iFAST Algebra:
Improving Formative Assessment to Support Teaching in Algebra

NSF DRK-12 PI Meeting

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UIC LEARNING SCIENCES RESEARCH INSTITUTE
UNIVERSITY OF ILLINOIS AT CHICAGO

OME

WPI

iFAST Research Team

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iFAST Algebra: Project Overview

- **Improving Formative Assessment to Support Teaching (iFAST) in Algebra**
  - 4-year project: 2013-2017
- **Goal is to develop a professional development model and instructional resources to support middle grades teachers in meeting challenges set by CSSM for students' learning of algebra**
  - Articulate a learning trajectory of algebra content in CMP3 in a way that is interpretable and useful for teachers
  - Empirically determine key landmarks and obstacles that inform teaching of middle-grades algebra

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A Focus on Formative Assessment

High-quality formative assessment practices:

- Enhance teaching effectiveness and student learning (Kingston & Nash, 2011)
- Enhance the learning process rather than simply capturing learning outcomes as summative assessments do (Black & Wiliam, 1998)
- Depend on:
  - clear learning goals
  - student learning trajectories
  - criteria for locating students along the trajectories
  - sharing of this info with students & using it to inform instructional decisions

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Formative Assessment: A Working Definition

- Formative assessment is a process in which teachers monitor student progress toward learning goals, gather evidence of student learning, provide feedback to students, and adjust the teaching and learning activities in which they are engaged in order to make progress toward the desired learning goals (Black et al., 2004; Heritage, 2010)

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A Focus on Learning Trajectories

- Learning trajectories describe how concepts and student understanding develop over time through instruction:
  - A researcher-conjecture, empirically-supported description of the ordered network of experiences a student encounters through instruction (i.e., activities, tasks, forms of interaction) in order to move from informal ideas through successive refinements of representations, articulation and reflection towards increasingly complex concepts over time (Confrey et al., 2008)
- A conceptual corridor incorporates the possibility of multiple pathways toward learning, as well as attention to landmarks, obstacles that students encounter along those pathways (Confrey et al., 2009)
- Curriculum programs (e.g., CMP3) propose hypothetical learning trajectories for student learning that are manifest in the order of units, investigations, problems across the school year

iFAST Algebra: Putting It All Together

- Learning trajectory work will inform our understanding of how students progress along trajectories
  - Identify conceptual corridor with respect to linear functions topics
- In turn, learning trajectory work will inform development of professional development model and instructional resources focused on formative assessment to be used with middle grades teachers
- We focus on the following research questions:
  1. What are changes in teachers' learning trajectories as they engage with different formative assessment strategies?
  2. What are obstacles, landmarks middle grades students encounter with respect to linear functions and equations and topics?

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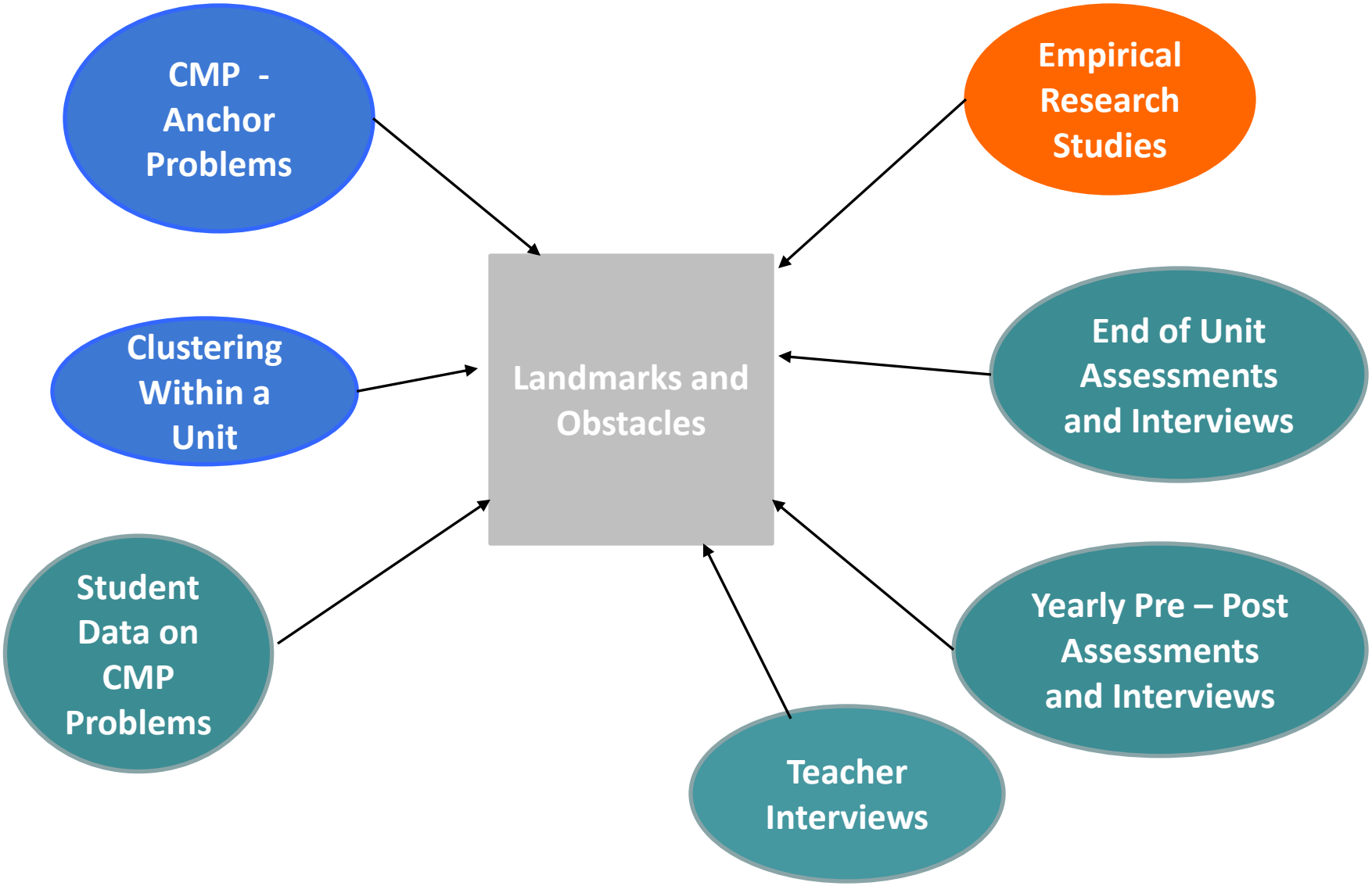
Articulating Hypothetical Learning Trajectories in iFAST

Researchers develop hypothetical learning trajectories (HLTs) in mathematics based on:

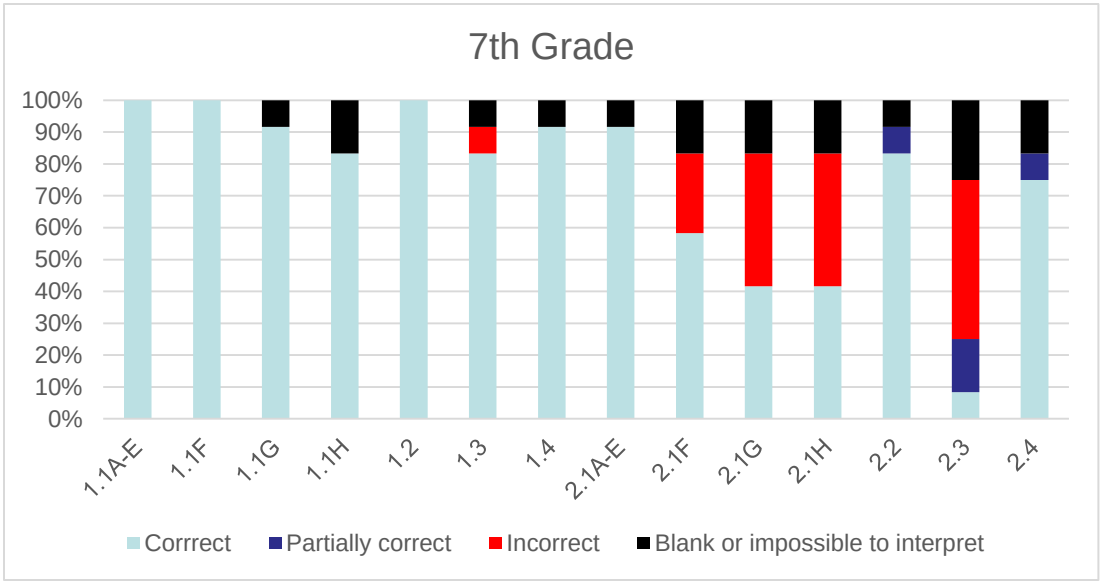
1. Analysis of what is in the curriculum (e.g., Olsen, 2010)

1. Empirical study of how students learn mathematical concepts and procedures (e.g., Clements & Sarama, 2004)

iFAST draws from both approaches.


CMP - Anchor Problems
Empirical Research Studies
Clustering Within a Unit
Landmarks and Obstacles
End of Unit Assessments and Interviews
Student Data on CMP Problems
Yearly Pre – Post Assessments and Interviews
Teacher Interviews

Student Performance on LF Interview



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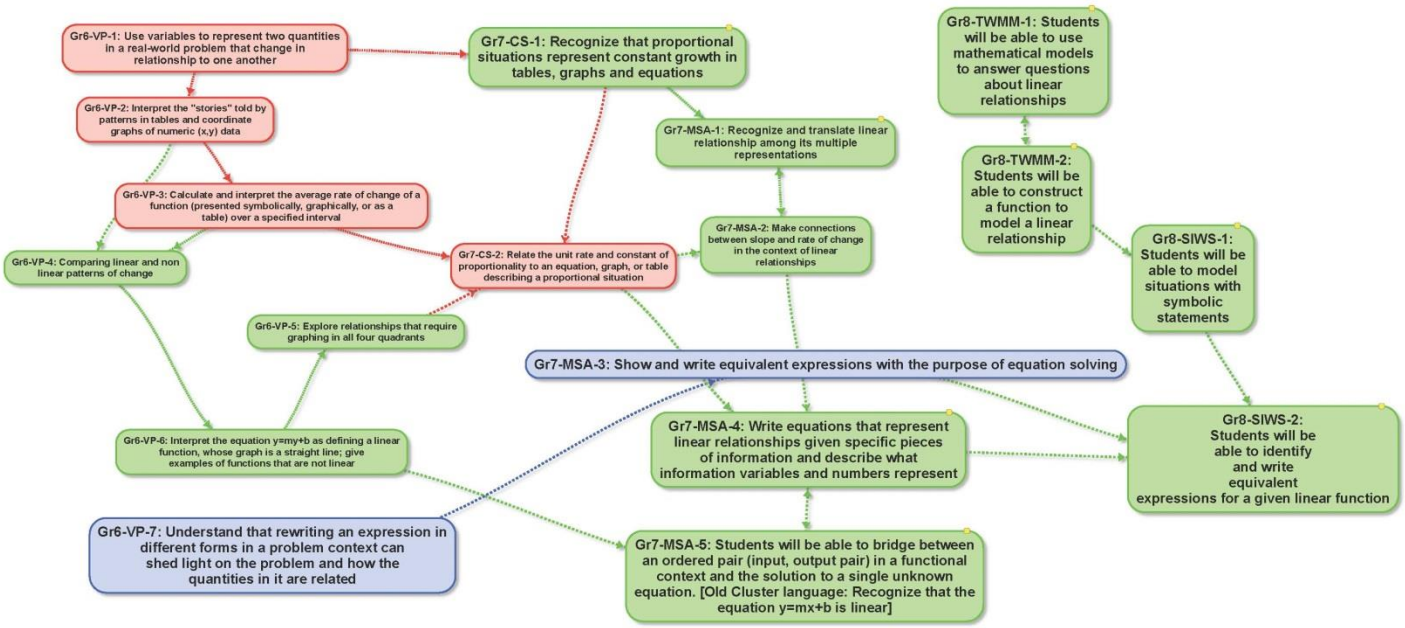
Hypothetical Learning Trajectory for Linear Functions in CMP3



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HLT: Transition from Proportional to Non-Proportional Linear Functions

Gr7-MSA-4: Write equations that represent linear relationships given specific pieces of information and describe what information variables and numbers represent

Topic | Style

Text: Gr7-MSA-4: Write equations that represent linear relationships given specific pieces of information and describe what information variables and numbers represent

Note:
1.4 Using (negative slope) the walkathon money (non-proportional LF)
A. Table-> [Qs: y-intercept and slope in context (e.g., money at the start of the project), generate Graph, write rule]
B. Graph -> [Qs: y-intercept and slope in context, generate Table, write rule]

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Year	LT Work	PD Work
AY 14-15	• Develop, administer student assessments • Map hypothetical, enacted LTs	• Broad focus on formative assessment strategies
AY 15-16	• Administer student assessments, interviews • Map enacted LTs	Continue focus on formative assessment, emphasizing analysis of student work

AY 16-17	• Administer student assessments, interviews	• PD with Cohort 2 teachers
		  • Focus on formative assessment
		  • Incorporate LTs into formative assessment work
		  • Pilot online tools

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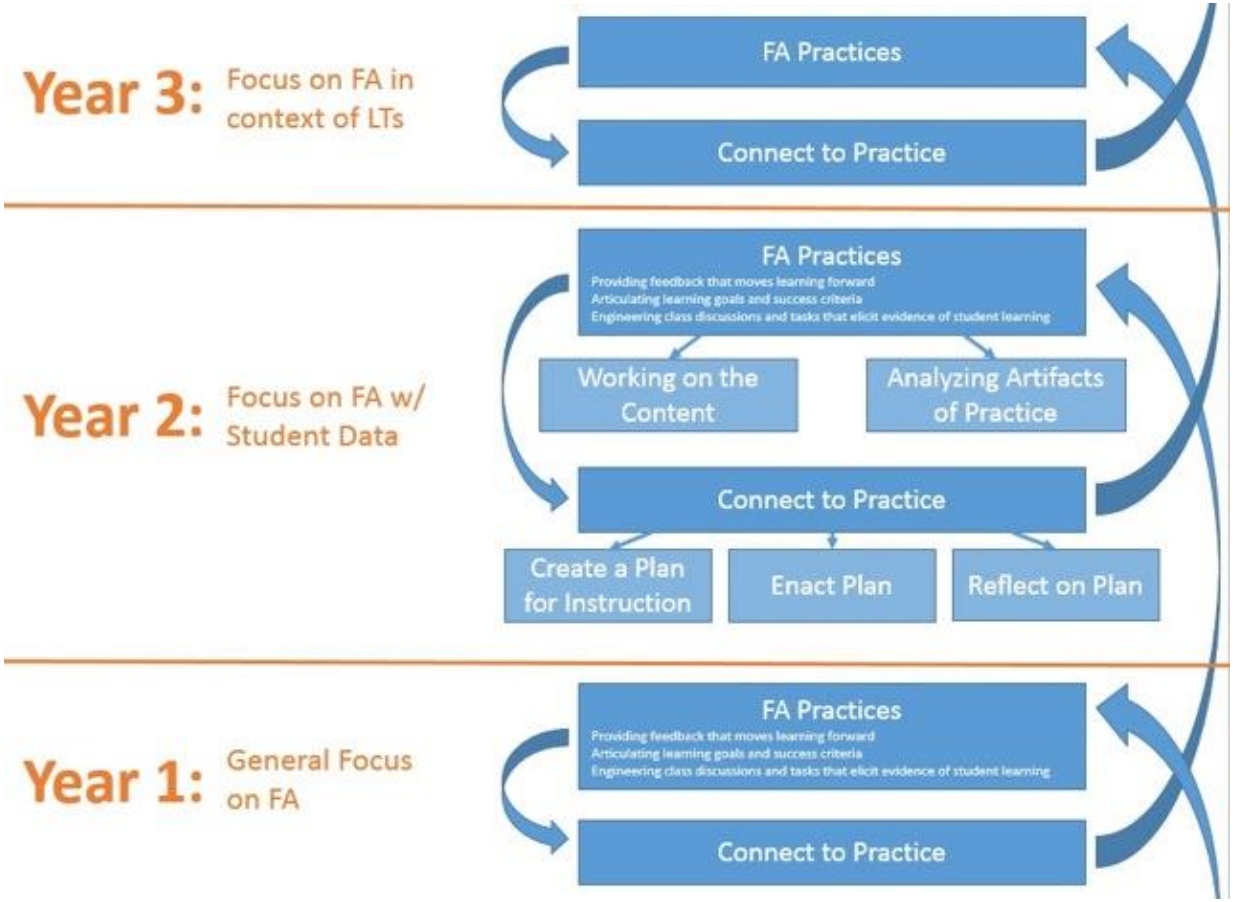
IFAST Professional Development



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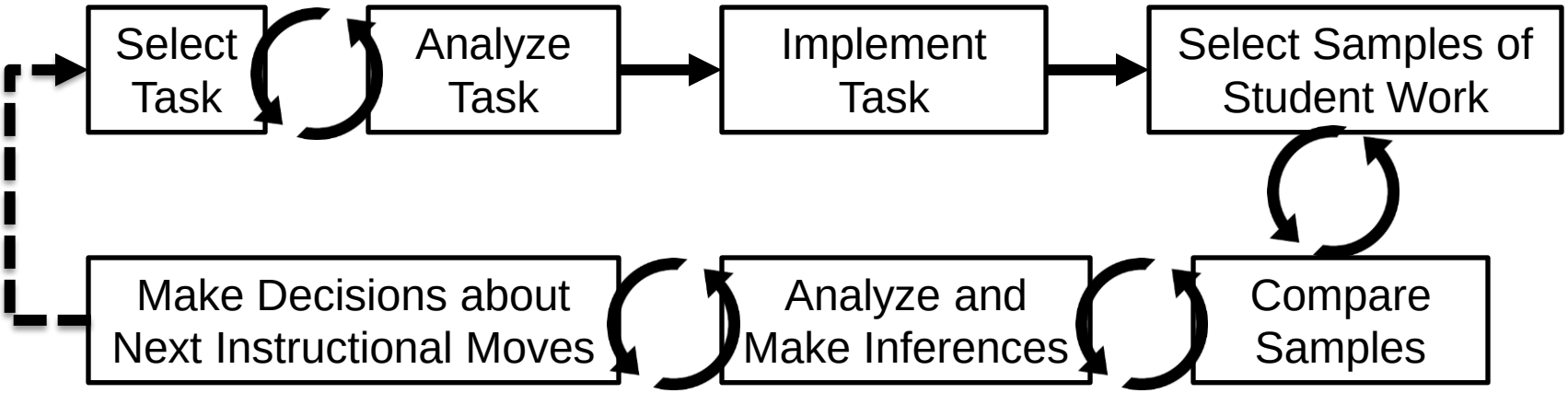
Analyzing Student Work: A Process of Formative Assessment



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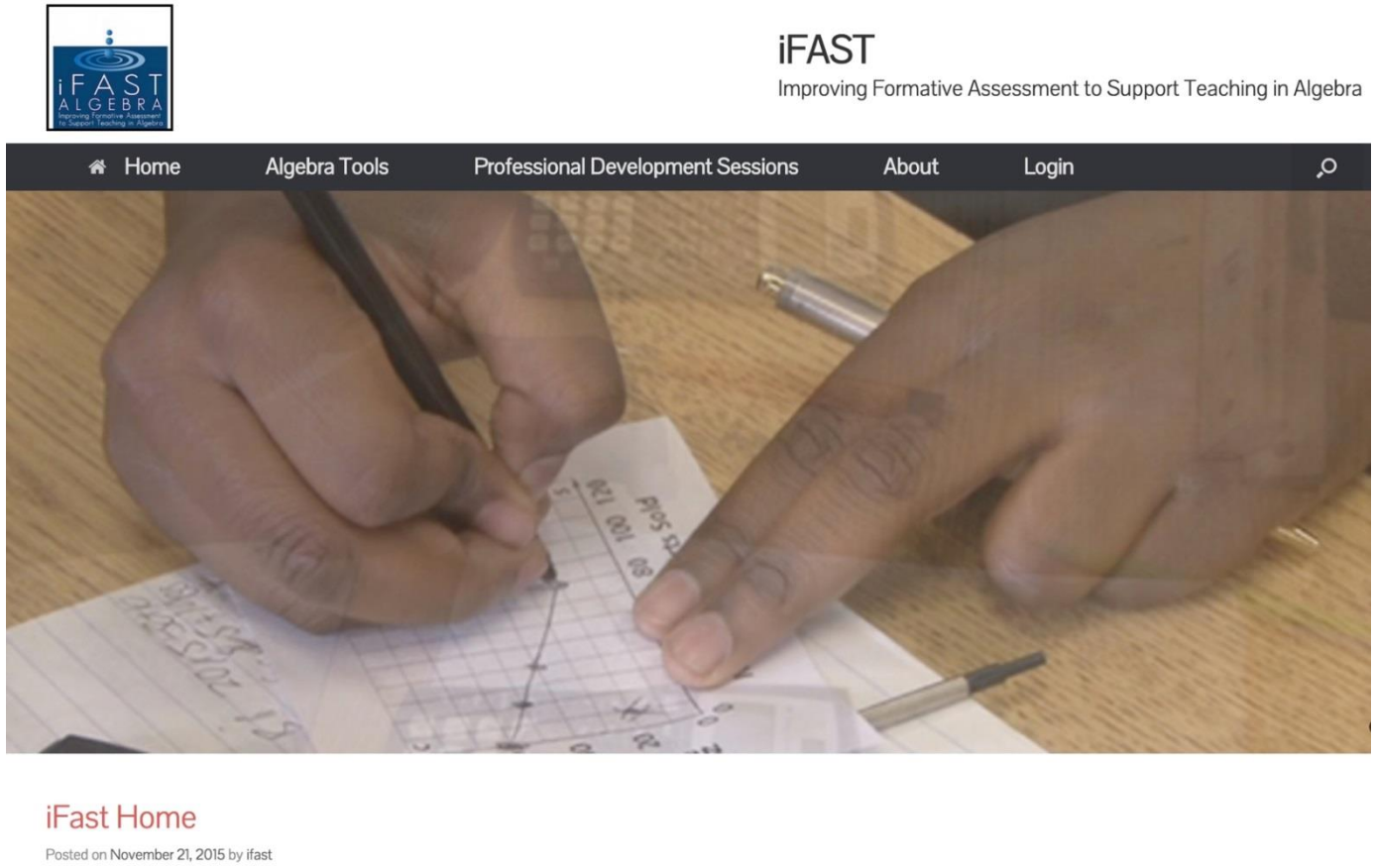
iFAST Algebra Tools



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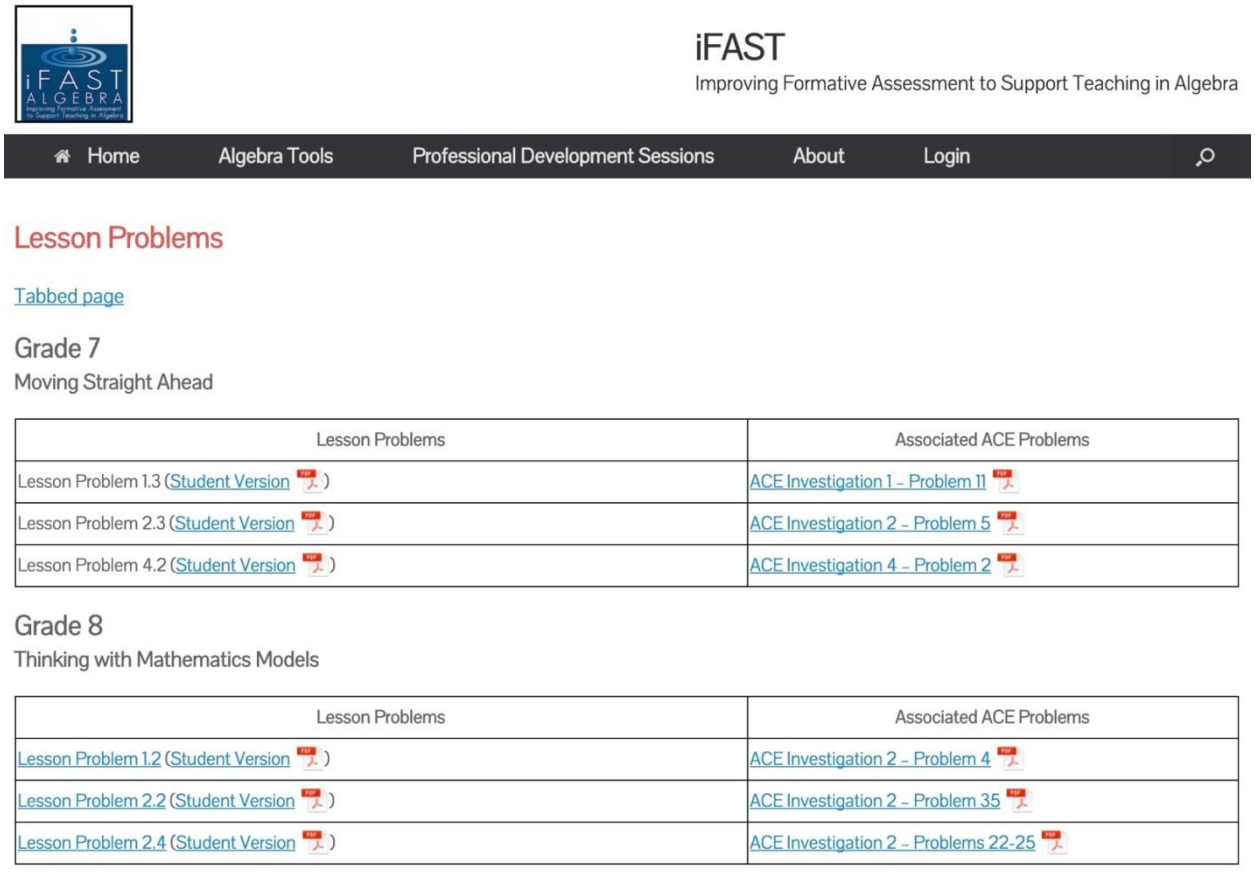
iFAST Algebra Tools: Select Task



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Home | Algebra Tools | Professional Development Sessions | About | Login

Lesson Problems

Tabbed page

Grade 7

Moving Straight Ahead

Lesson Problems	Associated ACE Problems
Lesson Problem 1.3 (Student Version)	ACE Investigation 1 – Problem 11
Lesson Problem 2.3 (Student Version)	ACE Investigation 2 – Problem 5
Lesson Problem 4.2 (Student Version)	ACE Investigation 4 – Problem 2

Grade 8

Thinking with Mathematics Models

Lesson Problems	Associated ACE Problems
Lesson Problem 1.2 (Student Version)	ACE Investigation 2 – Problem 4
Lesson Problem 2.2 (Student Version)	ACE Investigation 2 – Problem 35
Lesson Problem 2.4 (Student Version)	ACE Investigation 2 – Problems 22-25

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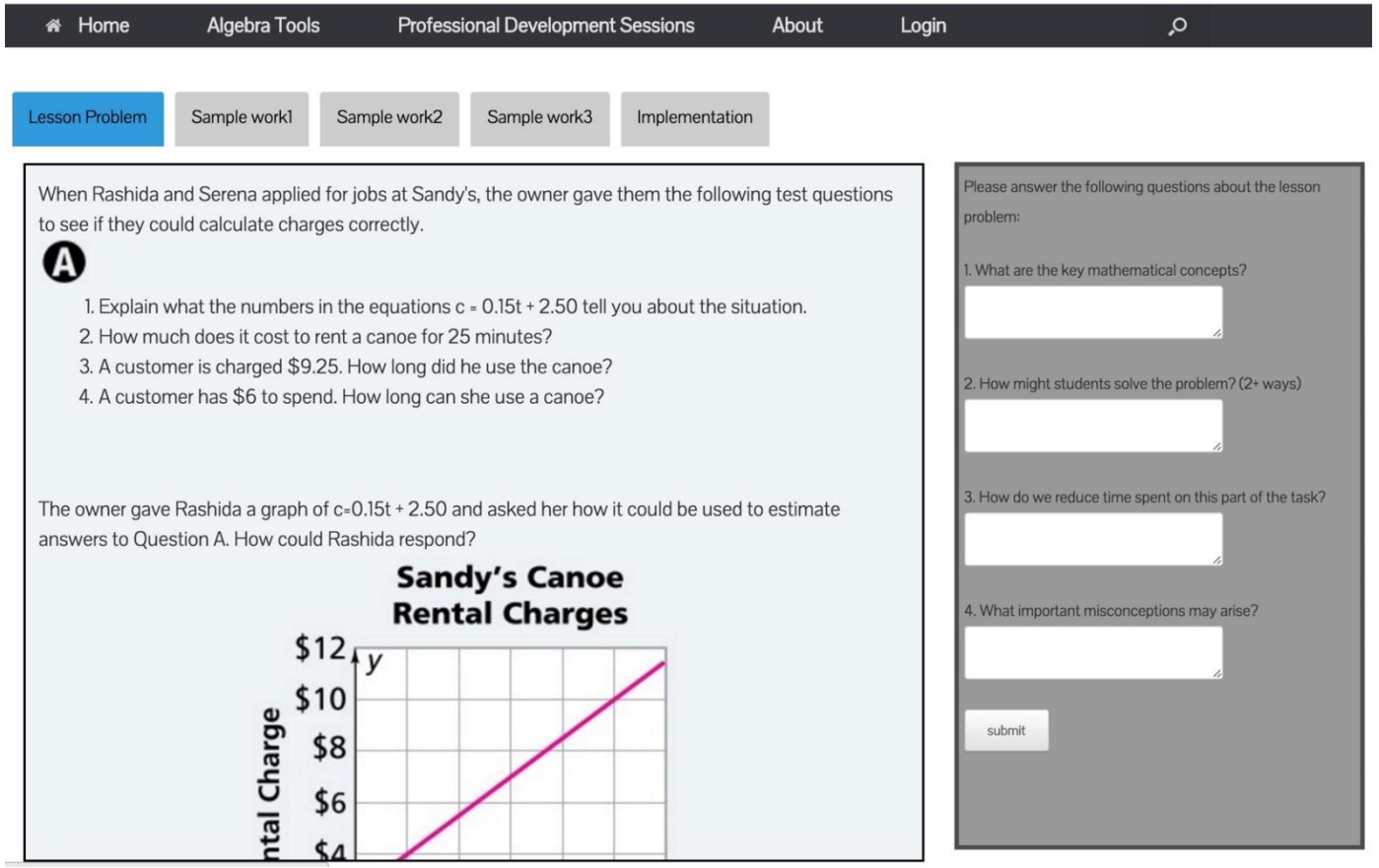
iFAST Algebra Tools: Select, Compare, Analyze Student Work



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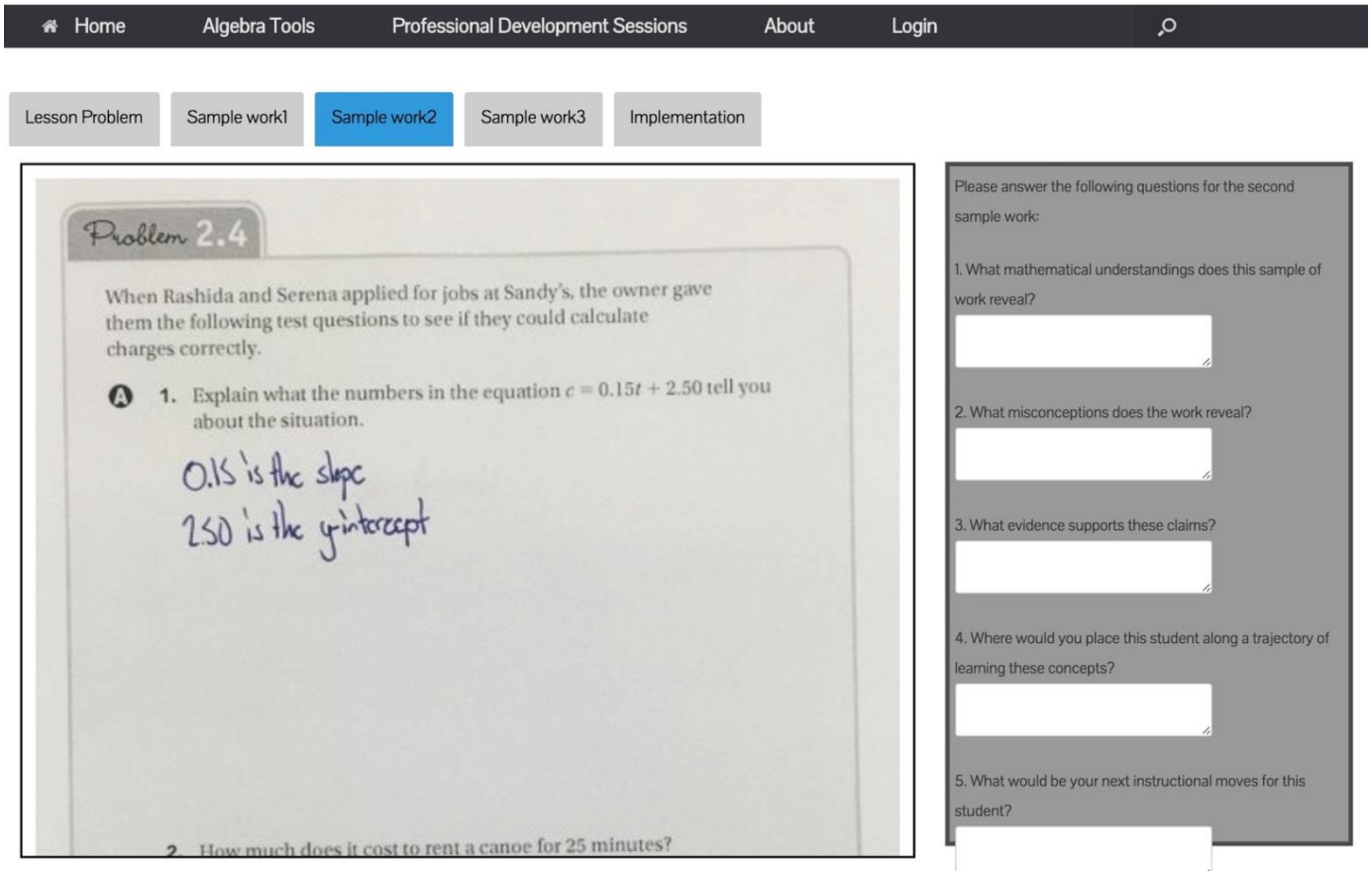
iFAST Algebra Tools: Select, Compare, Analyze Student Work



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What Have We Learned

- Cohort 1 teachers have their own “learning trajectories” for understanding of, enactment of formative assessment processes
- Preliminary data analysis indicates:
  - Cohort 1 teachers demonstrate significant gains in development of math knowledge for teaching across both years (MKT instrument)
  - Analyzing student work, making inferences about student understanding is challenging for Cohort 1 teachers
    - Little to no change in teachers’ performance on TASK instrument across two years
- Lingering Questions:
  - How do you represent the learning trajectory, together with the associated anchor problems and obstacles, in a way that is useable for teachers?
    - Pilot online algebra tools in coming school year

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