Development and Implementation of Learning Progression-Based Teaching Strategies (LPTSSs) for Environmental Science Literacy

January 23, 2012
What’s Ahead?

- Introduction to project, LPs, student and teacher knowledge – John Moore
- Our view of effective teaching and professional development (PD)
  - Theories of Action – Alan Berkowitz
  - Overview of our PD approaches – Sylvia Parker
- Showcasing innovative PD practices
  - PD for teacher content learning – Jennifer Doherty
  - PD for teacher pedagogical content learning – Jennifer Doherty
  - PD for responsive teaching – Michele Johnson
  - PD for self efficacy and motivation – Michele Johnson
- Conclusions and future directions – Alan Berkowitz
<table>
<thead>
<tr>
<th>Project Activities and Themes</th>
<th>Biodiversity</th>
<th>Carbon</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Progression Frameworks R&amp;D</td>
<td>Cross-cutting concepts, skills, models</td>
<td>Biodiversity Assessments</td>
<td>Carbon Assessments</td>
</tr>
<tr>
<td>Teaching Experiments</td>
<td>Leaf Pack Organisms Lessons &amp; Aides</td>
<td>Plant Growth Lessons &amp; Aides</td>
<td>School Campus Water Budget Lessons &amp; Aides</td>
</tr>
<tr>
<td>Professional Development R&amp;D and Implementation</td>
<td>Teachers’ Guide</td>
<td>Teachers’ Guide</td>
<td>Teachers’ Guide</td>
</tr>
<tr>
<td>Citizenship R&amp;D</td>
<td>Using Science in Decision-Making Case Study Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quantitative Reasoning R&amp;D</td>
<td>Literacy, Interpretation, Modeling Framework</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Culture and Place R&amp;D</td>
<td>Site-Specific PD Practices and Supports</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Guiding PD Questions

- What are learning progression based teaching strategies (LPTSs)?
- What supports and constrains teachers’ use of LPTSs?
- How have Professional Development (PD) activities in the Pathways Project influenced teachers’ use of LPTSs?
Core PD Hypotheses

• Teachers can use learning progression-based teaching strategies (LPTSSs) to foster culturally relevant environmental science literacy.

• We can provide PD experiences, resources and materials, and support that foster teachers’ effective use of LPTSSs.
Learning Progressions Include:

- A learning progression framework, describing levels of achievement for students learning (Model of cognition)
- Assessment tools that reveal students’ reasoning: written assessments and clinical interviews (Observation and interpretation)
- Teaching tools and strategies that help students make transitions from one level to the next (Empirical validation)
Learning Progressions

I. Force Dynamic

II. Hidden Mech.

III. School Science

IV. Model Based

KEY: learning
Research Methods: Iterative Research Process

**ASSESSMENTS:** Develop/revise interview protocol and written assessment items; Collect data

**MODEL OF COGNITION:** Develop/Revise Learning progression framework

**INTERPRETATION:** Analyze data and identify patterns of students’ learning performances
Biodiversity Strand Group: Student Understanding of Species Diversity in Ecosystems

Laurel Hartley, Jennifer Doherty, Cornelia Harris, Andy Anderson, Shawna McMahon, John Moore, Alan Berkowitz, MaryAnn Murphy, Marcia Angle, Carol Blanchette, Jonathon Schramm, Scott Simon, Brook Wilke, and others
Biodiversity LP research - Exploring student understanding of:

- Recognition of Biodiversity
- Individual Life Cycles
- Natural Selection
- Community Interactions
Oysters are filter feeders that live in the ocean and eat plankton (microscopic floating plant-like organisms).

a) What kinds of things do you think could cause a change in the amount of plankton in the water?

b) Explain how oysters and plankton interact with each other. Think about how one organism might help or harm the other.

c) If the number of oysters decreases, how might that impact the plankton population? What else would you need to know to feel confident about your answer?

d) What kind of information would you need to figure out how a decline in oysters might affect other parts of the ecosystem, besides the plankton?
## Interactions Rubric

<table>
<thead>
<tr>
<th>Score</th>
<th>Diagram</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td><img src="image1.png" alt="Diagram 4" /></td>
<td>Explains connections between abiotic and biotic</td>
</tr>
<tr>
<td>3</td>
<td><img src="image2.png" alt="Diagram 3" /></td>
<td>Explains multiple connections but still focuses on biotic</td>
</tr>
<tr>
<td>2</td>
<td><img src="image3.png" alt="Diagram 2" /></td>
<td>Predator-prey</td>
</tr>
<tr>
<td>1</td>
<td><img src="image4.png" alt="Diagram 1" /></td>
<td>Target organism or multiple unconnected organisms</td>
</tr>
</tbody>
</table>
Interactions Results

Oyster Interactions

N=127 high school students, 161 middle school students, 120 teachers
Challenges

• Basing PD on R&D that is on-going
  – student learning progression research is in progress
  – development and assessment of effective teaching strategies and resources are still in progress

• Engaging teachers in responsive teaching, requires
  – the CK, PCK, LPCK (LP content knowledge) required are beyond what many teachers have
  – the time, authentic experiences, and depth required for LPTs run counter to the prevailing emphasis on breadth and on level-3-focused standardized tests and curricula

• Some of our content is not in the MS and HS curriculum
What’s Ahead?

• Introduction to project, LPs, student and teacher knowledge – John Moore

➢ Our view of effective teaching and professional development (PD)
  – Theories of Action – Alan Berkowitz
  – Overview of our PD approaches – Sylvia Parker

• Showcasing innovative PD practices
  – PD for teacher content learning – Jennifer Doherty
  – PD for teacher pedagogical content learning – Jennifer Doherty
  – PD for responsive teaching – Michele Johnson
  – PD for self efficacy and motivation – Michele Johnson

• Conclusions and future directions – Alan Berkowitz
Effective Teaching in MS/HS Environmental Science

- Focus instruction on important **big ideas** in the field of study.
- Plan instruction based on **anticipated level of student understanding**, background and an interest.
- Develop and use **formative assessments** to guide selection of instructional strategies and sequences.
- Support student learning through careful **attention and response to student thinking**.
- Engage students in guided or open **inquiry with authentic events and experiences** ... with organisms and ecosystems outside.
- **Link environmental science to real problems** in the local environment.
- Have students **engage in and reflect on science-based citizenship practices**.
Premise: Learning progressions help teachers...

- Identify and focus on the important, big ideas and ways of thinking ... for themselves and their students
- Design lessons that are interesting and challenging
- Select and implement activities that move students along effective learning trajectories
- Probe and respond productively to student reasoning
- Help students use experiences and evidence from the real world to build understandings
Learning Progression-Based Teaching Strategies

- Anticipatory
- Formative
- Responsive
- Instructive
- Systemic
Key factors shaping teacher interest & practice in using learning progression-based teaching strategies

- **Contextual Factors**
  - local environment
  - school system
  - resources
  - PD

- **Personal Factors**
  - CK and PCK
  - teaching skills
  - interest in envt.

- **Self Efficacy**

- **Outcomes Expectations & Motivation**

- **Teachers' Practices**
  - Use of Learning Progression-based Teaching Strategies

- **Student Outcomes**
  - Learning
  - Interest

- **Teacher Outcomes**
  - Success
  - Learning

---

Learning Progressions for Environmental Science Literacy

Berkowitz, et al.– 1.23.12 – slide 20
Key factors shaping teacher interest & practice in using learning progression-based teaching strategies

Contextual Factors
- local environment
- school system
- resources
- PD

Personal Factors
- CK and PCK
- teaching skills
- interest in envt.

Self Efficacy

Outcomes Expectations & Motivation

Teachers' Practices
- Use of Learning Progression-based Teaching Strategies

Student Outcomes
- Learning
- Interest

Teacher Outcomes
- Success
- Learning
Key factors shaping teacher interest & practice in using learning progression-based teaching strategies

Contextual Factors
- local environment
- school system
- resources
- PD

Personal Factors
- CK and PCK
- teaching skills
- interest in envt.

Self Efficacy

Outcomes
- Expectations & Motivation

Teachers’ Practices
- Use of Learning Progression-based Teaching Strategies

Student Outcomes
- Learning
- Interest

Teacher Outcomes
- Success
- Learning
What Supports Effective Environmental Science Teaching?

- **Strong content understanding** of the topics of instruction and an honest appraisal of her/his own level of understanding.
- **Pedagogical content knowledge** based on an appreciation of student thinking and learning trajectories.
- **High quality instructional materials** that reflect the best of what we know about how students move along the learning progressions.
- **Tools for building student reasoning** and practice in using them.
- **Access to current research about student learning.**
- **Formative assessment tools** embedded in his/her instruction.
- **Practice with and support for responsive teaching** in professional development workshops, and in supported classroom teaching.
- **Self efficacy and motivation** to adopt, adapt and implement LPTSs.
What’s Ahead?

- Introduction to project, LPs, student and teacher knowledge – John Moore
- Our view of effective teaching and professional development (PD)
  - Theories of Action – Alan Berkowitz
  - Overview of our PD approaches – Sylvia Parker
- Showcasing innovative PD practices
  - PD for teacher content learning – Jennifer Doherty
  - PD for teacher pedagogical content learning – Jennifer Doherty
  - PD for responsive teaching – Michele Johnson
  - PD for self efficacy and motivation – Michele Johnson
- Conclusions and future directions – Alan Berkowitz
Overview of Our PD Approaches

- Professional development experiences – summer institutes and school year workshops
- Supporting resources
- A supportive, sustained learning community
- In-depth and extended professional development opportunities for select teachers and teacher-leaders
Overview of Our PD Approaches

• Professional development experiences – summer institutes and school year workshops
  – Explicit instruction in the theory and procedures of LPs
  – Examining student responses using learning progressions
  – Content teaching and learning with the TE units
  – Reflecting about and planning for classroom implementation
  – Practice with responsive teaching, use of formative assessments, and instructional aides with staff and other teachers.
  – In-school support
Overview of Our PD Approaches

• In-depth and extended professional development opportunities for select teachers, including
  – Year-long Teachers in Residence opportunities
  – Research Experiences for Teachers opportunities
  – Lead Teachers at some sites to help lead workshops and provide in-school support to other teachers.
  – Teacher exchanges between sites
  – Enrichment field trips, additional PD experiences, and participation in national meetings (e.g., LTER All Scientists Meeting)
<table>
<thead>
<tr>
<th>Site</th>
<th>Post Docs</th>
<th>Grad Students</th>
<th>Teachers in Residence</th>
<th>Research Exp. for Teachers</th>
<th>Workshop Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>High School</td>
</tr>
<tr>
<td>BES</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>23</td>
</tr>
<tr>
<td>KBS</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>7</td>
<td>54</td>
</tr>
<tr>
<td>SBC</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>SGS</td>
<td>2</td>
<td>3</td>
<td>7</td>
<td>6</td>
<td>34</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>17</td>
<td>13</td>
<td>22</td>
<td>126</td>
</tr>
</tbody>
</table>

* Elementary school teacher participation supported with other funds.
## Resources for Teachers

<table>
<thead>
<tr>
<th></th>
<th>Biodiversity</th>
<th>Carbon</th>
<th>Water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Learning Progression Frameworks</strong></td>
<td>Biodiversity Assessments</td>
<td>Carbon Assessments</td>
<td>Water Assessments</td>
</tr>
<tr>
<td><strong>Teaching Experiment Curriculum Units</strong></td>
<td>Leaf Pack Organisms Lessons</td>
<td>Plant Growth Lessons</td>
<td>School Campus Water Budget Lessons</td>
</tr>
<tr>
<td></td>
<td>Teachers’ Guide</td>
<td>Teachers’ Guide</td>
<td>Teachers’ Guide</td>
</tr>
<tr>
<td><strong>Research: Citizenship</strong></td>
<td>Using Science in Decision-Making Case Study Unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PD: Modeling and Teaching LPTs</strong></td>
<td>Site-Based Websites for Idea Exchange</td>
<td>Site-Specific Lesson Plans</td>
<td>Teaching Materials and Supplies In-School Support</td>
</tr>
</tbody>
</table>
What’s Ahead?

- Introduction to project, LPs, student and teacher knowledge – John Moore

- Our view of effective teaching and professional development (PD)
  - Theories of Action – Alan Berkowitz
  - Overview of our PD approaches – Sylvia Parker

- Showcasing innovative PD practices
  - PD for teacher content learning – Jennifer Doherty
  - PD for teacher pedagogical content learning – Jennifer Doherty
  - PD for responsive teaching – Michele Johnson
  - PD for self efficacy and motivation – Michele Johnson

- Conclusions and future directions – Alan Berkowitz
Teachers learn environmental science while carrying out activities in the Teaching Experiment units from all three strands.

“The MSP Pathways Project has helped me understand student misconceptions, student gaps in learning, and helped me have a clearer, deeper understanding of the science that I am teaching.” —Teacher
Hands-on Experimental Work
Tools For Reasoning

Community Change Process Tool

| Describe environment before the disturbance | Abiotic: Sunlight and nutrients available to crops | Biotic: The crop plant is far more abundant than weed species, herbivores that prefer consuming the crop plant are abundant |

**Describe the disturbance:** Spraying of round-up on fields planted with crops genetically modified to be round-up resistant resulted in development of resistance in weeds.

Hypothesize the changes to the ecosystem

- **Abiotic/Biotic:** Very
- **Abiotic/Biotic:** Less light and nutrient availability
- **Abiotic/Biotic:** Less growth of crops
- **Abiotic/Biotic:** More insects and other organisms that feed on weeds

**Mechanism for Change:** Shadowing and competition from weeds
**Mechanism for Change:** Fewer resources available for crops
**Mechanism for Change:** More biomass for insects to eat

Comparing Powers of Ten

- Can you think of any items that are smaller than \(10^{-10}\)?
- Can you think of any items that are larger than \(10^5\)?

Learning Progressions for Environmental Science Literacy

Berkowitz, et al. – 1.23.12 – slide 36
Impact on Teachers’ Content Knowledge

A. What do you predict will happen to the amount of oxygen (O₂) and carbon dioxide (CO₂) in each chamber? (Choose one of the three options for each sentence below.)

B. Explain your choice. What do you think each plant is doing with oxygen (O₂) and carbon dioxide (CO₂) in each chamber?

![Diagram showing plant experiments with light and gas probes.]
Impact on Teachers’ Content Knowledge

Use the table below to explain where you think that carbon is found inside a tree and how it gets there.

<table>
<thead>
<tr>
<th>Location</th>
<th>Choose either YES or NO</th>
<th>If you chose YES, explain how the carbon gets to that location. Include molecules in your explanation if you can.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does a tree have carbon in its leaves?</td>
<td>YES □ NO □</td>
<td></td>
</tr>
<tr>
<td>Does a tree have carbon in its wood?</td>
<td>YES □ NO □</td>
<td></td>
</tr>
<tr>
<td>Does a tree have carbon in its roots?</td>
<td>YES □ NO □</td>
<td></td>
</tr>
</tbody>
</table>

![Bar chart showing the number of teachers' responses to the location of carbon in trees.](chart.png)

- Pre (n=15)
- Post (n=15)
A tropical rainforest is an example of an ecosystem. Which of the following statements about matter and energy in a tropical rainforest is the most accurate? Please choose ONE answer that you think is best.

- a. Energy is recycled, but matter is not recycled.
- b. Matter is recycled, but energy is not recycled.
- c. Both matter and energy are recycled.
- d. Both matter and energy are not recycled.

![Bar chart showing the proportion of responses for different levels of reasoning before and after intervention. The chart shows a significant increase in responses at Level 2-3 and Level 4 after the intervention.]
What’s Ahead?

- Introduction to project, LPs, student and teacher knowledge – John Moore
- Our view of effective teaching and professional development (PD)
  - Theories of Action – Alan Berkowitz
  - Overview of our PD approaches – Sylvia Parker
- Showcasing innovative PD practices
  - PD for teacher content learning – Jennifer Doherty
  - PD for teacher pedagogical content learning – Jennifer Doherty
  - PD for responsive teaching – Michele Johnson
  - PD for self efficacy and motivation – Michele Johnson
- Conclusions and future directions – Alan Berkowitz
PD for Pedagogical Content Knowledge

We view PCK as having *at least* these four aspects:

(1) Curricular content knowledge about the school science

(2) Discourse knowledge about the nature of science communication (verbal and non-verbal) in use by materials, by students, by other teachers

(3) Anticipatory knowledge about the what, how, and why of student thinking in science contexts

(4) Implementation knowledge about how to use 1, 2, and 3 and ENACT ideas in practice that help students learn.
PD for Pedagogical Content Knowledge: “Consider Student Thinking” activity

<table>
<thead>
<tr>
<th>Level</th>
<th>Teacher Generated Rubric: Characteristics of student answers for the level</th>
<th>Teacher Generated Rubric Letters of Student Responses</th>
<th>Learning Progression Rubric Letters of Student Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 (Highest)</td>
<td>Addresses population change by discussing both biotic and abiotic</td>
<td>A, H</td>
<td>J</td>
</tr>
<tr>
<td>3</td>
<td>Use biological terminology but still does not address both biotic + abiotic</td>
<td>C, J</td>
<td>A, C, H</td>
</tr>
<tr>
<td>2</td>
<td>Attempt to explain population changes only abiotic factors, not biotic</td>
<td>F, G, E</td>
<td>E, G, I</td>
</tr>
<tr>
<td>1 (Lowest)</td>
<td>Basic concept of population death No explanation Why</td>
<td>B, I, D</td>
<td>B, F, J</td>
</tr>
</tbody>
</table>
Impact on Teachers’ Pedagogical Content Knowledge.

“The training I received gave me knowledge both in content and Learning Progressions (LP) to better execute the content. The teaching experiments (TE) themselves provided me with a premade framework that I can use to push these concepts. The TEs were thoughtfully designed and allowed me opportunities to present information in a new way. The LP information has enabled me to look at my students ways of constructing knowledge in a new way.” —Teacher
Sample PCK Question: Predicting Student Responses

A mature maple tree can have a mass of 1 ton or more (dry biomass, after removing the water), yet it starts from a seed that weighs less than 1 gram. Which of the following processes contributes the most to this huge increase in biomass?

A. Absorption of mineral substances from the soil via the roots.
B. Absorption of organic substances from the soil via the roots.
C. Incorporation of carbon dioxide gas from the atmosphere into molecules by green leaves.
D. Incorporation of water from the soil into molecules by green leaves.
E. Absorption of solar radiation (sunlight) into the leaf.

Would you expect your students to answer this question differently from you? Explain how you would expect them to reason about this question.
Sample PCK Question: Evaluating Student Responses

Imagine you ask your students: “Many streams in the United States have similar, but not identical, insects living in the water. Why are the insects living in the water similar but not the same?” Consider answers from two students:

Student A’s answer “Because there have been different selection pressures at different places that have resulted in slightly different mixtures of critters or different evolution.

Student B’s answer “Because streams are the same size so most insects will be the same size too. The insects are not the same because not all insects can live in the same climate.”

What characteristics of the answer from student A make it different than the answer from student B?

Do you think one answer is more sophisticated than another? Why or why not?
Sample PCK Question: Responding to Students

You suspect that a few of your students see plants only as “scenery” or a “backdrop” for animals interacting in a community.

Please give an example of what you might have a student do or what you might say to a student to help them understand that plants are living things that play a role in an ecological community.
What’s Ahead?

- Introduction to project, LPs, student and teacher knowledge – John Moore
- Our view of effective teaching and professional development (PD)
  - Theories of Action – Alan Berkowitz
  - Overview of our PD approaches – Sylvia Parker
- Showcasing innovative PD practices
  - PD for teacher content learning – Jennifer Doherty
  - PD for teacher pedagogical content learning – Jennifer Doherty
  - PD for responsive teaching – Michele Johnson
  - PD for self efficacy and motivation – Michele Johnson
- Conclusions and future directions – Alan Berkowitz
PD for Response Teaching

Modeling responsive teaching with responsive PD

✓ facilitation guides for PD providers, key points at a glance, optional approaches to activities,

✓ formative pre-assessments of participants, embedded assessment throughout, “Gots and Needs” each day at the workshops and adjustments to workshops made in response,

✓ conscious and purposeful modeling of responding to participant thinking
Formative Assessment and Responsive use of LP

- Each strand has a formative assessment resource in their teaching experiment units
- Taught, modeled, and practiced during PD
- Reviewed between teachers and TiRs
Formative Assessment and Responsive use of LP

The Story of Adrienne Checkpoint:

As we saw in her initial answer about growing trees, Adrienne describes trees as growing when they have the things they need for life (water, air, sun, soil). The tree uses these things to make their matter as they grow, while sunlight and soil minerals are used for energy. The readings and discussion in this lesson will provide a chance for Adrienne to understand much more explicitly the parallel-but-different roles of matter and energy in the process of plants growing and living.

The previous lessons have helped Adrienne to see that gases have perceptible mass and that carbon dioxide in particular is exchanged in and out of plants in the light and in the dark. But she may still be confused about how these two ideas are connected, or what they have to do with other concepts she knows about growing plants. The reading ideas to the notion that plants make their own food, which she has learned. Specifically, the initial product of photosynthesis, glucose, molecules joined together inside the plant into a molecule that bonds. Knowing from lesson 6 that gases have mass, and from under light conditions, she is then able to account for the increase it comes mainly from the carbon atoms incorporated into glucose.

Formative Check:
Discuss with your class.

1. Which of the objects placed on our Powers of 10 chart have mass?
   Students should realize that ALL of the objects have mass because they are all made of matter.
   Typical Level 2 response: Will vary, but could state that only objects big enough to be seen w/ naked eye will have mass.
   Typical L3: All have mass, but not the same kind of mass (i.e. – molecules don’t add up to enough mass to be comparable to macroscopic objects).
   Typical L4: All have mass, and the amount of mass tends to be proportional to the size of the object, since larger objects are just aggregations of many, many smaller ones.

2. Why didn’t we have a picture of sunlight to include on our chart?
   Sunlight is not matter, it is a form of energy and one does not measure energy by spatial size.
   L2: We can’t say for sure how big it is.
   L3: Sunlight has mass when it’s connected to something else, like leaves during plant growth.
   L4: Pure light has no mass, and no distinct spatial boundary.
2. Before students separate organisms from leaves, they should observe the leaves. Then have students separate the organisms from the leaves. There are two methods of separation:

A. Pick through the leaves, removing organisms with tweezers, plastic spoon/fork or fingers.

B. Using a strainer
   i. Agitate the leaves in a bucket or tray of water to dislodge the invertebrates.
   ii. Remove the leaves from the water and place in a separate container.

Learning Progression Look Fors: Ask students what happened to the leaves while they were in the stream? How does a leaf go from being “perfect” when it falls from the tree to “disappearing” when they pulled it out of the bags? Lower level students know about decomposers, but often don’t invoke them to explain how a leaf changes over time. They also don’t understand where the mass of a leaf goes- i.e. that it is eaten by microbes. Most students will simply say that the leaf ‘disappears’. This is a connection to the carbon strand- remind students of conservation of matter.
Formative Assessment and Responsive use of LP

School Map Formative Assessment

Below is a map of a school campus.

1. If you were looking from the side instead of from above, what would the shape (height) of the land be like across the distance from Point X to Point Y? (Circle the answer you think is the best.)

   - A
   - B
   - C
   - D
   - E
   - F

   Explain your reasons for your answer.

Level 2: Force-Dynamic Reasoning with Mechanisms

Description
Level 2 responses begin to connect maps to landscapes. However, students who provide level 2 responses have trouble connecting the details of a map representation to a 3-dimensional landscape. While they realize the map is a representation of a place, level 2 students may just describe what they see on the map without understanding the implicit connection to things like topography in the landscape.

Suggestions
Level 2 responses demonstrate understanding that a map is a representation of a landscape, however, students who provide level 2 responses have limited understanding of how the map implicitly represents aspects of the landscape. Thus, similar activities as those described for level 1 can also be useful for students who respond at level 2. These activities will help students develop spatial reasoning connecting maps with 3-D landscapes.

Learning Progressions for Environmental Science Literacy
"I monitored students’ progress as they compiled their lists, and as they worked in groups to make their posters. As [described in LP Look for], most students focused their lists on macroscopic features of the ecosystem. I used this observation to focus my questioning on what microscopic features students might know about already, but didn’t think about as being present in the riparian system.”—Teacher

“We looked at [the fertilizer assessment], and it made me realize that we should have done more with the substances section. We will be doing the substances activities this spring.”—Teacher
Impact on Teachers’ Use of Responsive Teaching

“[Learning Progressions] will help you think about how to challenge students to get to the next level. More helpful than just asking for mastery of a standard.” – Teacher

“[The project] has helped me to realize that my students are a part of something that is helping shape the way in which I teach. If my students aren't getting to a level that they need then I need to revamp my teaching lessons/approaches to content.” – Teacher
What’s Ahead?

• Introduction to project, LPs, student and teacher knowledge – John Moore
• Our view of effective teaching and professional development (PD)
  – Theories of Action – Alan Berkowitz
  – Overview of our PD approaches – Sylvia Parker
• Showcasing innovative PD practices
  – PD for teacher content learning – Jennifer Doherty
  – PD for teacher pedagogical content learning – Jennifer Doherty
  – PD for responsive teaching – Michele Johnson
  ➢ PD for self efficacy and motivation – Michele Johnson
• Conclusions and future directions – Alan Berkowitz
Designing Professional Development to Build Self Efficacy and Motivation for LPTSs
Teacher PD Survey

- Taken by 95 teachers in May-June 2011 before site PD workshops

- Teachers rated 18 items on whether items supported or constrained their abilities to use learning progression teaching strategies (LPTS) to teach environmental science curricula.
Factors Supporting or Limiting Teachers’ Use of LPTS

- my personal commitment to the environment
- practical wisdom and skills from my teaching
- my confidence students will learn and succeed
- my motivation to use the four practices
- my ability to teach hands-on and outdoors
- the training I have received from the Project
- my understanding of student’s env. sci. thinking
- support from administrators and other teachers
- my environmental science knowledge
- the training I received in college
- my ability to differentiate instruction
- availability of nearby organisms and habitats
- the curriculum I am required to teach
- the availability of supplies and equipment
- standards and standardized tests
- adequate time for using the practices
- the opportunity to take students on field trips
- adequate time for preparation and planning

% Responses
Providing a Supportive Professional Community

- Professional development experiences
- Supporting resources
- Learning community
Providing a Supportive Professional Community

- A supportive learning community, including
  - Arena for sharing of resources and feedback
  - Planning meetings with Teachers in Residence, project scientists and educators, or Graduate Fellows
  - Review of student pre-assessment data to help teachers provide feedback about student thinking and learning
  - In-school support during TE implementation
  - Continued over 2 or more years for sustained growth and support
Impact on teachers self-efficacy and motivation

“[The PD was] well designed, collaborative, supportive, promoted connections between schools. I learned most about the relevance and importance of practices and exploration in extending scientific literacy.” — Teacher

“The training I received from the P.D. helped me to change my teaching style from an authoritative to a democratic mode. It helped me gain confidence to teach carbon experiments with substantial support from the professional team at our local site.” — Teacher
What’s Ahead?

• Introduction to project, LPs, student and teacher knowledge – John Moore

• Our view of effective teaching and professional development (PD)
  – Theories of Action – Alan Berkowitz
  – Overview of our PD approaches – Sylvia Parker

• Showcasing innovative PD practices
  – PD for teacher content learning – Jennifer Doherty
  – PD for teacher pedagogical content learning – Jennifer Doherty
  – PD for responsive teaching – Michele Johnson
  – PD for self efficacy and motivation – Michele Johnson

➢ Conclusions and future directions – Alan Berkowitz
Current Activities

• Case studies of practices and assessment methods
• Further development of LPTSSs and supports for them
  – in the Teaching Experiment units
  – in our PD practices
  – in our teacher supports, e.g.,
    • providing feedback about student thinking and learning,
    • modeling responsive teaching through responsive PD
• Complete products
Promising directions for understanding and fostering the use of learning progressions

- Develop cost effective and reliable methods for describing teachers’ classroom use of LPTSs to support ...  
  - research into the factors that foster effective use?  
  - useful PD activities and resources?
- Relate student outcomes to teachers’ use of LPTSs and to the PD we provide
- Describe “teaching progressions” that reflect implementation of LPTSs
- Examine the importance of place, culture and context in the effectiveness of our PD
Bottom Line

- Learning progressions
  - focus on the really important core ideas
  - give us an “ear” for hearing student thinking in useful ways
    - common patterns of student thinking across topics
    - guiding responses, instructional choices
  - scaffold instruction within a unit and across years
- PD can support teachers’ use of learning progressions
  - build capacity through CK, PCK, LPCK (LP content knowledge)
  - help motivate .. I want to do this!
  - deepen self efficacy ... I can do this!
Challenges

- Basing PD on R&D that is on-going
  - student learning progression research is in progress
  - development and assessment of effective teaching strategies and resources are still in progress

- Engaging teachers in responsive teaching, requires
  - the CK, PCK, LPCK (LP content knowledge) required are beyond what many teachers have
  - the time, authentic experiences, and depth required for LPTSs run counter to the prevailing emphasis on breadth and on level-3-focused standardized tests and curricula

- Some of our content is not in the MS and HS curriculum