Teachers' Uses of Learning Progression-Based Tools for Reasoning in Teaching about Water in Environmental Systems

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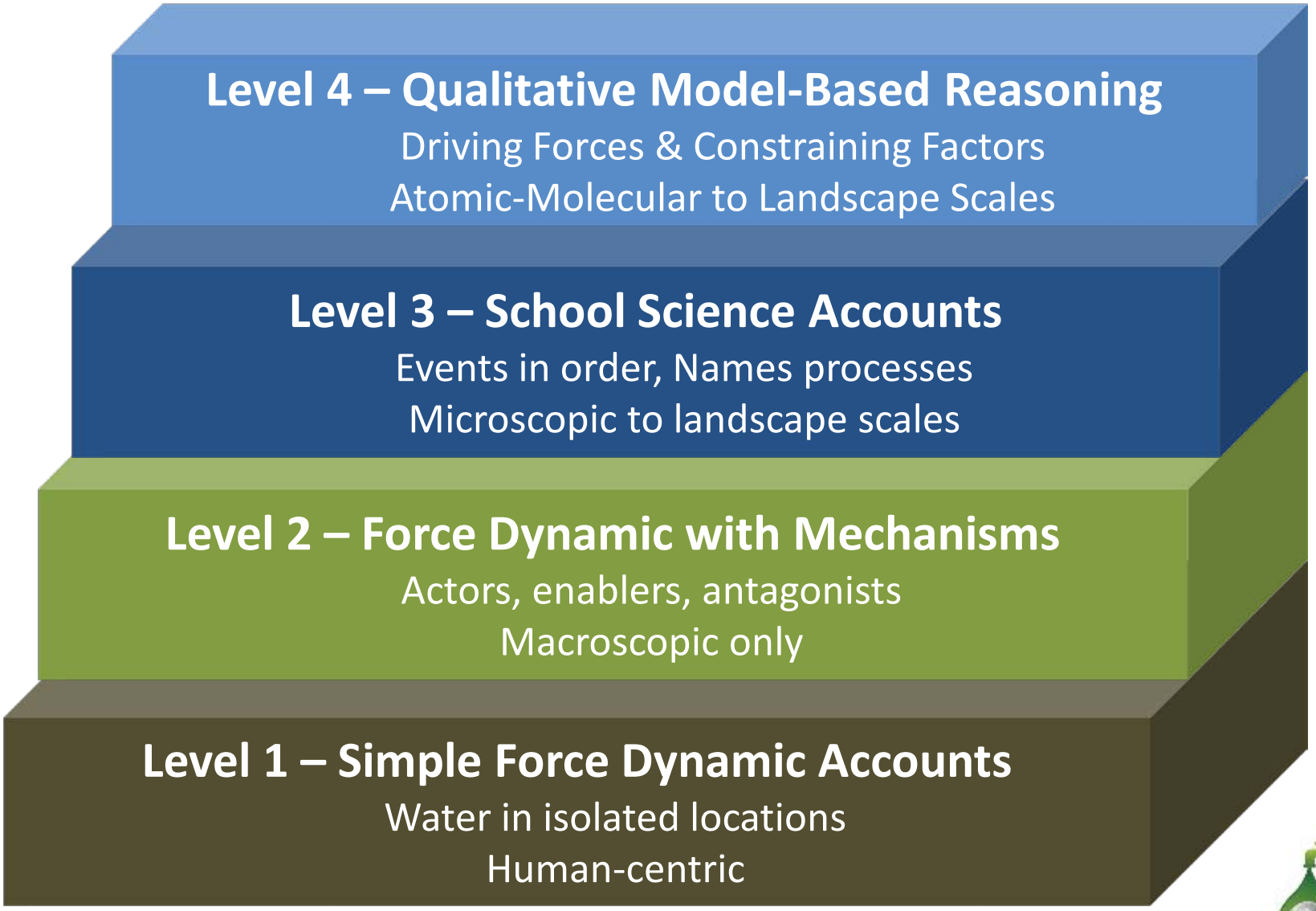
Reasoning Tools for Understanding Water Systems

Project Goal:

1. To develop learning progression-based instructional tools that support student learning about water in environmental systems
   a) Formative assessments
   b) Graphic reasoning tools

2. To identify promising teaching practices that make effective use of these instructional tools

Water Systems Learning Progression

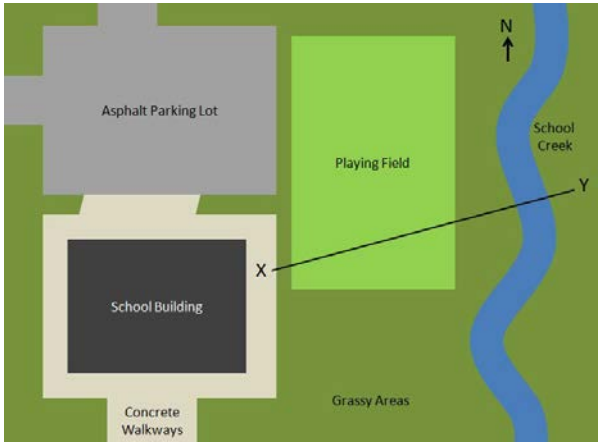


Learning Progression-Supported Teaching

- Establishing learning goals
- Using formative assessment
- Scaffolding reasoning by engaging students in scientific practices
- Situating content and practices in students' place, culture, and motivating real world issues.

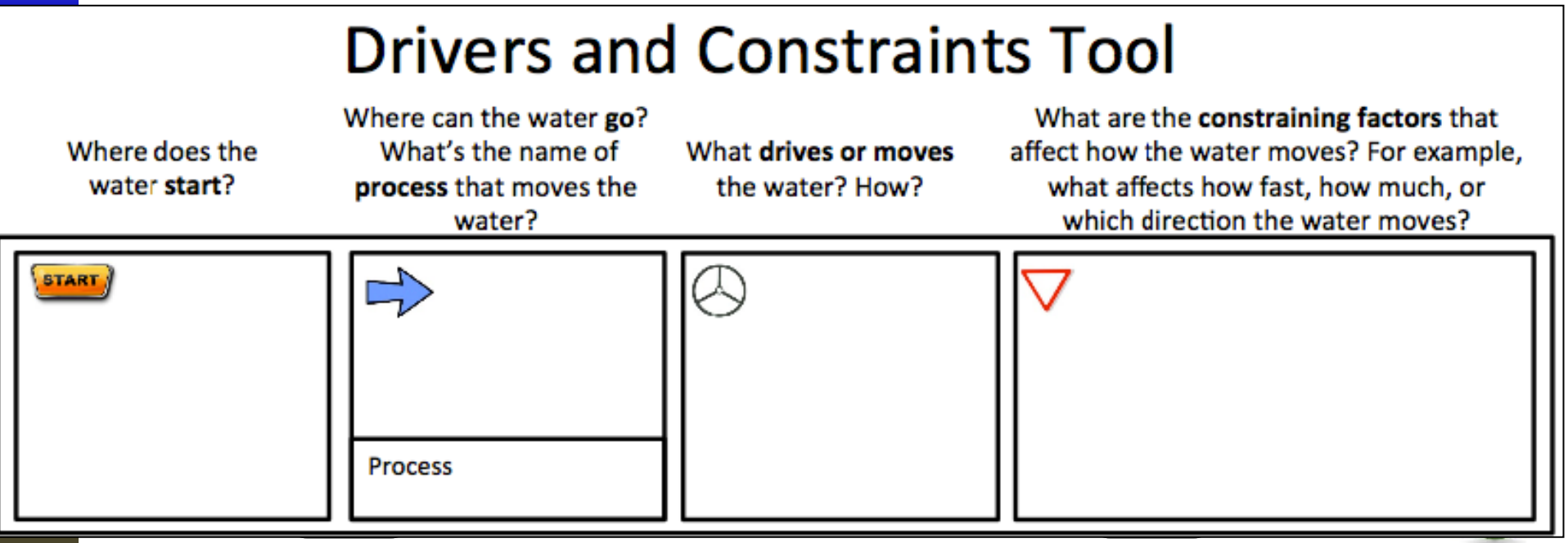
LP-Based Formative Assessments

- Quick classroom assessments
- Include supporting materials for teachers:
  - Assessment item
  - Description of purpose and target response
  - Key for determining students' levels of achievement
  - Suggestions for instruction for students at each level



Graphic Reasoning Tools

- Intended to scaffold development of scientific accounts (hows and whys)
- Address specific LP-related challenges students encounter
  - Considering likelihood of multiple/diverse pathways
  - Attending to driving forces and constraining factors
  - Providing accounts at multiple scales



Research Questions

1. Does incorporation of LP-based tools into instruction impact student learning?
2. How do teachers use learning progression-based formative assessments and graphic reasoning tools?

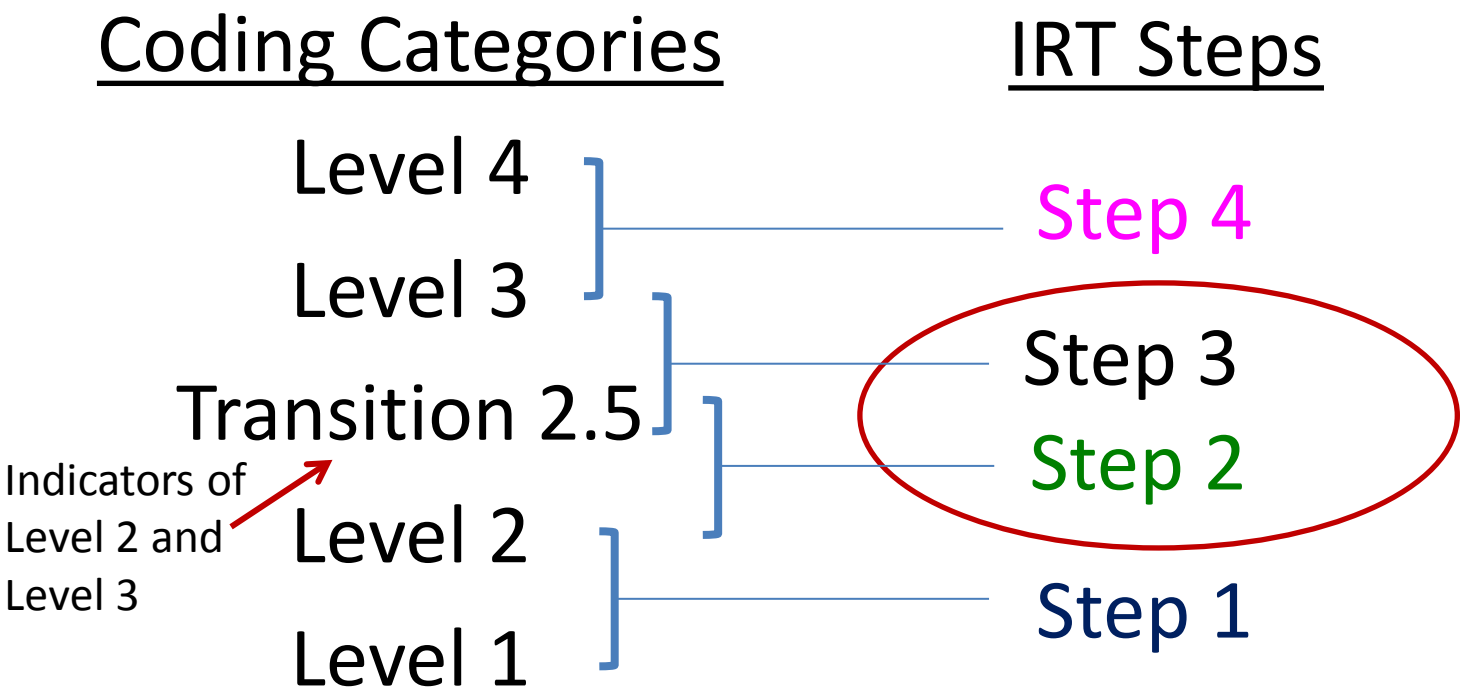
Study Design

	Participant Teachers	Comparison Teachers
No. of Teachers	9	8
No. of Students	249	213
Intervention	4-day Workshop	None
Curricula	Various	Various
Formative Assessments & Tools for Reasoning	Yes	No
Student Pre-Post Assessment	Yes	Yes
Classroom Observations	Field Notes	None
Teacher Interviews/ Focus Groups	Yes	None

Data Analysis

- Coded all student assessment responses
  - Interrater Reliability 0.5 Cohen's Kappa (moderate)
  - IRT Analysis
- Coded field notes and teacher interviews
  - Learning goals
  - Use of formative assessments
  - Use of tools for reasoning
  - Situation in local places
  - Alignment of instruction with LP
- Extreme Comparison (large vs no effect size)

Coding Categories & Analysis



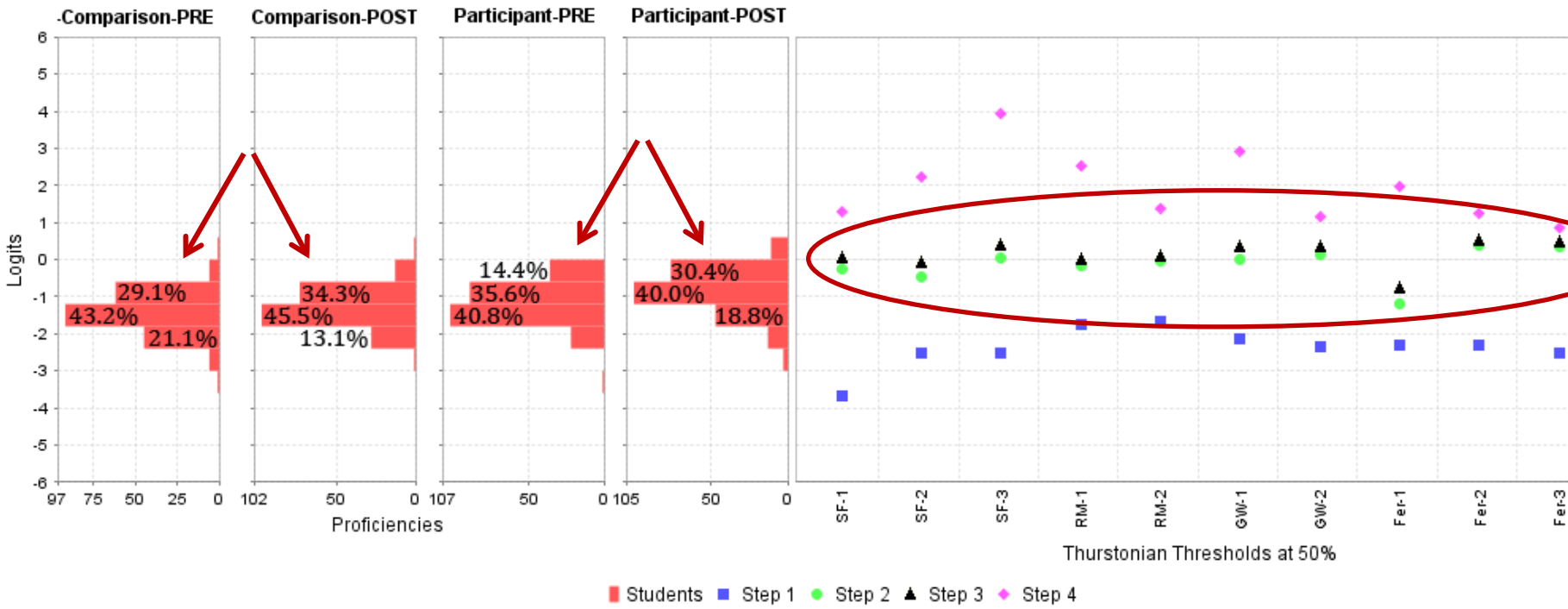
Participant Teachers and Comparison Teachers

- Overall, there is a significant difference between pre-post student change (gain) for participant vs. comparison teachers ($t(461) = 3.59$, $p < .01$).

	Participant Teachers (n=250)	Comparison Teachers (n=213)
Mean gain	0.18 (.30)	0.09 (.24)

Wright Map

PRE and POST Distributions of Participant and Comparison students according to ability in the Learning Progression



Heat Map of Effect Size by Teacher

Label	Hedges' g		
Lexi Masters	1.23		large effect
Alana Moore	1.22		medium effect
Ann Elton	1.03		small effect
Caryn Worth	0.85		no effect
Becca Thomas	0.67		
Renee Bond	0.54		
Claudio Castillo	0.32		
Jonah Booker	0.12		
Philip Grant	0.03		

Large Effect Size (Ann Elton)

Learning Goals	Level 3 “Explain what makes a watershed”
Curriculum Materials	Activities from workshop
Formative Assessments	Identify class level on LP Target instruction
Tools for Reasoning	Open brainstorming; beginning press for explanation
Situation in Local Places	Situated activities in local watershed
Use of LP	Identify student level and target instruction
Alignment of instruction	School Science Stories (level 3) on the way to beginning MBR (level 4)

No Effect Size (Philip Grant)

Learning Goals	Level 3 "SWBAT recognize that population growth affects runoff in a watershed"
Curriculum Materials	*Project Wet* activities
Formative Assessments	"Anticipatory set" to hook student interest & activate prior knowledge
Tools for Reasoning	Worksheets; Level 4 language but no support for reasoning; no press for explanation
Situation in Local Places	Generic, abstract, or hypothetical watersheds
Use of LP	Grade students
Alignment of instruction	Not aligned (unproductive school science)

Interpretations

Both teachers teaching school science, but

Ann = attends to student thinking; productive school science (level 3) moving towards model-based reasoning (level 4)

Philip = performs school-required elements of instruction but no focus on student thinking; unproductive school science.

Conclusion

- School science (level 3) instruction is a strong contextual characteristic of classroom instruction; model-based reasoning (level 4) not-typical
- More vs less-productive school science (level 3)
- LP-based formative assessments and graphic tools for reasoning have the potential to support learning if used in ways that lead to productive uses of school science.

Questions

Paper available at:

http://www.umt.edu/watertools/default.aspx

http://www.pathwaysproject.kbs.msu.edu

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