006)

Positioning (based on van Langenhove & Harré (1990))

…the ways in which people use action and speech to arrange social structures… recognizes that there can be multiple kinds of conversation happening in any mathematics classroom, each of which assigns fluid roles to the participants. (Wagner & Herbel-Eisenmann, 2009)

- People can position themselves &/or others
- Not necessarily intentional

Positioning on two levels

- Individual level: between/among people
  - *Who is considered knowledgeable in my classroom? About what (e.g., procedures? concepts?)? Whose voice is being heard? In what ways? Who is considered a 'struggling' learner?*
- Classroom level: what it means to know and do mathematics
  - *Is mathematics about procedures, concepts and/or something else? What kind of mathematical practices (e.g., argumentation, explanation, just answers) do we engage in? What is emphasized, thinking processes or doing processes? Do we generate mathematics collaboratively or is it something done individually?*

Some of the analytic activities we have incorporated

Example activities & analyses

- A written or video case
  - Identify examples of key discourse ideas
    - How does the language in these small groups or whole class reporting out resemble what we might expect?
    - Where do you see some of the TDMs happening?
  - What seems to be happening around that TDM in terms of ideas from the Language Spectrum and in terms of positioning?

Example activities & analyses

- Other artifacts related to the task
  - Textbook excerpts
    - What characteristics of the math register do you see?
    - How might students make sense of this text?
  - Student written work
    - What characteristics of language do you see that you would want to highlight when you select solutions to have students share?
    - How would you sequence the solutions to work toward your mathematical or social goals?
    - Who might need more support to use language like the math register?

Example activities & analyses

- Connecting to Practice activities
  - Select 3 focus students and attend to their language use
  - Record small groups; Record whole class reporting out
    - What are you currently doing?
    - What happens when you try using TDMs?
  - Bring examples of student work

Evaluation: Horizon Research

- M-DISC materials is intended to have an impact on
  - participants' awareness and use of strategies for promoting mathematical classroom discourse; and
  - their understanding of ways in which such discourse can affect students' learning of mathematics and identities as mathematical learners.
- Embedded evaluations:
  - written journals about prompts in materials; "Connecting to Practice" activities journals & discussions; discussions around videos in materials
- Additional evaluation sources:
  - self-analysis of video; pre- and post- Likert scale participant questionnaire; participant interviews

Observations from internal pilot

- Teacher Discourse Moves
  - Participants found these useful tools to open up classroom discourse
  - When they started to use the TDMs, participants were surprised by what students did and how engaged they were
  - Concerned about time…

Observations from internal pilot

- Positioning
  - Many social aspects of teaching/learning rarely considered by participants prior to PD
    - Purposeful about norms; Relationships between identity development, what it means to know and do math, and discourse previously transparent
  - Shifting meanings of positioning
    - Noun: "Low-level kids"
    - Verb: About ways students behave, social norms, and what it means to know/do math (maybe less about identity development)

Observations from internal pilot

- Language Spectrum, Math Register
  - Participants hadn't considered that communication is different in different communication contexts—recognized the need to put students in different contexts to support them well (especially writing)
  - Some participants focused only on "vocabulary" rather than on other meaning systems or grammatical choices
  - Participants got more nuanced in their noticing of the kind of language students used

Thank you!

For more information go to www.mdisc.org

Virtual Learning Communities: An Online PD Resource for STEM Teachers

David Beer

University of Chicago

Energy-A Multidisciplinary Approach for Teachers

Sue Kowalski

BSCS

Partners

- Oregon Public Broadcasting
- National Renewable Energy Lab
- Great Lakes Bioenergy Research Center
- RMC Research
- National Teachers Enhancement Network

Purpose of the Course

Enhance participant teacher

- Content knowledge
- Pedagogical Content Knowledge (PCK) and
- Practice

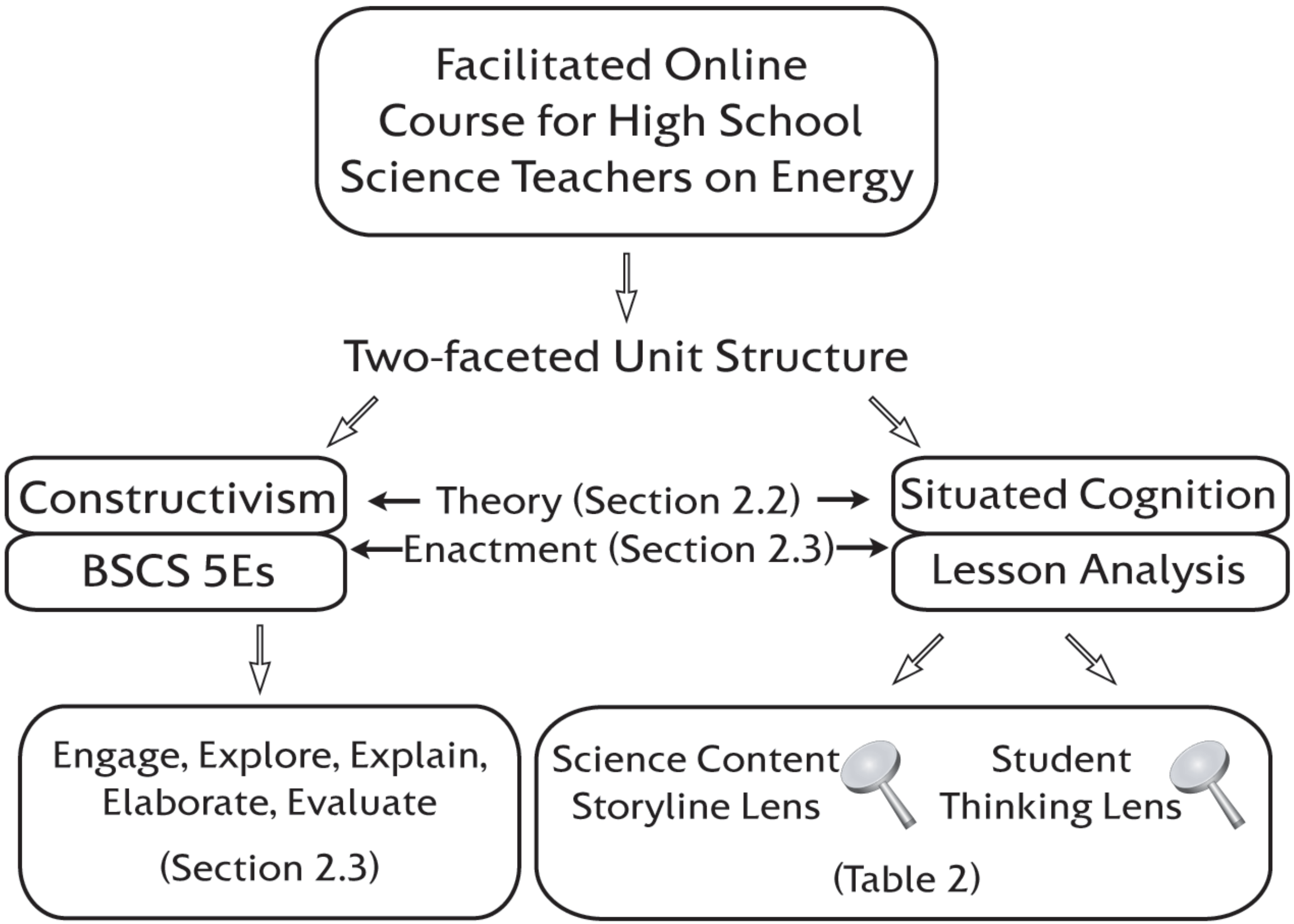
as related to key energy concepts

Intended Audience

High school science teachers

- Teaching out of their field of endorsement
- Teaching in schools in low-income neighborhoods
- Teaching in schools with high percentages of students from racial/ethnic groups typically underrepresented in the sciences

Theoretical Framework



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Strategies for Effective Science Teaching:
Using the Student Thinking and Science Content Storyline Lenses

STeLLA Conceptual Framework

Student Thinking — Learning to analyze science teaching through two lenses — **Science Content Storyline**

allows you to learn and use strategies for more effective science teaching

Science Teaching

Strategies to Reveal, Support, and Challenge Student Thinking	**Strategies to Create a Coherent Science Content Storyline**
1. Ask questions to elicit student ideas and predictions	A. Identify one main learning goal
2. Ask questions to probe student ideas and predictions	B. Set the purpose with a focus question or goal statement
3. Ask questions to challenge student thinking	C. Select activities that are matched to the learning goal
4. Engage students in interpreting and reasoning about data and observations	D. Select content representations matched to the learning goal and engage students in their use
5. Engage students in using and applying new science ideas in a variety of ways and contexts	E. Sequence key science ideas and activities appropriately
6. Engage students in making connections by synthesizing and summarizing key science ideas	F. Make explicit links between science ideas and activities
7. Engage students in communicating in scientific ways	G. Link science ideas to other science ideas
	H. Highlight key science ideas and focus question throughout
	I. Summarize key science ideas

Illustration—Coal Unit

Engage	
Content	Analysis of Practice
Express understanding about: • production of electricity from a coal-fired power plant.	Express understanding about • effective science instruction
Explore	
Explore trends in data : • What do data indicate about the origin of coal? • What variables relate to electrical energy production by induction?	Explore research: • What are students' ideas related to where plant matter, and thus coal, comes from? • What are one student's thoughts about the process of induction?

Illustration—Coal Unit

Explain	
Content	Analysis of Practice
Develop an explanation for generating electricity from coal in a systems context: • inputs • outputs • mining→transportation→power plant	Identify key questioning strategies that • reveal, • support, and • challenge student thinking about electricity generation Identify the use of these questions in practice (video)

Illustration—Coal Unit

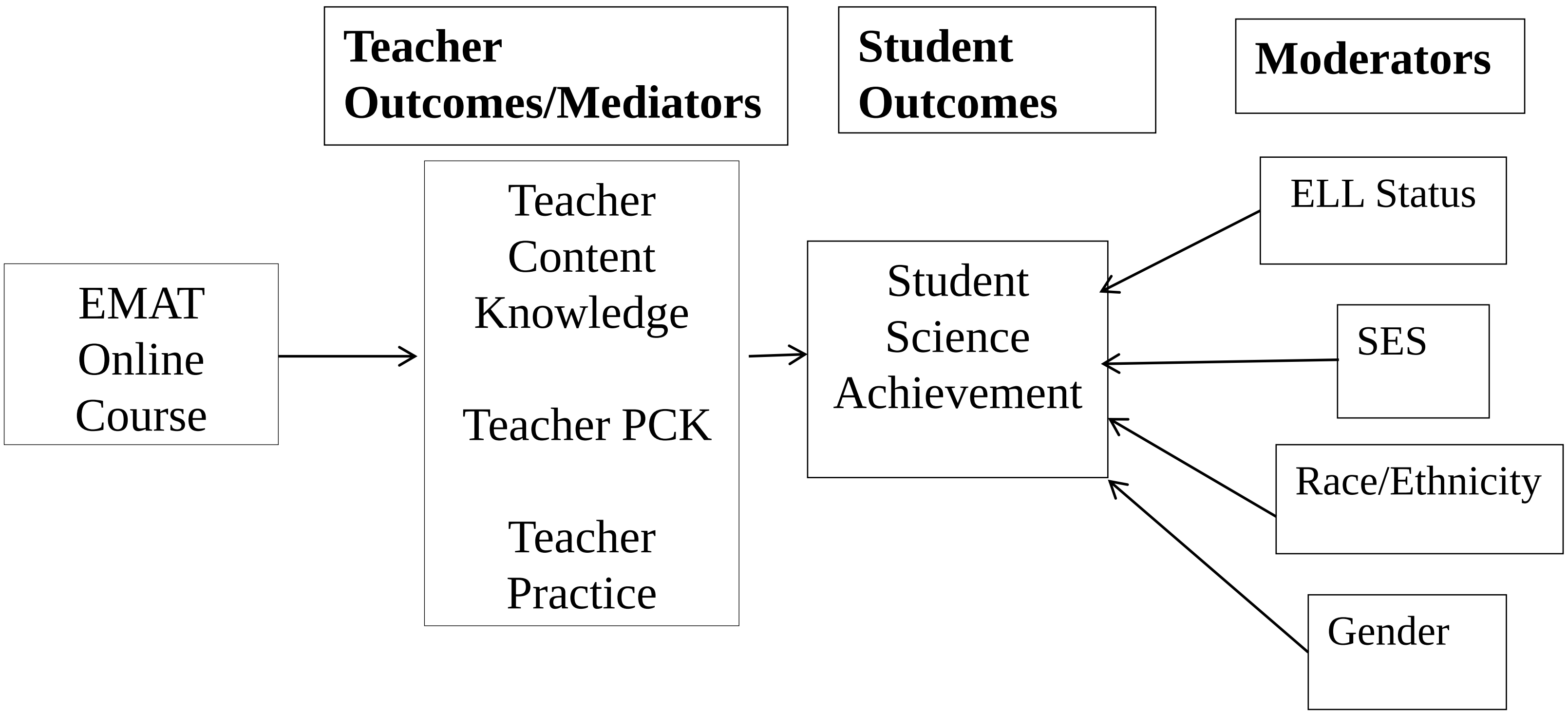
Elaborate	
Content	Analysis of Practice
Examine electricity generation considering: • efficiency • heat loss	Examine questioning strategies considering: • what are students thinking about electricity generation? Synchronous discussion of video • Make a claim • Provide evidence • Consider alternatives

Illustration—Coal Unit

Evaluate	
Content	Analysis of Practice
Demonstrate understanding by: • creating and submitting a refined systems diagram.	Demonstrate understanding by: • analyzing classroom video for student thinking about induction

Figure 3. Theory of Action

Theory of Action



Assessing Impact

- Teacher learning outcomes
  - Content knowledge (pre/posttest)
  - Pedagogical content knowledge (analysis of practice tasks, pre/post)
  - Practice (video, pre/post)
- Student learning outcomes
  - Content knowledge (pre/posttest)

Research Design

2012-2013
Comparison Group

Teachers teach
Students learn

Assess teachers (pre)
Assess students (pre and post)

→

Summer, 2013
Intervention

Teachers take EMAT course

→

2013-2014
Treatment Group

Teachers teach
Students learn

Assess teachers (post)
Assess students (pre and post)

EMAT Project Timeline

Year 1 | Year 2 | Year 3 | Year 4 | Year 5

Develop Pilot Unit

Develop Tests

Pilot Unit and Tests

Recruit Teachers for Field Test 1

First Field Test
Teacher Pre/Post
Teacher Surveys

Second Field Test
Teacher Pre/Post
Teacher Surveys

2nd Advisory Board Meeting

Develop All Units for Field Test 1

Revise All Units for Field Test 2

Revise All Units for Final Version

Pre/Posttest FT1 Control Students

Pre/Posttest FT1 Treatment Students

Field Test 1 Teachers Film Themselves Teaching (Pre)

Field Test 1 Teachers Film Themselves Teaching (Post)

Recruit Teachers for Field Test 2

3rd Advisory Board Meeting

4th Advisory Board Meeting

Pre/Posttest FT2 Control Students

Pre/Posttest FT2 Treatment Students

Field Test 2 Teachers Film Themselves Teaching (Pre)

Field Test 2 Teachers Film Themselves Teaching (Post)

Discussion questions

1) What do these and other approaches to analysis –of-practice PD have in common? What are important differences?
2) How are these and other projects contributing to our knowledge about how to assess the impact of analysis-of-practice professional development?
3) What can our collective projects contribute to understanding analysis-of-practice PD as a mechanism for improving mathematics and science education? What other research is going on in this area? What are gaps in our knowledge?

Thank you for your participation!

STeLLA Lesson Analysis includes…

- Viewing Basics
- Analysis Basics
- Analysis Process
- Analysis Protocol

Video Viewing Basics

- Viewing Basic #1: Look past the trivial, the little things that “bug” you.
- Viewing Basic #2: Avoid the “this doesn’t look like my classroom” trap.
- Viewing Basic #3: Avoid making snap judgments about the teaching or learning in the classroom you are viewing.

Analysis Basics

- Analysis Basic #1: Focus on student thinking and the science content storyline.
- Analysis Basic #2: Look for evidence to support any claims.
- Analysis Basic #3: Look more than once.
- Analysis Basic #4: Consider alternative explanations and teaching strategies.

Lesson Analysis during Spring Study Groups

- Teachers identify, analyze, and use STeLLA lenses and strategies in a new content area
- Teachers collaboratively develop lessons

Discussion questions

1) What do these and other approaches to analysis-of-practice PD have in common? What are important differences?
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