TEACHERS' USE OF LEARNING PROGRESSION-BASED FORMATIVE ASSESSMENT IN WATER INSTRUCTION

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Learning Progression-Based Formative Assessment

Promise

- Support interpretation of students' ideas & provide guidance for responding w/ instruction that builds on conceptual resources

Challenge

- Few LP-based instructional materials
- Requires knowledge & practices not common among teachers today

Requisite Knowledge & Practice

- Understanding of an LP including…
  - Characteristic ways of knowing across levels
  - Challenges associated w/ transitions
- Capacity to…
  - Elicit & interpret students' ideas w/respect to LP
  - Identify appropriate learning goals
  - Design/enact instruction that builds on strengths & responds to challenges

Study

- Multiple case study
  - 2 teachers
  - 1 middle school (Laurie), 1 high school (Jen)
  - Participating in LP-based PD project
- Both taught *School Water Pathways* unit
- Study focused on use of *School Map* FA w/in unit
- Case teachers are contextualized w/in a larger data set

Research Questions

How do teachers…

1. Understand water systems LP and use it in instruction?
2. Describe purpose of formative assessment?
3. Interpret students' ideas w/respect to LP framework?
4. Respond to students' ideas w/instruction?

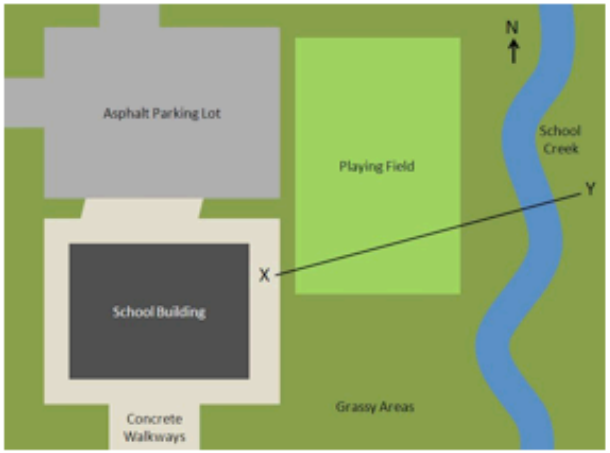
Environmental Science Learning Progression

- Level 4: Scientific Model-Based Reasoning
  - Accounts are explanations governed by driving forces & constraining factors
- Level 3: School Science / Phenomenological Reasoning
  - Accounts are descriptions of ordered events and processes
- Levels 1 & 2: Force-Dynamic Reasoning
  - Accounts describe actors with purposes, helped by enablers

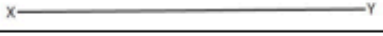
School Map FA

L	Uses…
4	Principle-based understanding of drivers (gravity) & constraints (topography) to make inferences about shape of land & direction of flow
3	School science stories (e.g., rivers flow into lakes) to interpret map & direction of flow
2	Force-dynamic interpretation of map (water wants to flow to connected places)

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 	D 
B 	E 
C 	F There's no way to know.

Explain your reasons for your answer.

_____
_____
_____

2. Circle which direction you think School Creek is flowing:

a. North b. South c. You can't tell from the map

Explain how you know.

_____
_____

Data Sources

- Pre & post-instruction teacher interviews
- Lesson observations & videos
- Completed student formative assessments
- Teacher written assessments addressing science content knowledge & pedagogical content knowledge (PCK)*

- *Assessments for case teachers plus 153 project teachers

Data Analysis

Case Study Data

- Identified excerpts reflecting themes from research questions.
- E.g., for instruction research question…
  - What reasons does teacher give for instructional choices?
  - How does teacher use knowledge of student ideas in planning?

- Science Content & PCK Assessments
  - Science content coded on 4-pt LP scale using previously validated procedure (Gunckel, et al., 2012).
  - PCK coded on 3-pt scale, coders came to consensus for all responses.
    - Category A: PCK not aligned with LP or big ideas
    - Category B: PCK associated with teaching for school science accounts
    - Category C: PCK associated with teaching for model-based reasoning

Target for Interpreting Students' Ideas

- Students responding at **L2** understand map represents a landscape, but have trouble connecting map to 3-D shape of land

- Students responding at **L3** make inferences about shape of land from map, but fail to govern inferences using drivers & constraints

Target Instructional Response

Effective response provides…

- 1st hand experiences connecting 3-D landscapes w/ maps
- Support in reasoning w/ drivers & constraints

Jen's Interpretation of Student Ideas

- (Pre-interview) Some of them were able to use kind of common sense and figure out the answer before we even talked about stuff, so that was pretty good. Some of them did assume water was flowing north to south regardless of what was going on around the water or the schoolyard. Some gave answers that were completely off the wall… More of them answered with a solid answer than I thought would so I was actually surprised at their results, how good they were.

Jen's Instructional Response

- (Lesson Dialogue) Open your notebooks and turn to your notes section. I'm going to show you a quick PowerPoint. Rather than having a separate vocab list, we're just going to hit the vocab as we go through. Most of the stuff is probably words you guys have seen before, but it's going to give it a definition.

Laurie's Interpretation of Student Ideas

- (Post Interview) I saw that most of the student responses were around a 2.5.

- Common ideas were that the landscape is a straight line and that either the water is flowing south or you can't tell from the map.

- Having developed spatial relations and transferring 3-D space onto a 2-D space is still difficult at the 6^{th} grade level.

Laurie's Instructional Response

- (Post Interview) Their reasoning was that if they were standing and looking at the river it would be a straight line, which indicates they are not taking into account terrain and the 3-D landscape. What I did to address this misconception was to first pull out a watershed model and discuss with students the path water takes when traveling downhill and why it takes that path (path of least resistance). We also discussed how, in the model, the rivers (or paths the water flowed down) were indented and at a lower elevation than the area surrounding the river path.

Synopsis of Cases

Facet	Jen	Laurie
Under-standing of LP	• Responses & talk reflect L3 w/access to L4 • Sees LP as useful for supporting learning w/implicit goal of L3 accounts	• Responses & talk reflect L4 w/ minor problems • Views LP as tool for planning instruction that builds students' ideas through experience.
Purpose of FA	• Views learning as acquisition of facts. • FA allows her to assess facts students do/don't know so she can cover appropriate content	• Situates FA practice w/in LP (identifying students' LP-aligned ideas & practices)

Synopsis of Cases

Facet	Jen	Laurie
Interpreting students' ideas	• Recognizes student challenges, but does not situate w/in LP. • Interprets responses as right/ wrong.	• Describes what students know & do, as well as specific challenges (i.e., spatial reasoning). • Situates responses in LP.

Instructional response	• Consistent w/ teaching for L3
	  ○ Didactic
	  ○ Focuses on vocab rather than principles
	  ○ Does not address students' need for 1st hand experience
		• Provides relevant experience w/ 3-D watershed model to respond to challenge w/ spatial reasoning.
		• Connects to local area to support reasoning from personal experience.

Project Teacher Knowledge & Practice

Item	Level/Category	2011-12 (N=98)	2012-13 (N=55)
Science Content	1/2	20%	21%
	3	61%	65%
	4	19%	14%
Learning Goals	A	47%	32%
	B	49%	59%
	C	4%	9%
Interpreting Students' Idea	A	28%	11%
	B	60%	72%
	C	12%	17%
Instructional Response	A	32%	23%
	B	53%	64%
	C	15%	13%

Interpretation

- Many teachers demonstrate knowledge & practice that aligns w/ instruction likely to support Level 3 school science descriptions rather than Level 4 model-based reasoning.

- Teachers like Jen bring strengths including valuing…
  - Understanding students' ideas
  - Helping students become "deeper thinkers"
  - Helping students develop accurate accounts

Conclusion

- Promise of LPs depends, in part, on PD efforts that build on teachers' strengths & help them develop more challenging LP-aligned knowledge & practice that support student learning toward model-based reasoning.

Questions & Queries

Paper may be accessed at…
www.pathwaysproject.kbs.msu.edu
Further project info at…
www.umt.edu/watertools

For questions, contact Beth Covitt at…
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