From:

The Math Door

–opening doors to mathematical learning–

An Introduction to Math-Mapper 6-8 as a Means for Mathematics Improvement

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Charlene Marchese, Math Supervisor PreK-8, Freehold Township Schools
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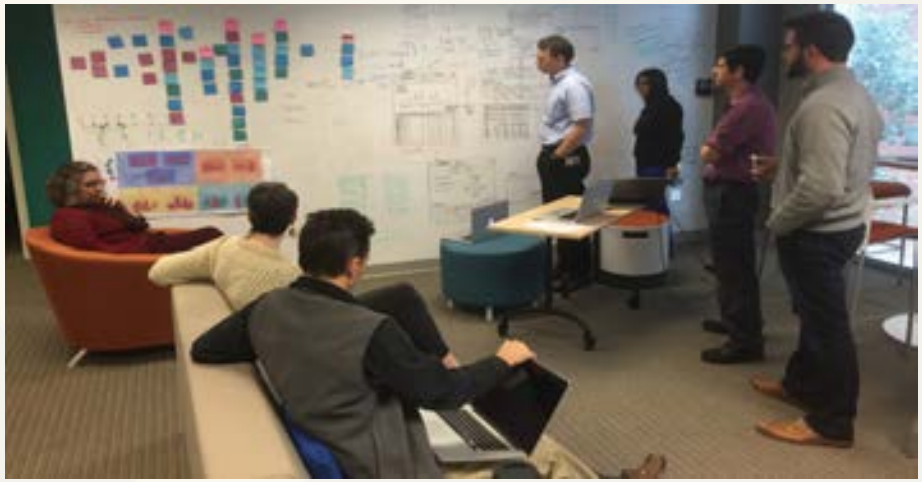

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Math-Mapper Development Partners and Collaborators--

Freehold Schools, New Jersey, Schools:

Dr. Ross Kasun, Superintendent
Dr. Pam Haimer, Assistant Superintendent, Curriculum and Instruction
Dr. Charlene Marchese, Supervisor of Mathematics Pre K-8
The Math Teachers of Barkalow and Eisenhower Middle School

Harnett County Schools, North Carolina:

Dr. Stan Williams, Superintendent
Brian Graham, Principal of Highland Middle School
The Math Teachers of Highland Middle School

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The Math Door--

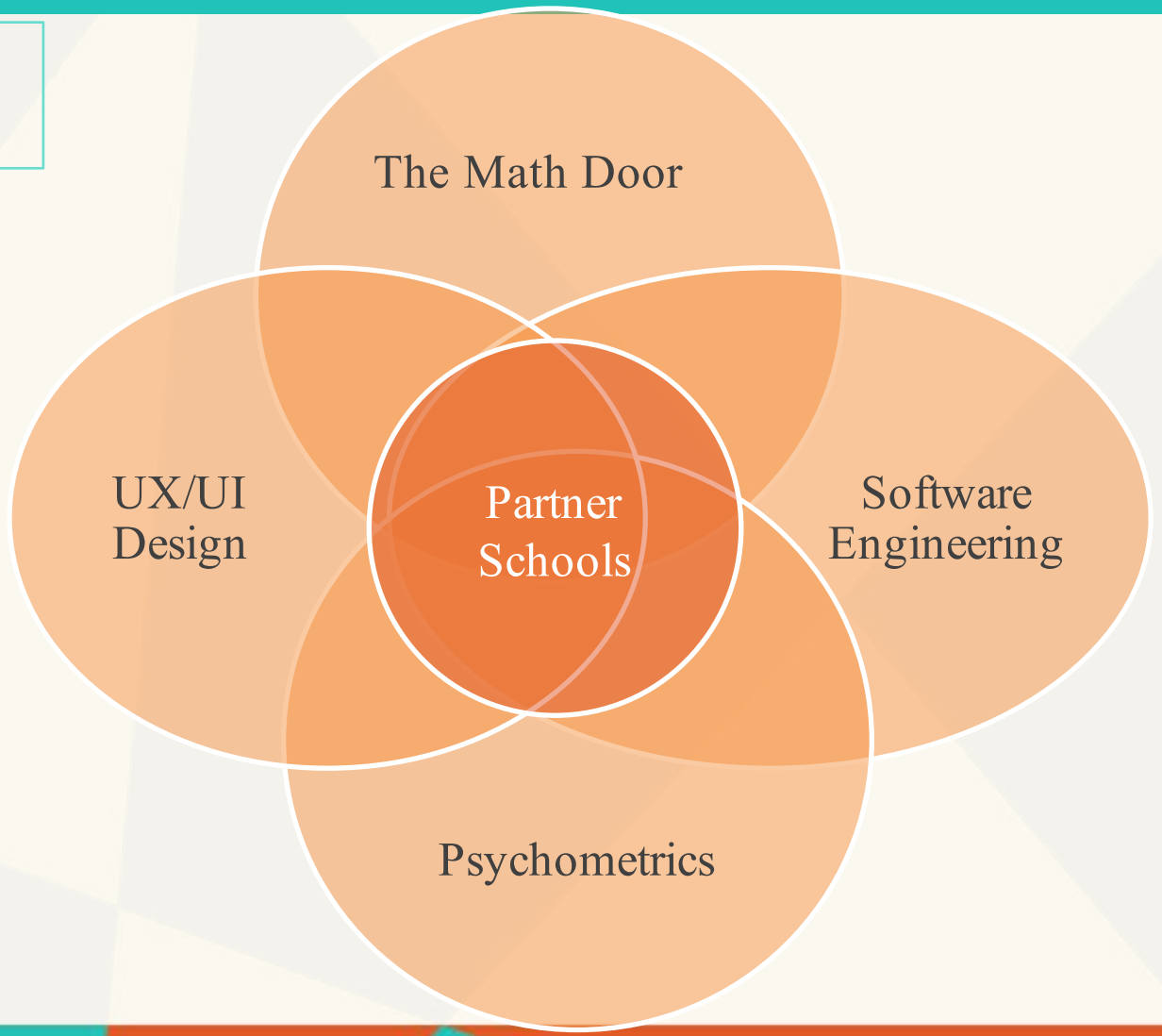
The *Math Door*:

- A Pack-Start (NC State University) Startup, founded Spring 2016
- Winner of New Schools Venture Fund *Ignite Math* Program, 2016
- Semi-finalist for the Intel Accelerator, Summer 2016

Math-Mapper 6-8:

- Built with prior and ongoing support from National Science Foundation and the Bill and Melinda Gates Foundation
- Intellectual property licensed from NCSU

How We Work: A Cross-Field Approach



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How We Work: SUDDS Research Group

We leverage ground-breaking work by the Scaling Up Digital Design Studies research team on Learning Trajectories and Assessment

Research-based

Rapid Prototyping

Partnerships with and of Teachers and Students

Agile Development

Design Research

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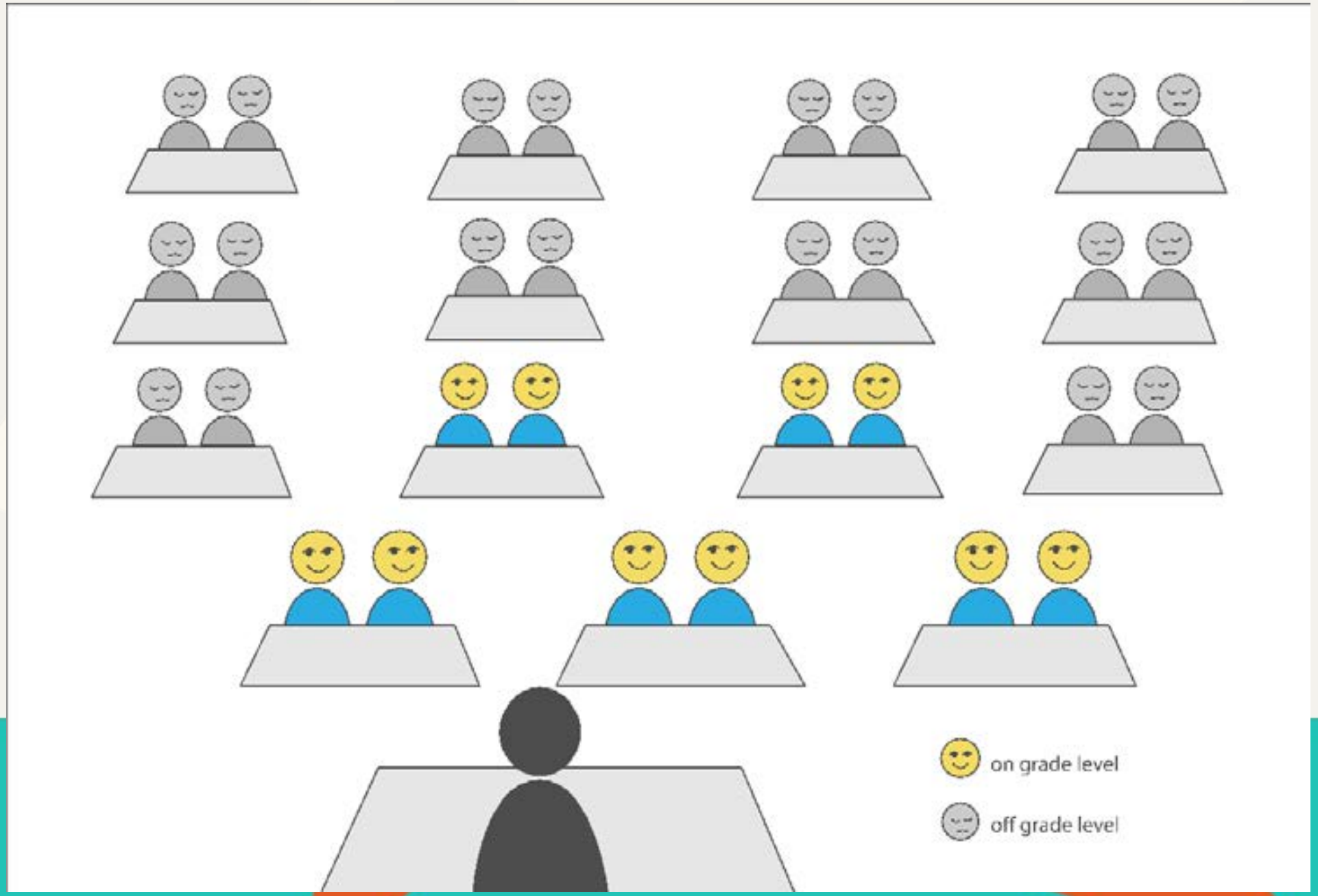
Overview of Presentation

- Challenges and Dilemmas: A New Approach
- Components of a Digital Learning System (DLS)
- Demonstration: Math-Mapper 6-8 DLS
- What we have learned from our Partnerships
- Opportunities for Future Partnerships

Grand Challenge

- To design a way to meet the needs of all students **without** devolving into excessive individualization
- This is the proper meaning of personalization

"So here we are" —



"So here we are" — Dilemmas

- How do we *all* know what we are supposed to learn—and succeed?
- What is the proper role for standards?
- How can open-ed materials support coherent learning?
- Can we practice *assessment for learning*?
- How can data support wise and timely instructional decisions?
- How can we leverage a more active role for students?

What if…

- …a coherent, internally consistent navigation of the mathematical concepts for deeper understanding?
- …students accomplished the CCSS expectations?
- …open resources aligned with concepts, and helped students deepen their mathematical reasoning?
- …diagnostic assessments for formative use and personalizing learning, and they matched way we navigated the concepts?
- …the teachers *and* the students were partners in this learning?
- …everyone in the classroom progressively developed more sophisticated mathematical understanding and reasoning?

Math-Mapper 6-8:

A Digital Learning System for Navigating, Exploring, and Assessing Middle Grades Mathematics

Informs teachers and students:

- *what* the students need to learn,
- *where* to learn it, and
- *how well* they understand it.

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- Challenges and Dilemmas: A New Approach
- Components of a Digital Learning System (DLS)
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Math-Mapper 6-8

An innovative digital learning system, where students and teachers can…

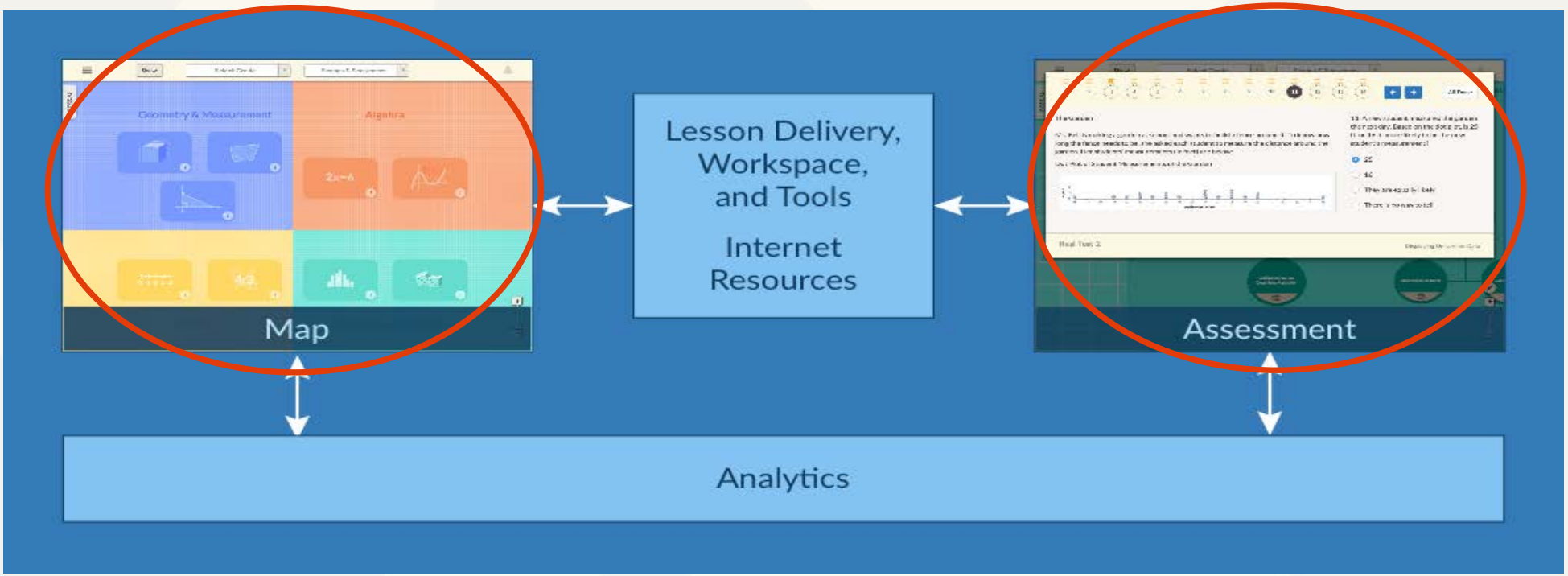
- Navigate the content of middle school mathematics, organized around an underlying framework of big ideas and research-based learning trajectories
- Select and sequence aligned open source curricular resources
- Assess, in real time, students' progress, identifying needs and next steps
- (Compatible with a variety of curriculae, chosen by schools and teachers)

Math-Mapper 6-8, a Digital Learning System (DLS)

1. A Learning Map

2. Curated Links to Open Resources

3. Diagnostic Assessments--administered, scored and reported in real time



- Challenges and Dilemmas. A New Approach
- Components of a Digital Learning System (DLS)
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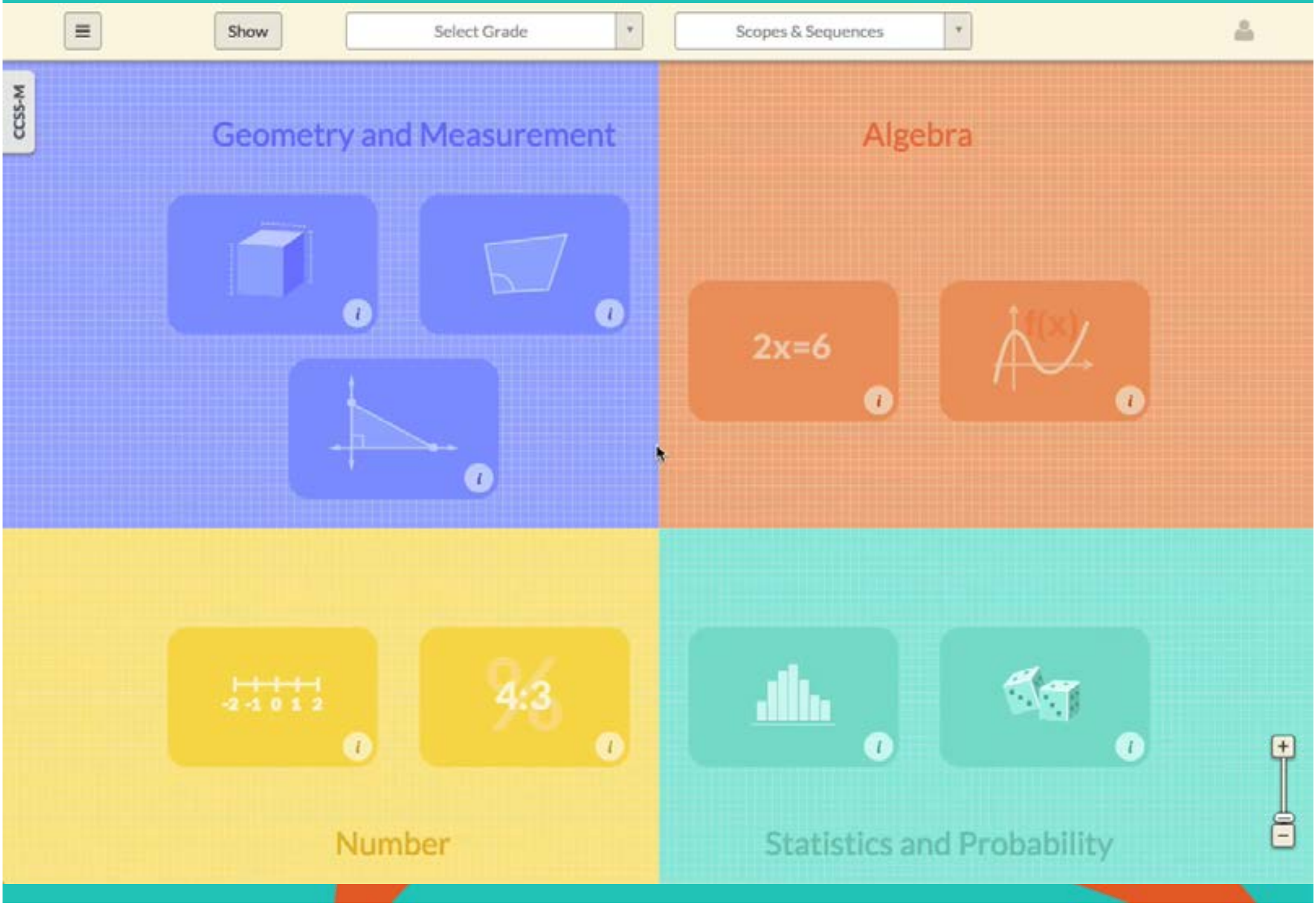
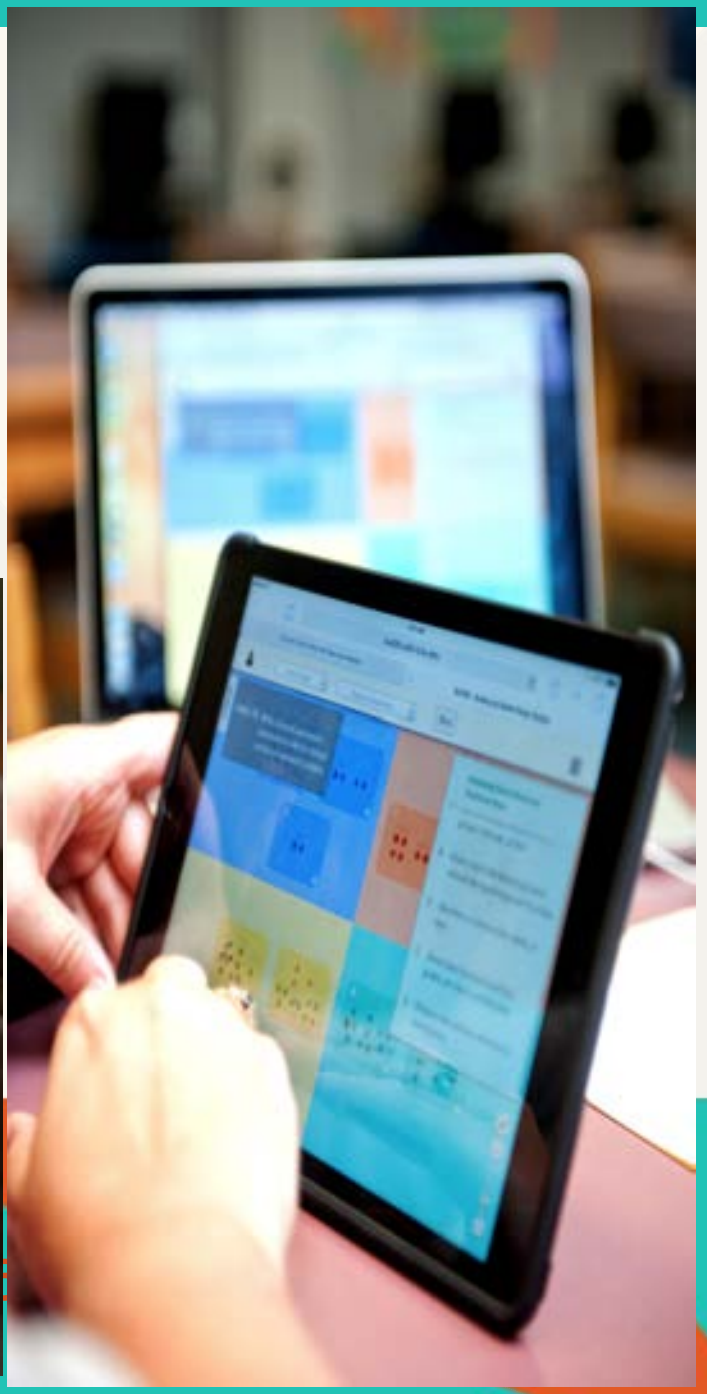
Demonstration



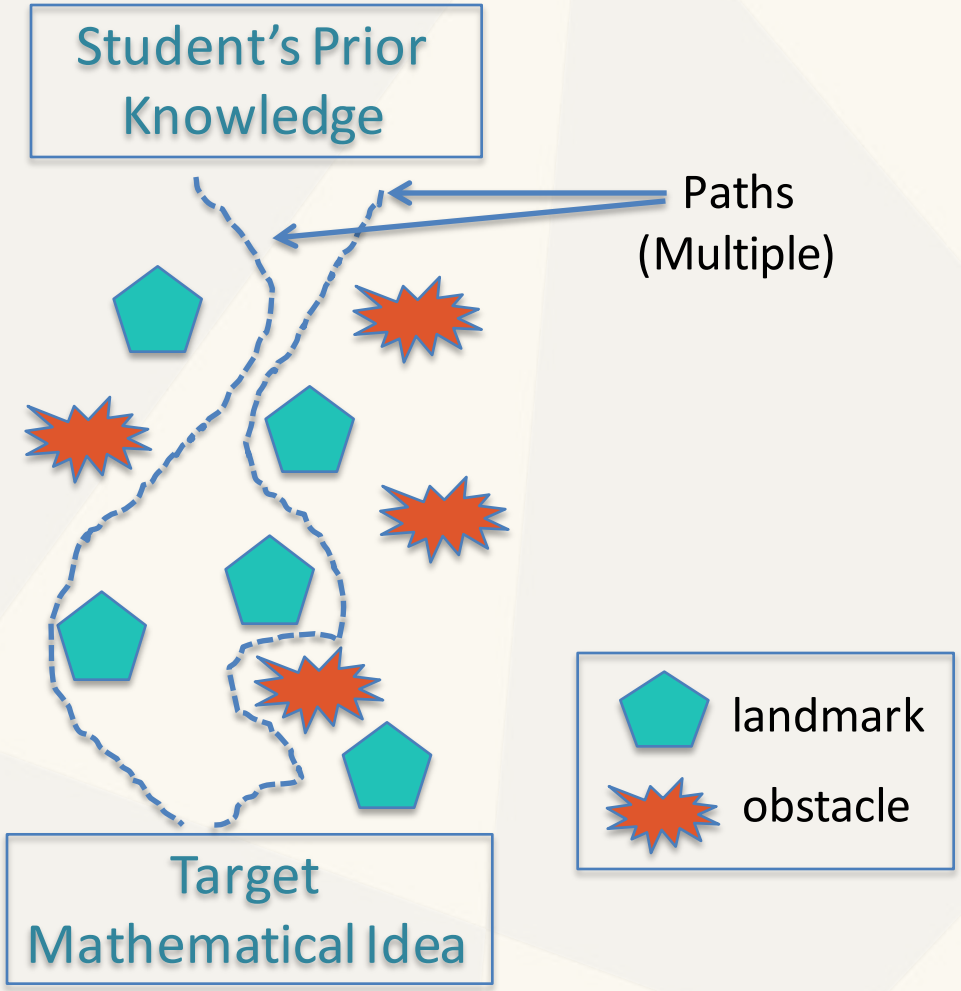
The Underlying Learning Framework

Starting with a Learning Map...

A Learning Map is a navigational system that helps teachers and students to visual the content to be learned structured hierarchically based on research on student thinking.



The Underlying Learning Framework



A **learning trajectory (LT)** connects students' prior knowledge to a target concept.

LTs are comprised of *proficiency levels*, which describe the likely landmarks and obstacles students may encounter as they proceed from naïve to sophisticated understandings.

Middle School Mathematics in Nine Big Ideas

Geometry and Measurement

Measure, compose, and scale perimeter, area, and volume

Compose, characterize, and transform lines, angles, and polygons

Represent and explore Pythagorean Theorem and polygons using coordinate points

Algebra

2x=6

Algebraically relate, express, modify, and evaluate unknown quantities

Represent and use relations and functions of two variables

Position, compare, and operate on one dimensional quantities

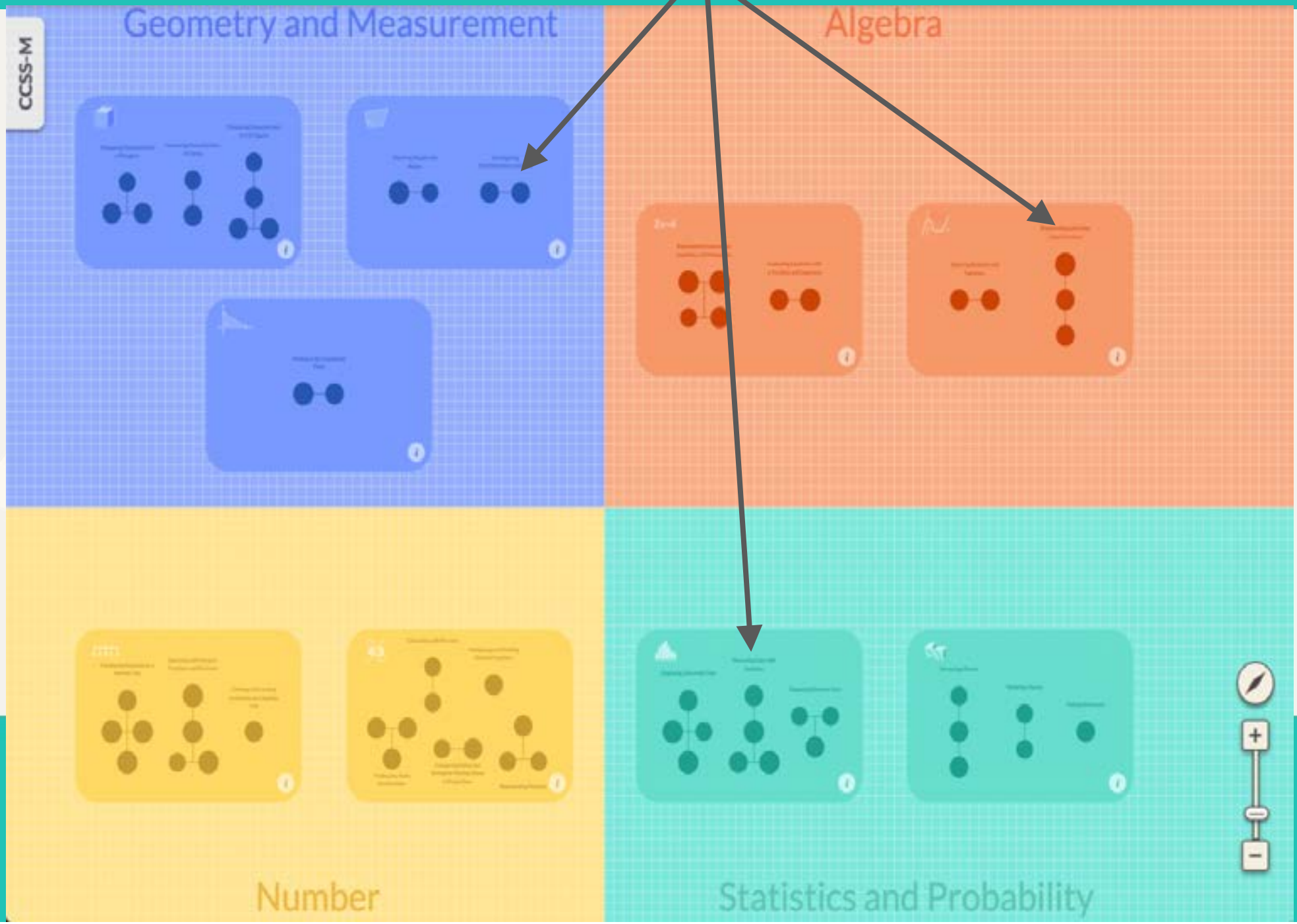
4:3

Compare quantities to operate and compose with ratio, rate, and percent

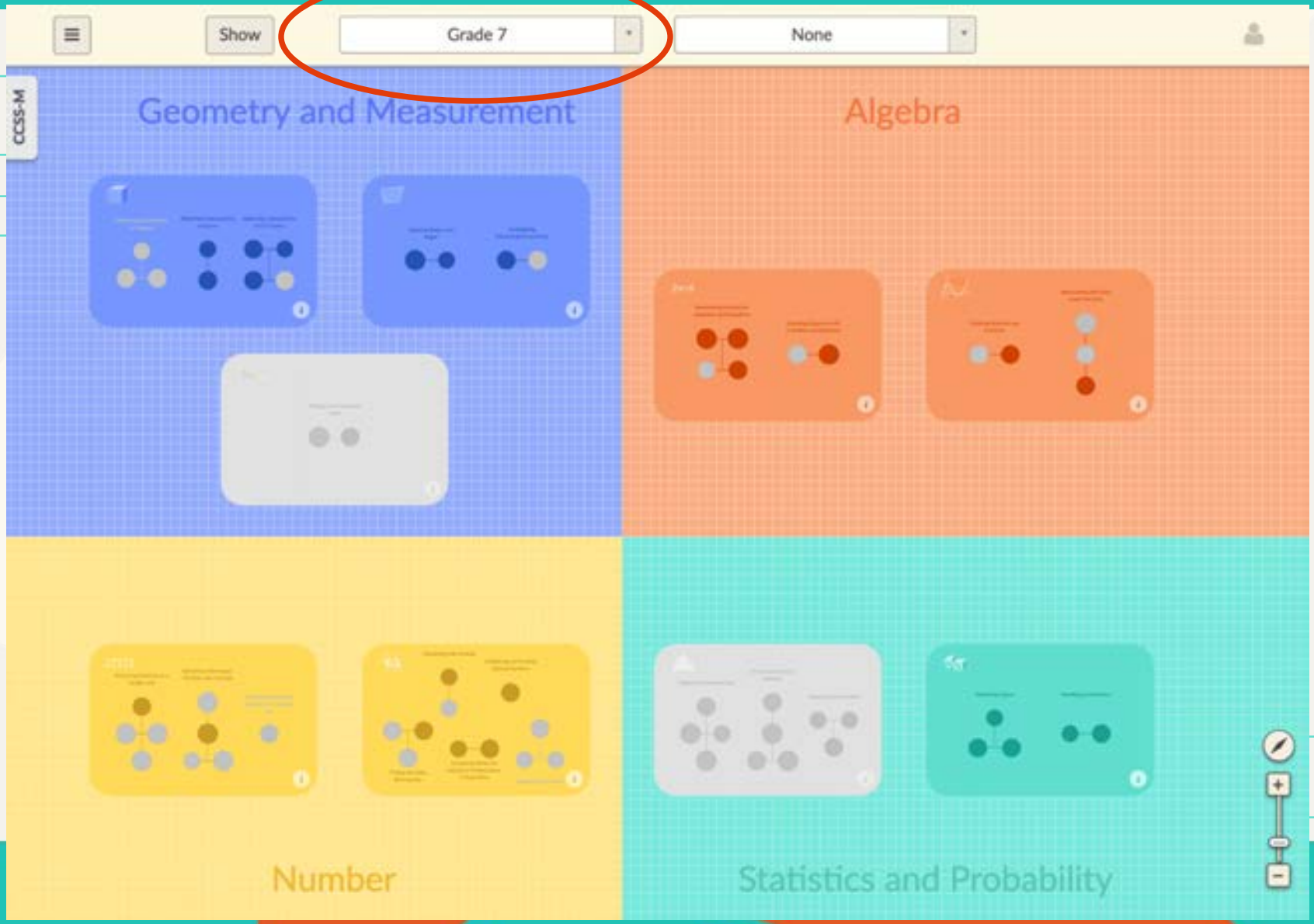
Display date and use statistics to measure center and variation in distribution

Use probability to measure chance and model chance events to make informal inferences

The Related Learning Clusters within the big ideas



Apply Grade-specific Filters



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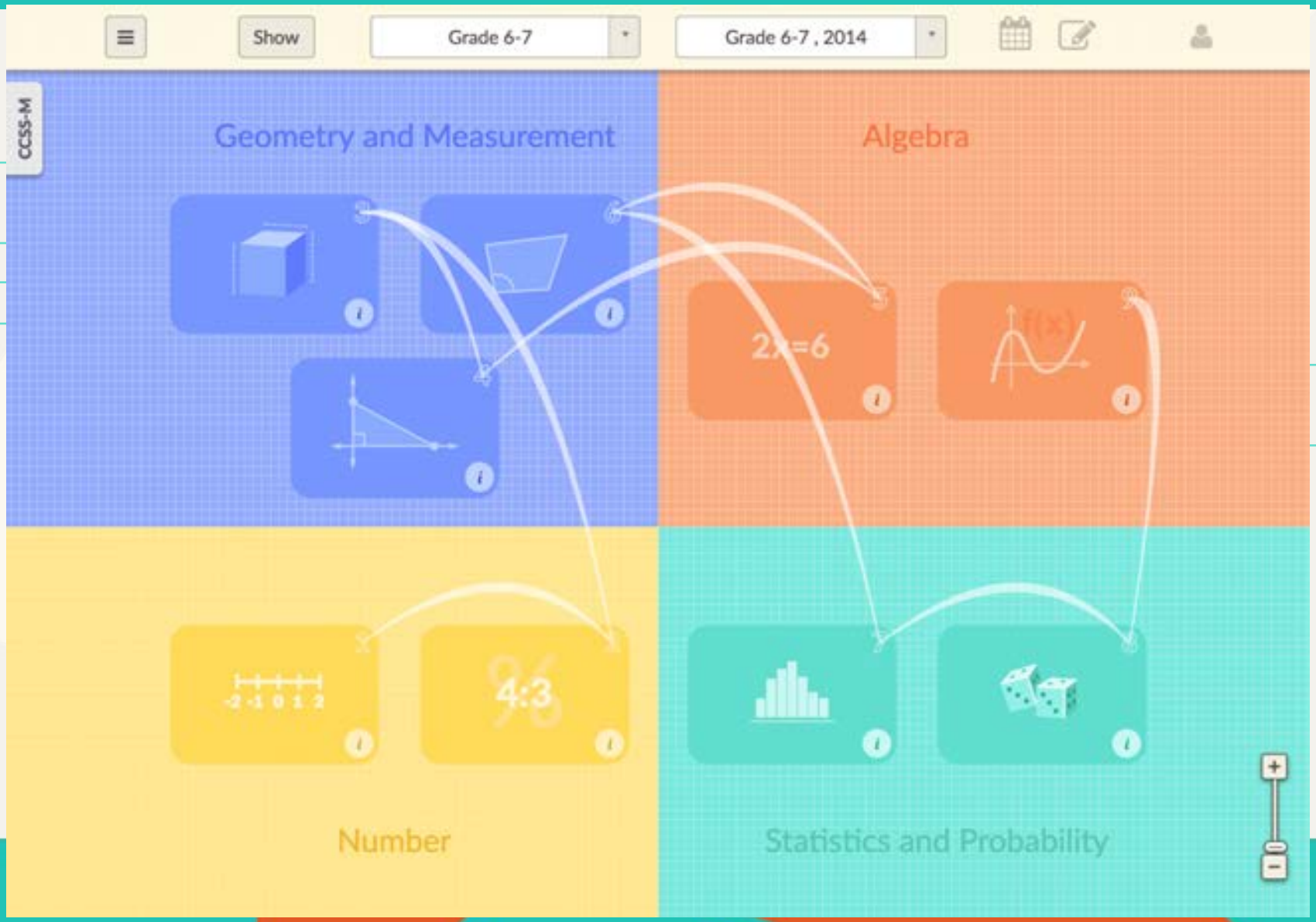
Apply Scopes and Sequences to Support Personalization



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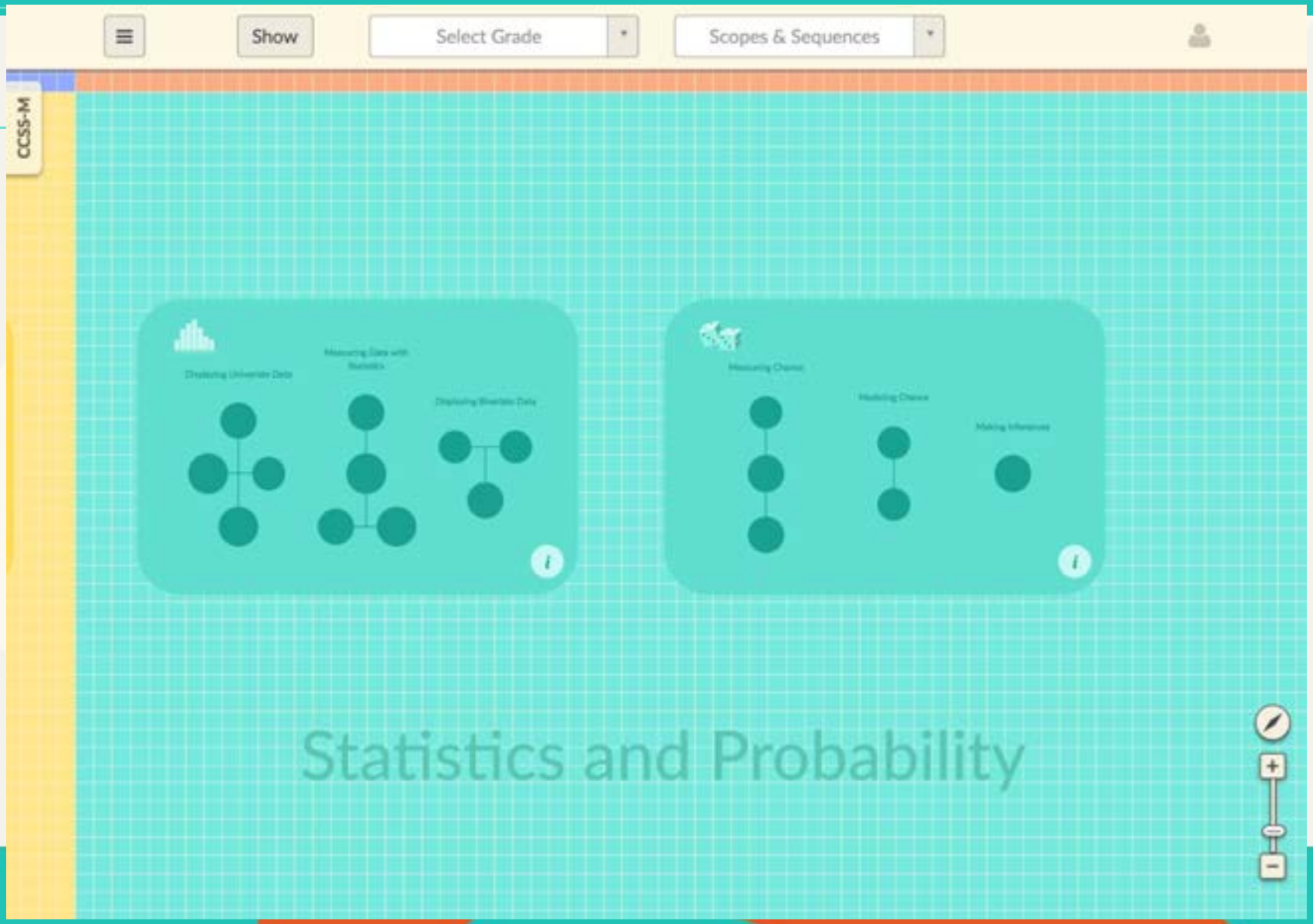
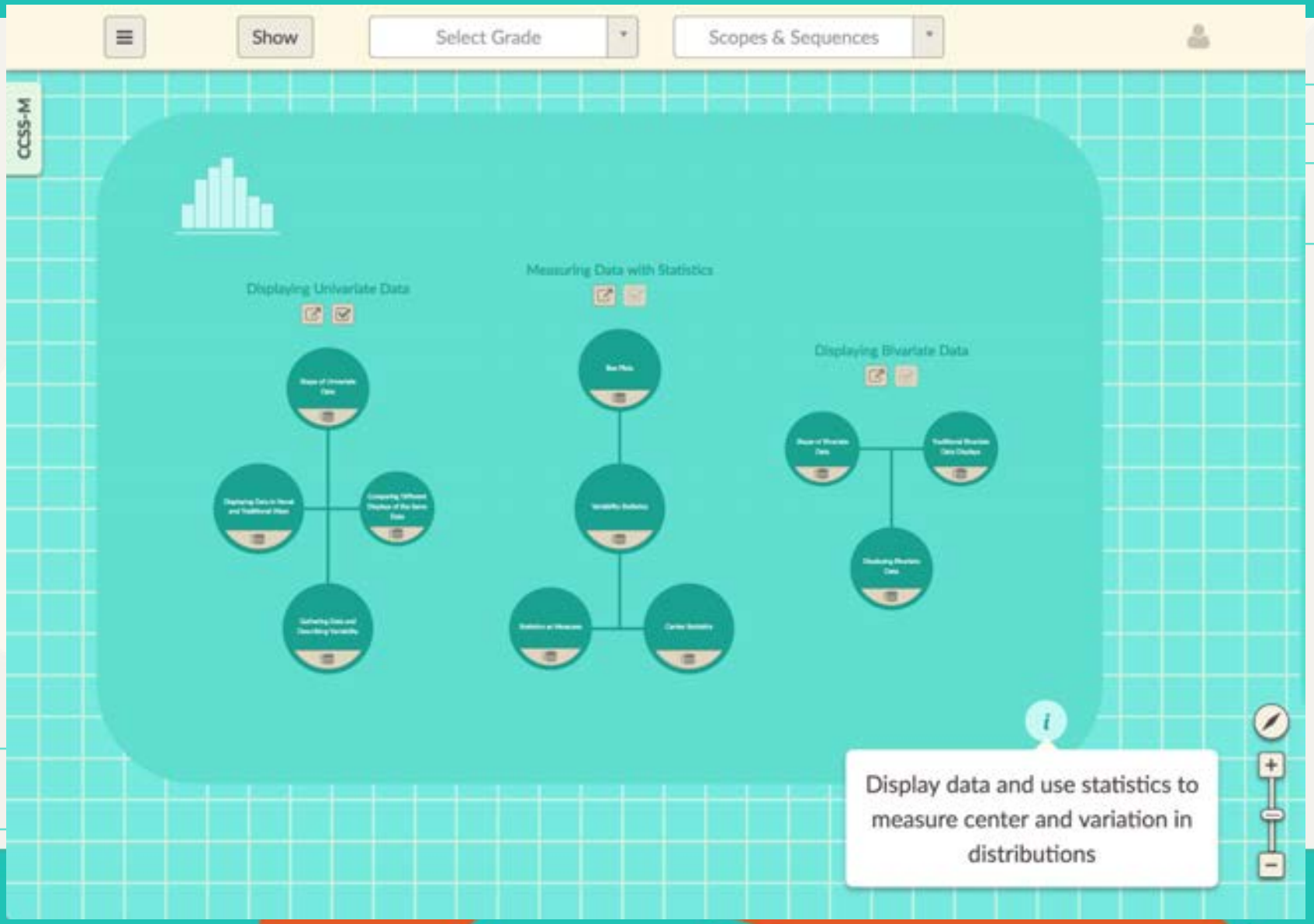
Zoom into a Field



Zoom Into a Region: A Big Idea Broken into Clusters



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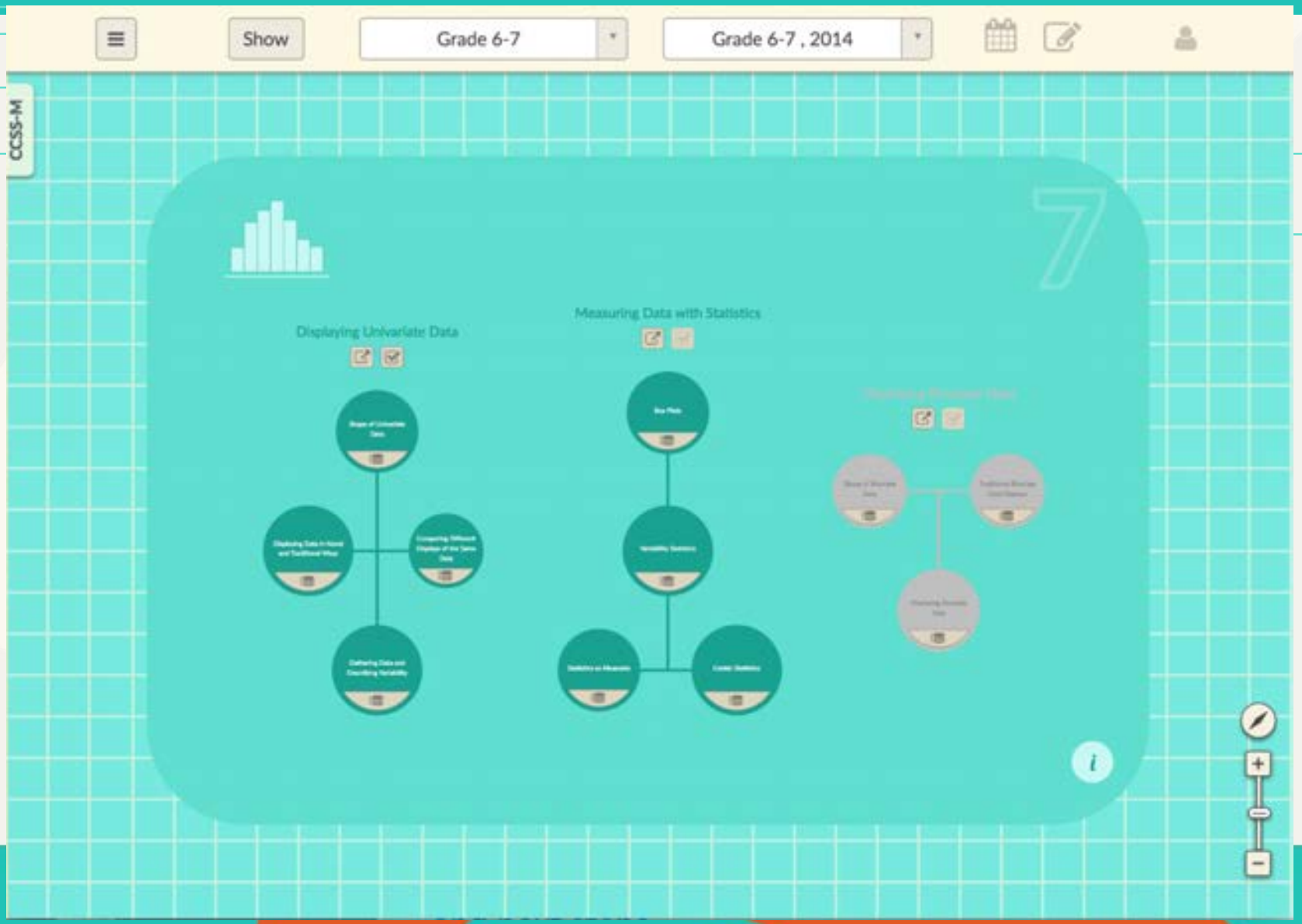
Filter Down to a Grade Range



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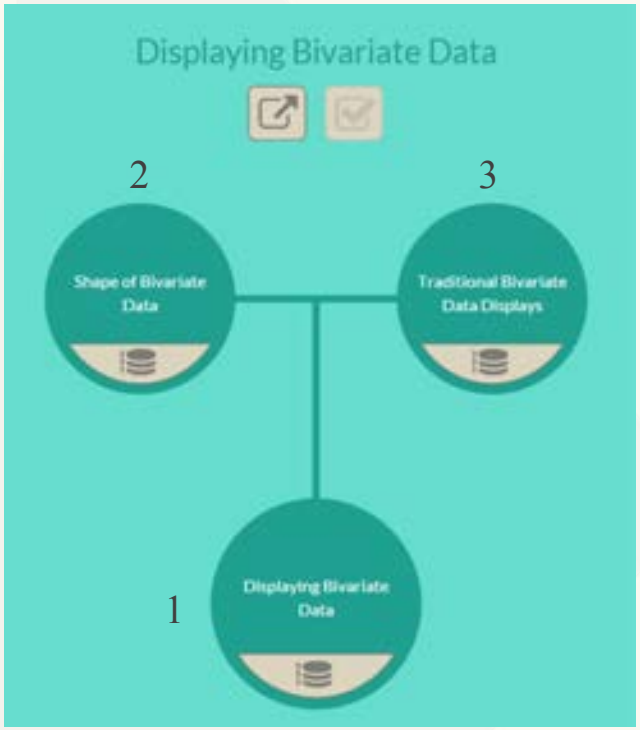
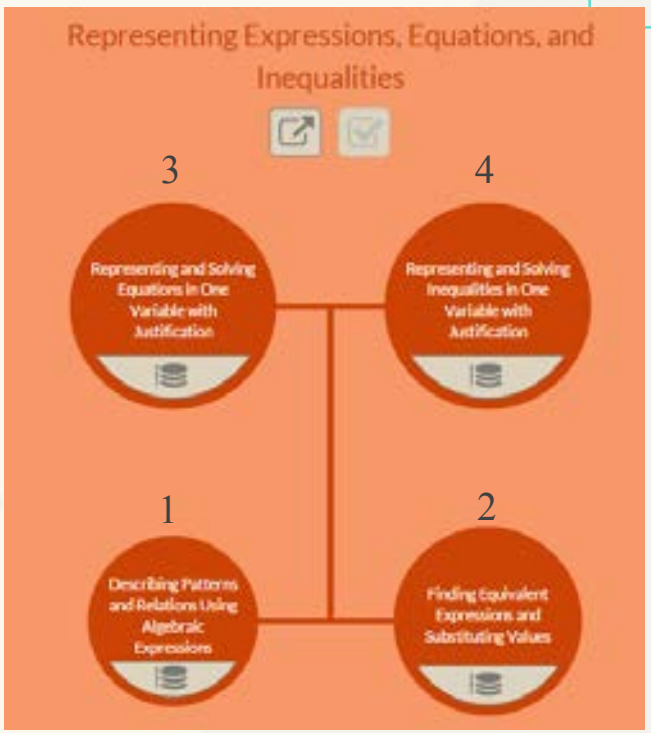
The Shapes of Clusters Inform Possible Sequences

1 then 2 then 3
(linear path)

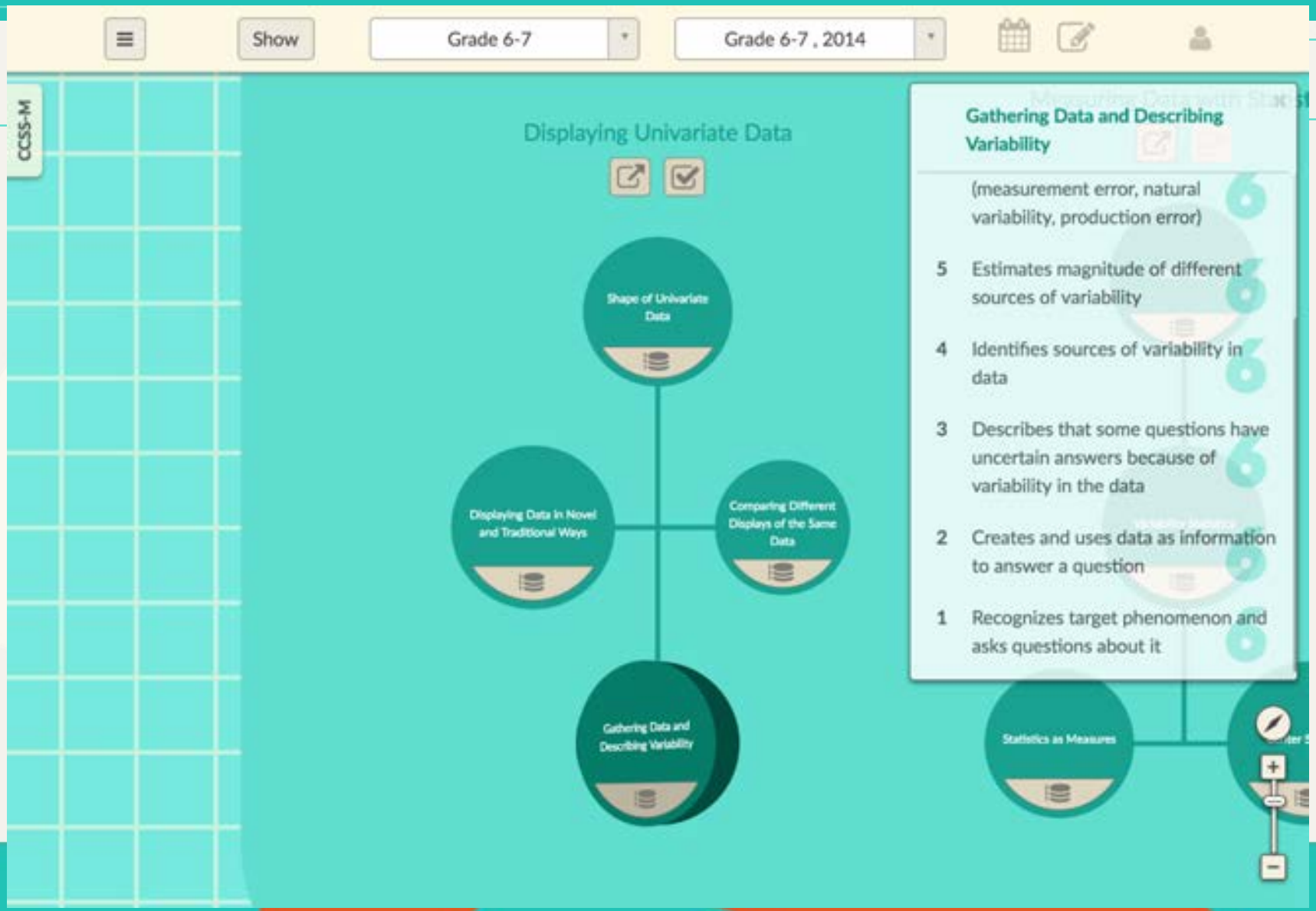


1 then (2,3) or (3,2)
(Divergent)



(1, 2) or (2,1) then (3,4) or (4,3)
(Convergent then Divergent)

Open a Construct to Reveal its Learning Trajectory



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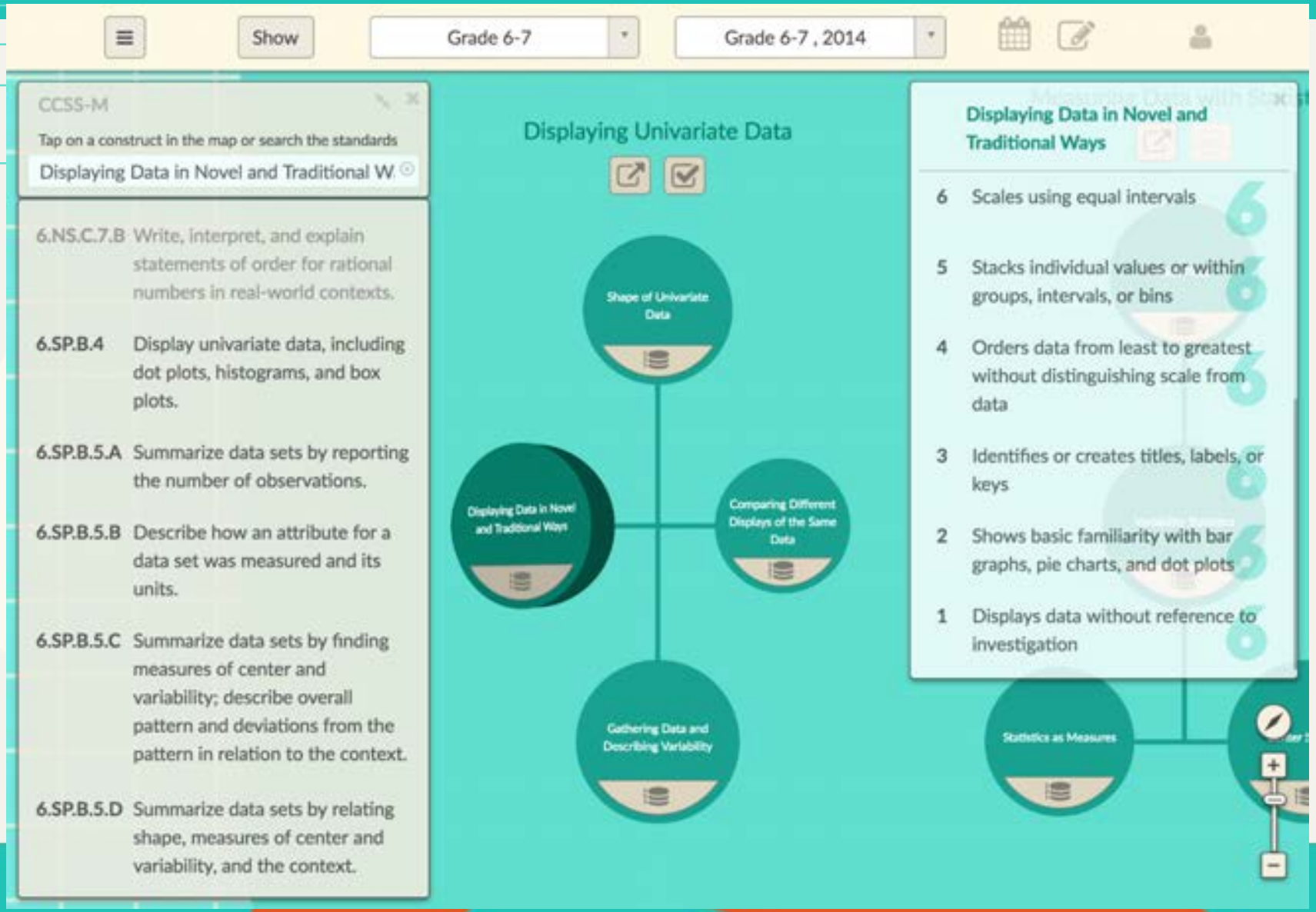
Find the Common Core Standards linked to the LT



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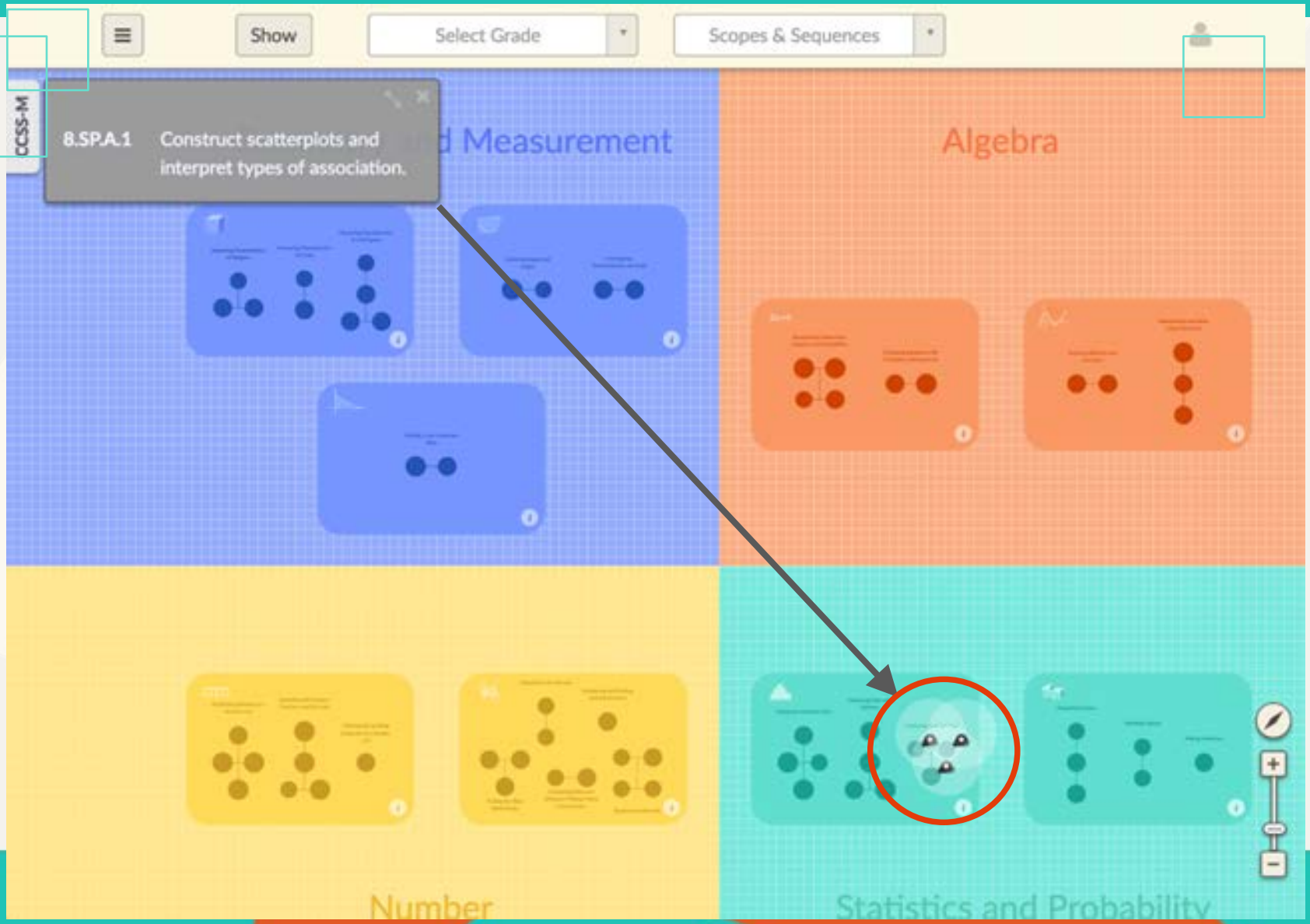
Find the Common Core Standards in the Big Ideas



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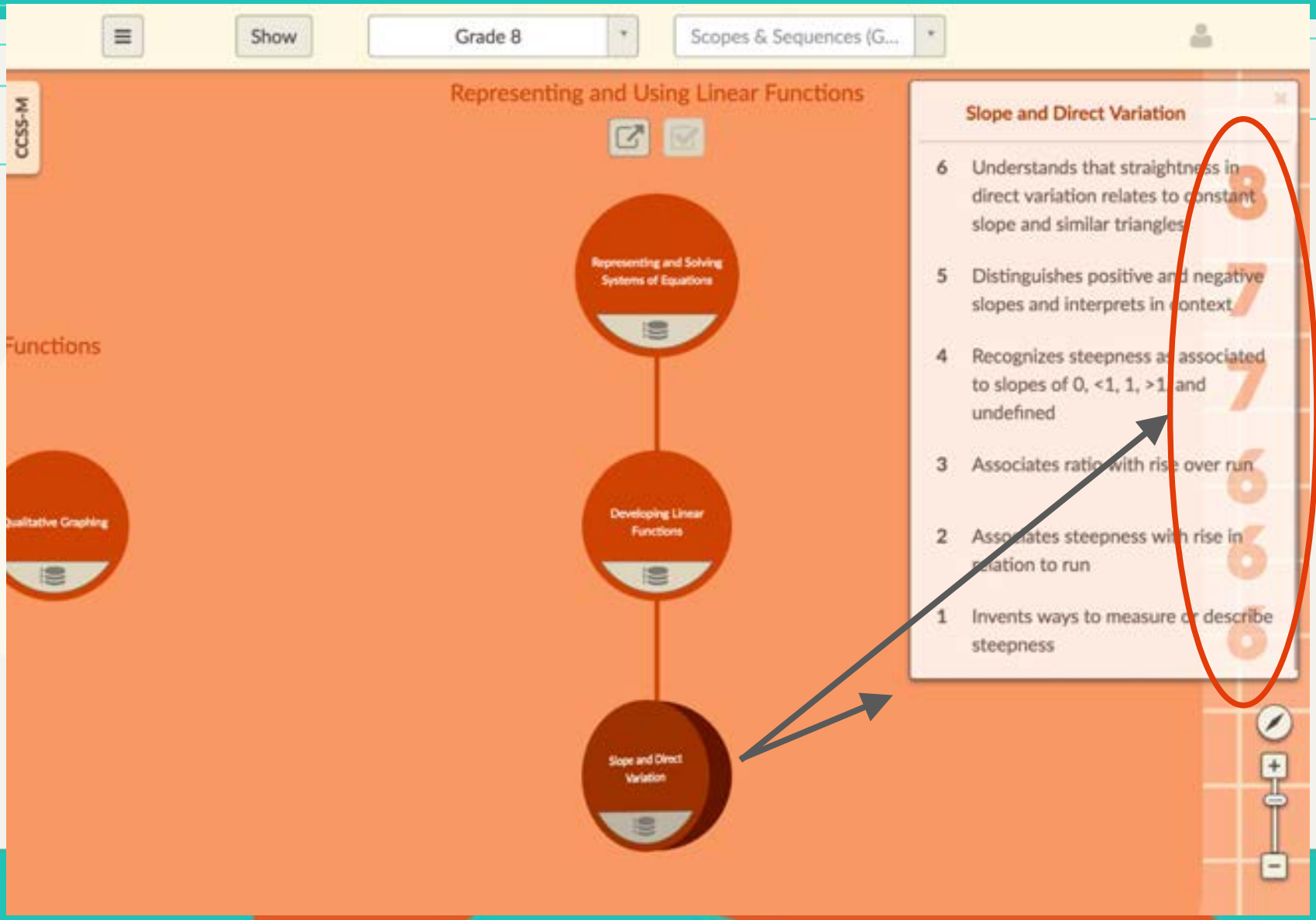
Move Below or Above Grade



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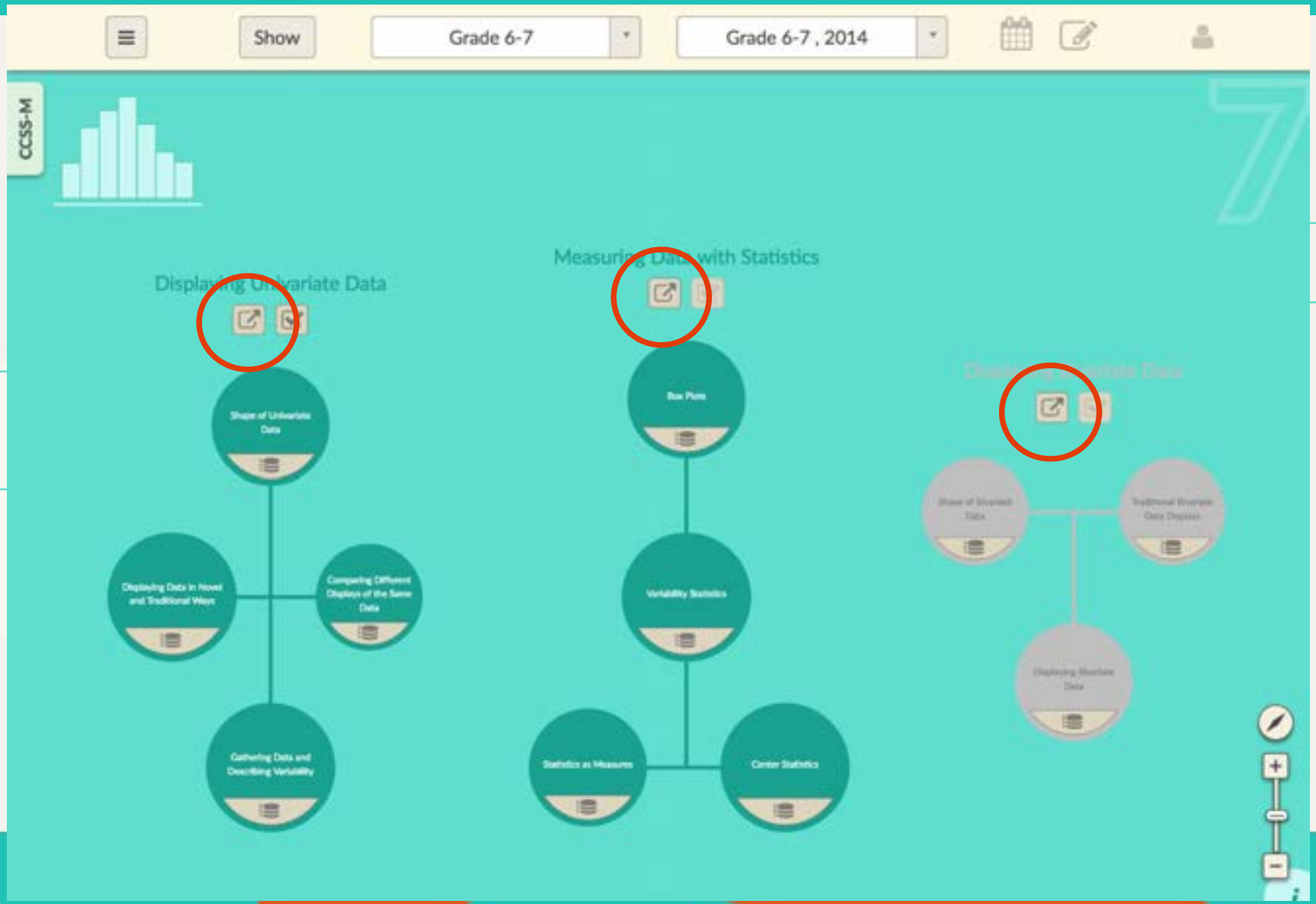
Find the Links to Resources



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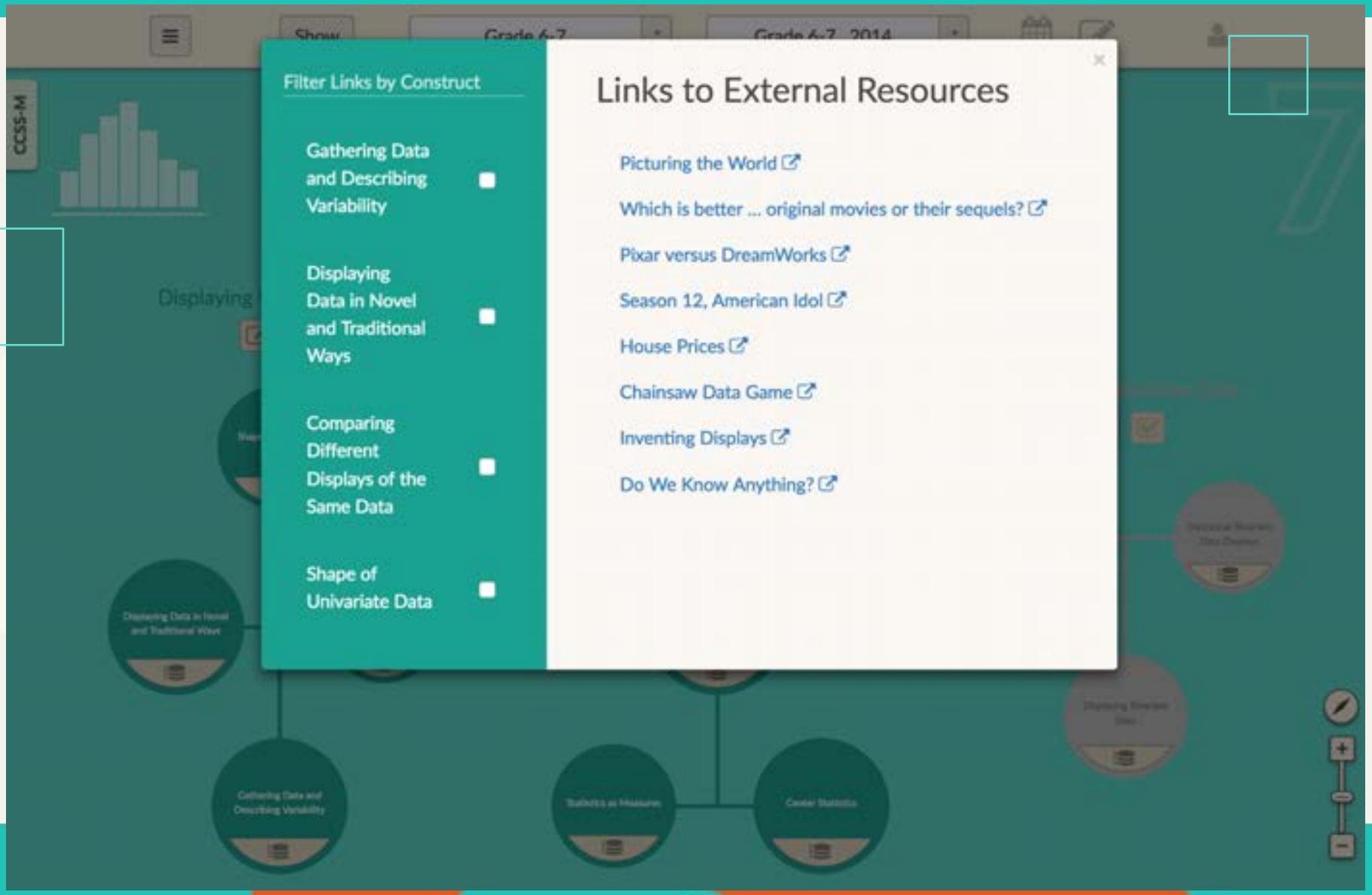
Aligned Curated External Resources



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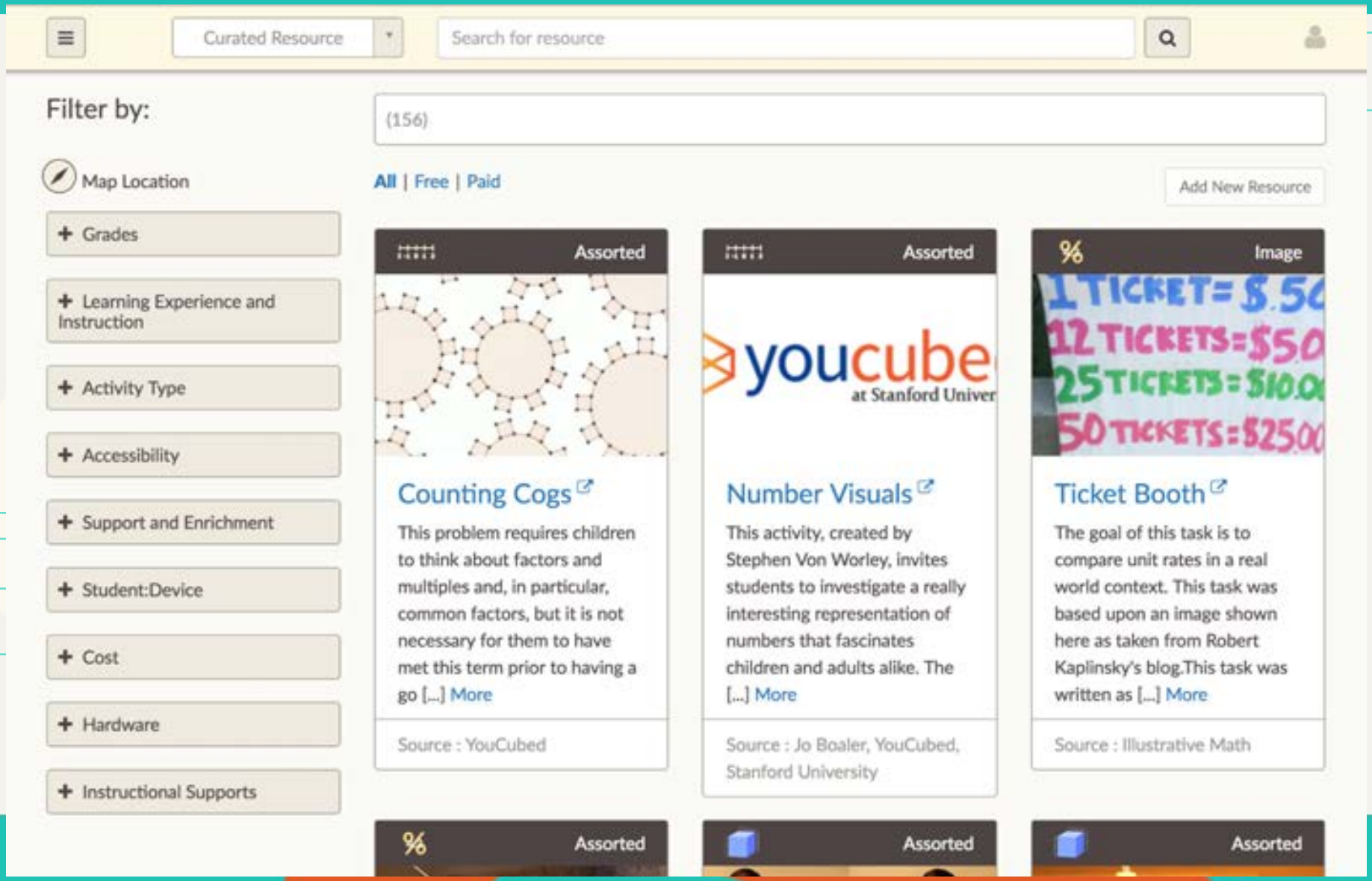
Browse the Resourcery of External Open/Free Resources



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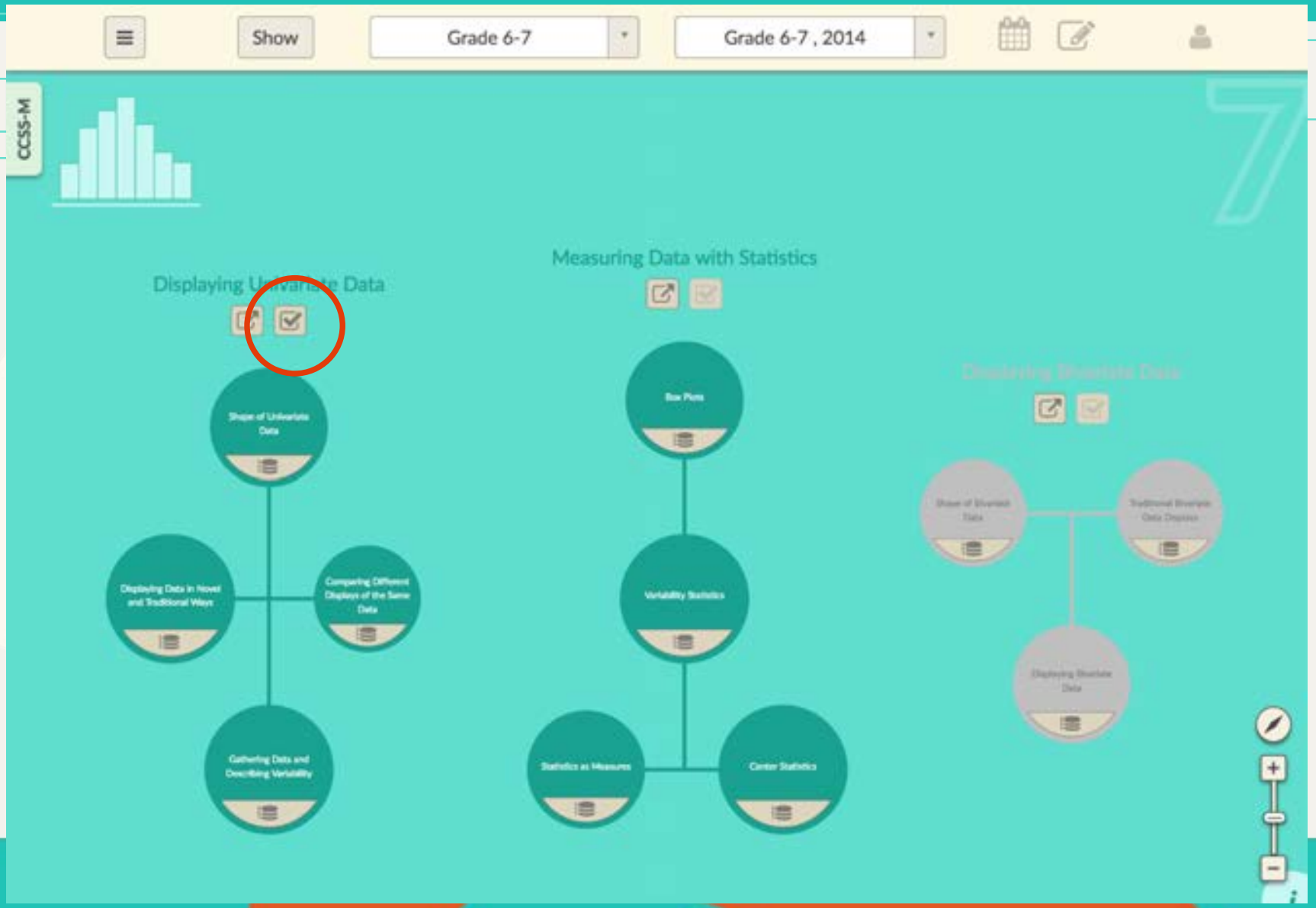
Link to Assessments



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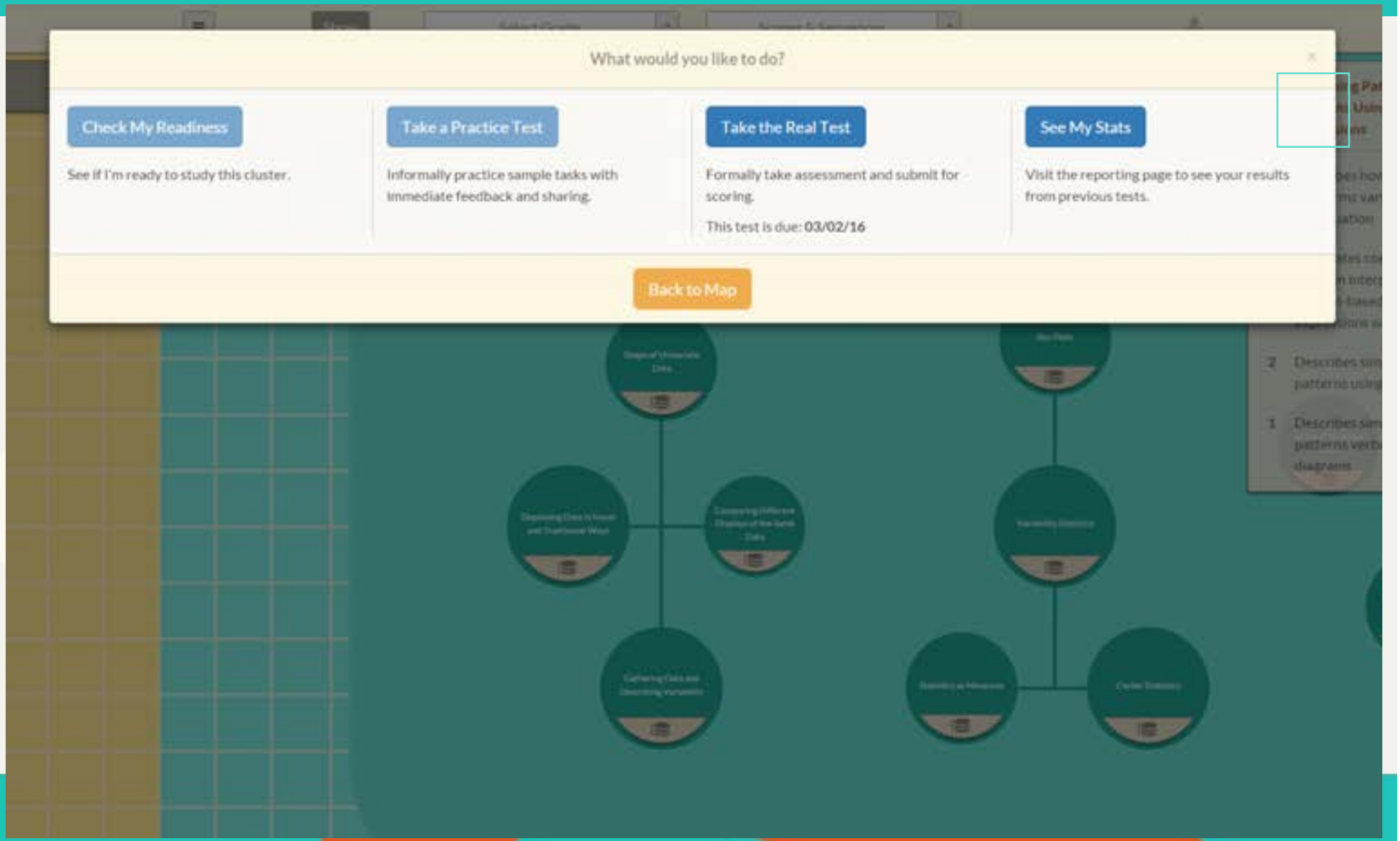
Take an Assessment



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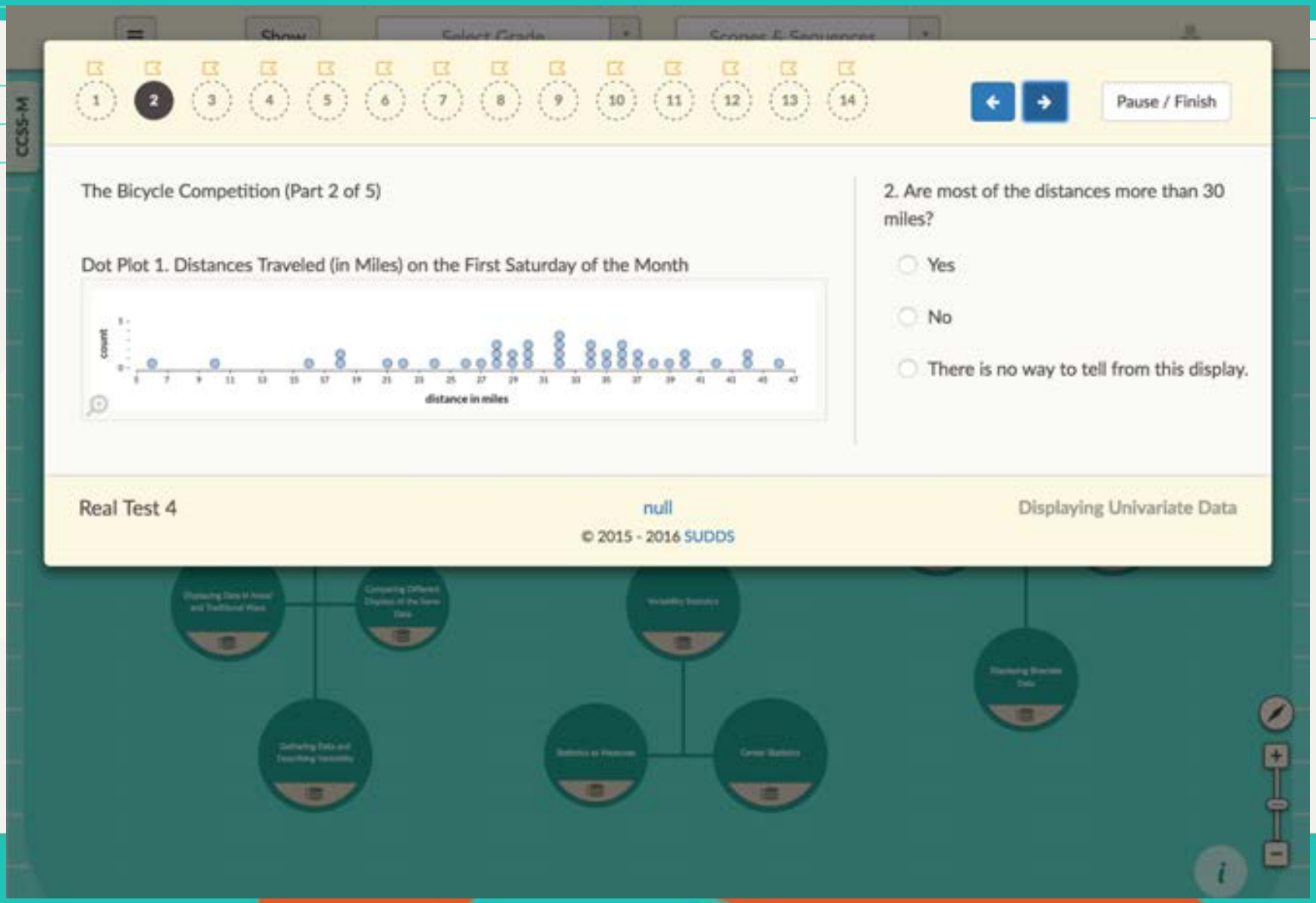
Interact with Items and Tasks in Fully Responsive Pages



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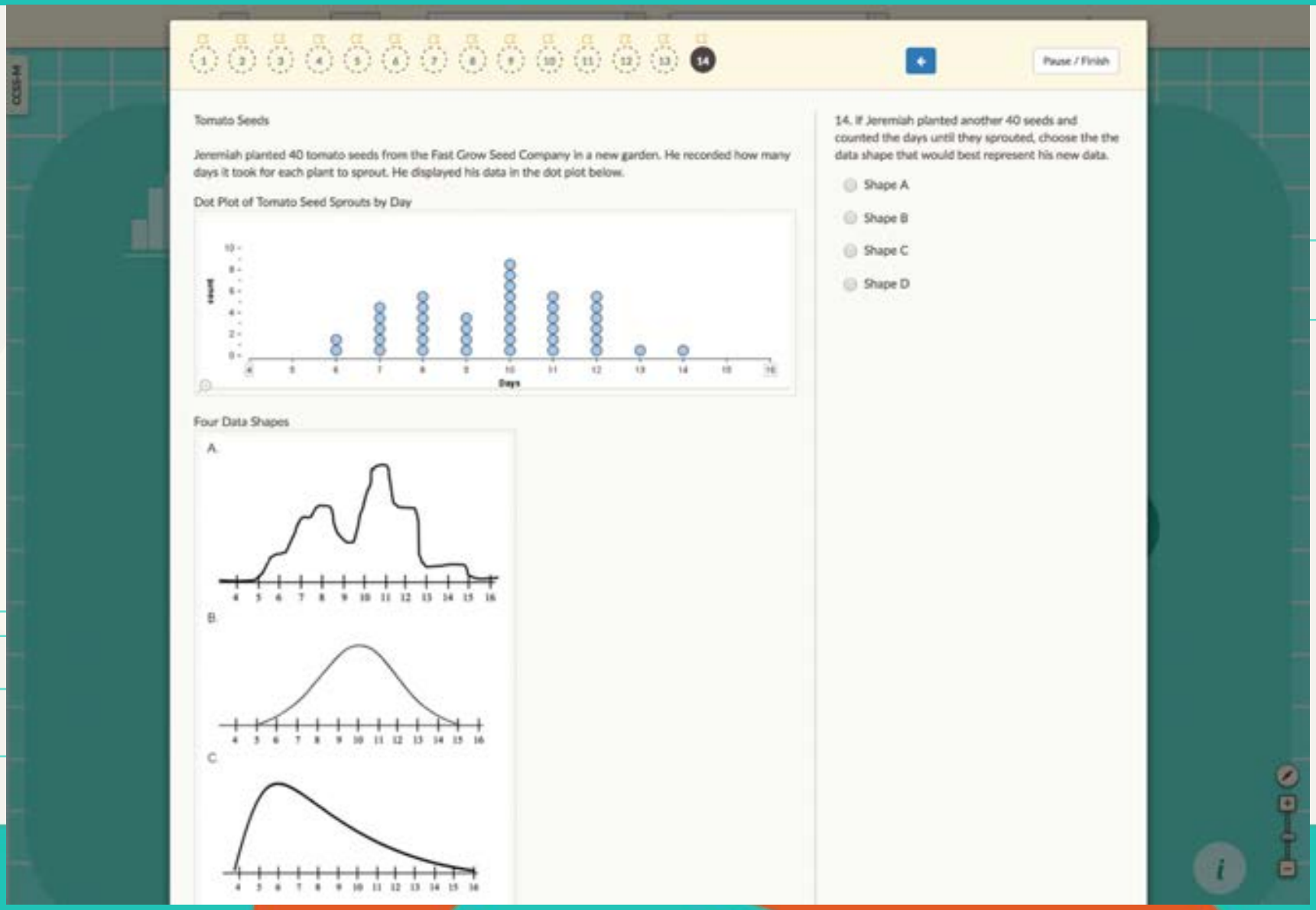
Tasks Designed to Maximize Learning



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Assessments:
Student Reports,
Student Responses,
Promoting Reflection, Discourse, and Learning

Assessment Conditions for Instructional Guidance

Assessment Results must be:

- Timely
- Systematic for all students
- Accurate
- Relevant to what is being taught
- Informative about student progress
- Precise
- Can be taken multiple times

Diagnostic Assessment Features

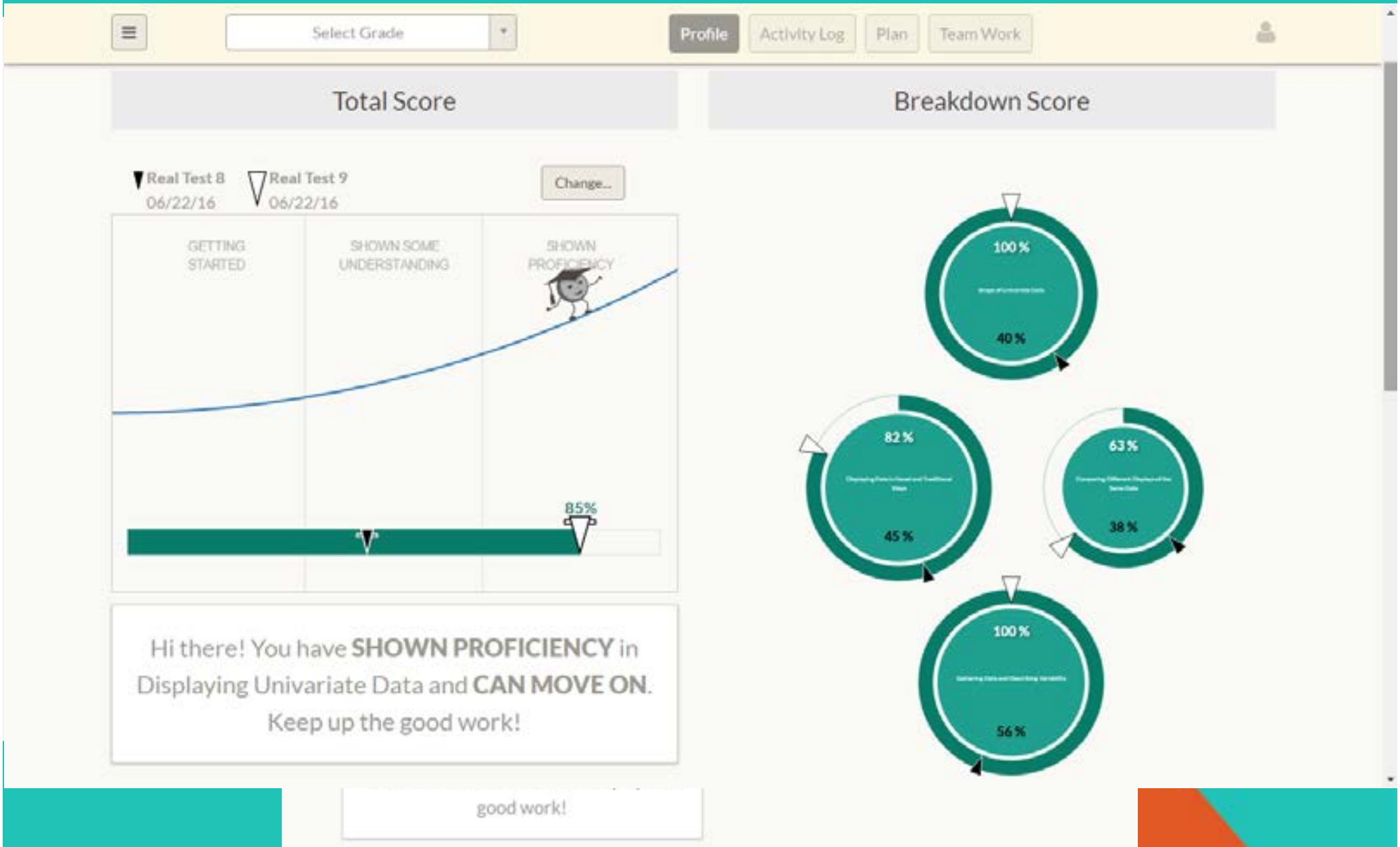
- Practice Tests focus on each construct and its learning trajectory
- Focus on *conceptual* issues of understanding
- "Real Tests" focus on a Cluster to avoid over-testing
- Each test: 10 items; about 30 minutes
- Coordinated with curriculum
- Used formatively to guide/support instructional decision-making
- Machine-generated, scored immediately

Tasks Are Designed to be Diagnostic

Tasks and items were designed to:

- differentiate between low, intermediate, and pro levels of performance as defined by the Learning Trajectory
- Measure progress along the LT
- Flag misconceptions and systematic errors
- Be consistent with an elaboration document

Feedback Messages Encourage a Growth Mindset



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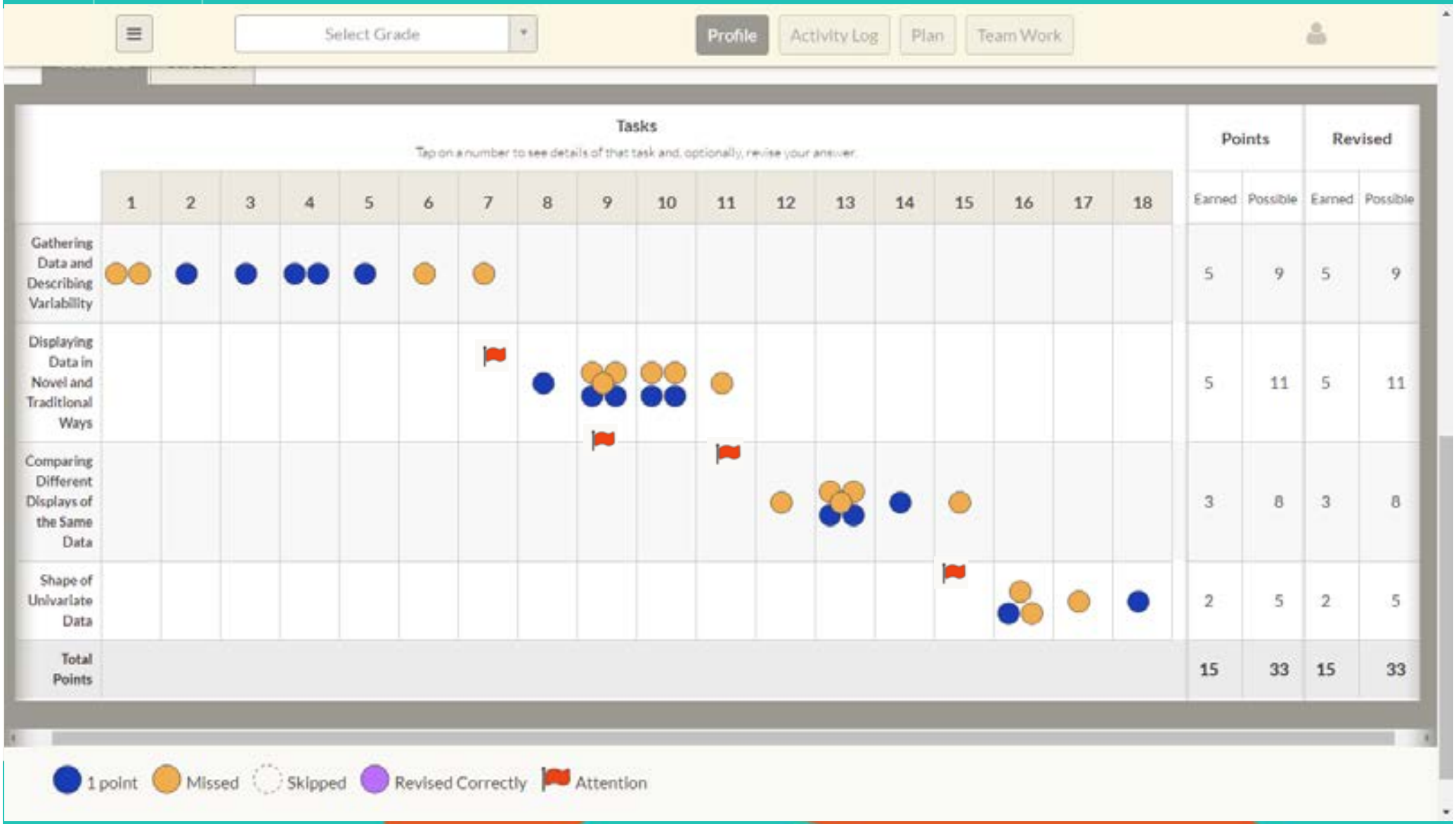
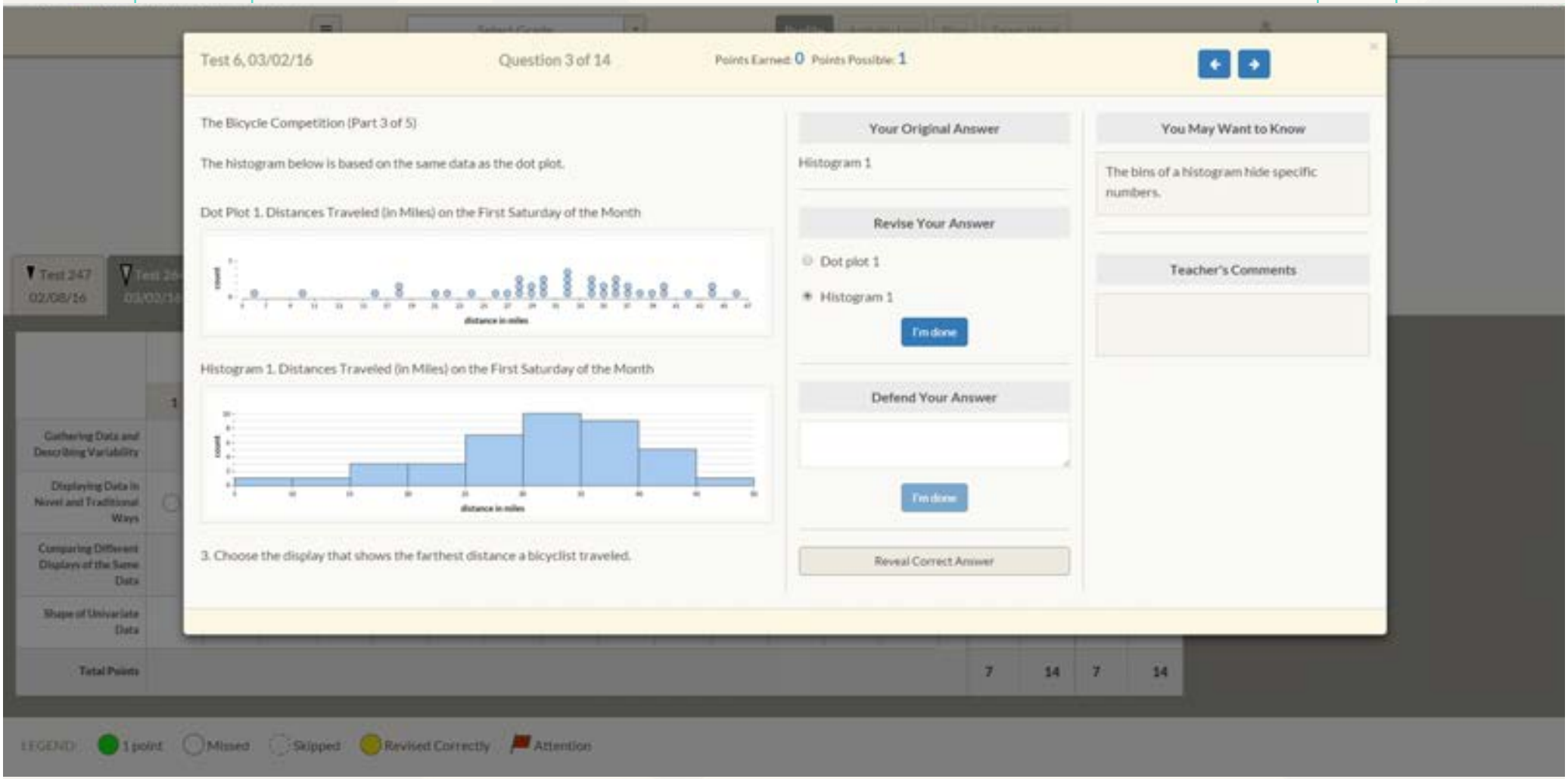
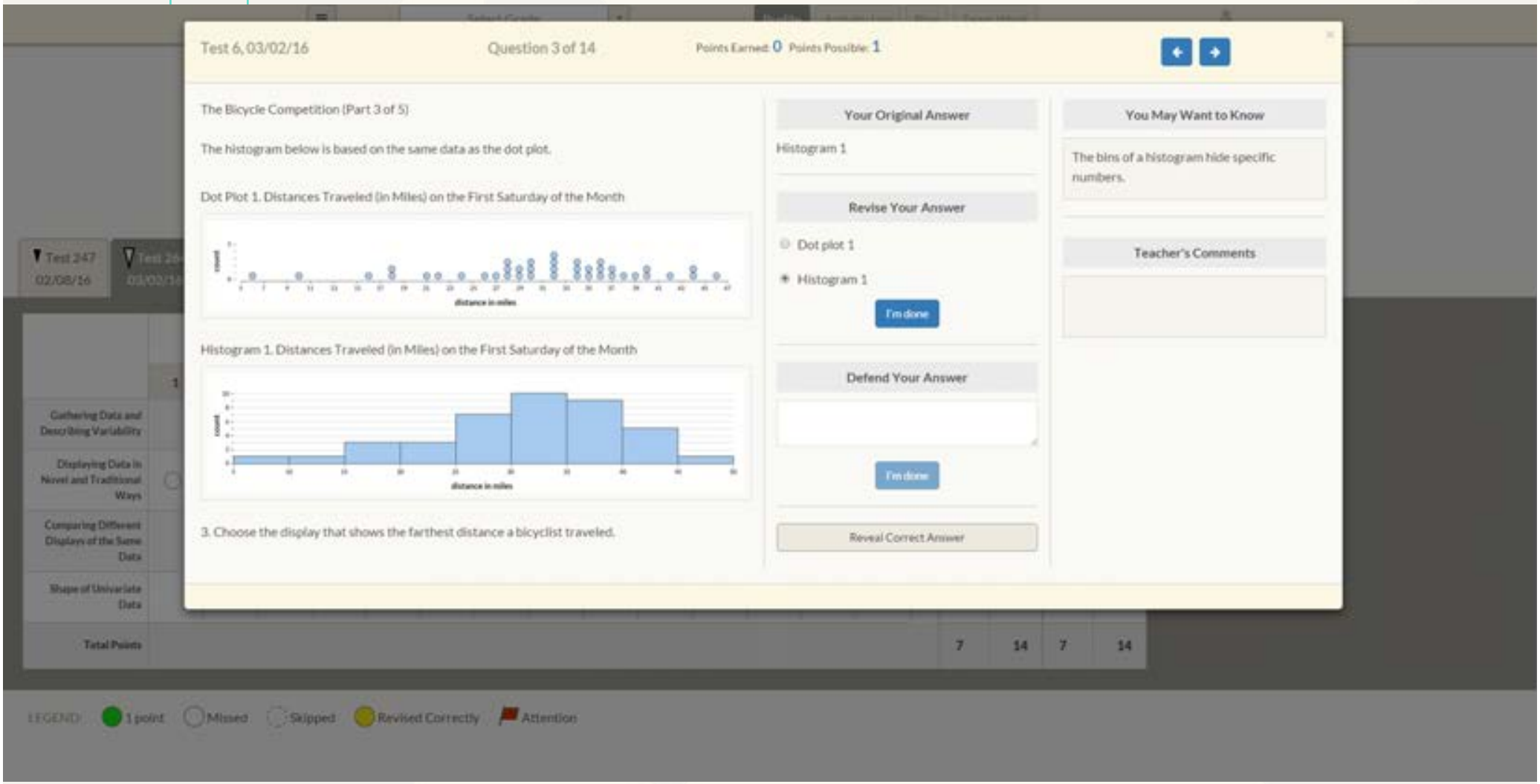
Visualize Score Patterns and See Misconceptions



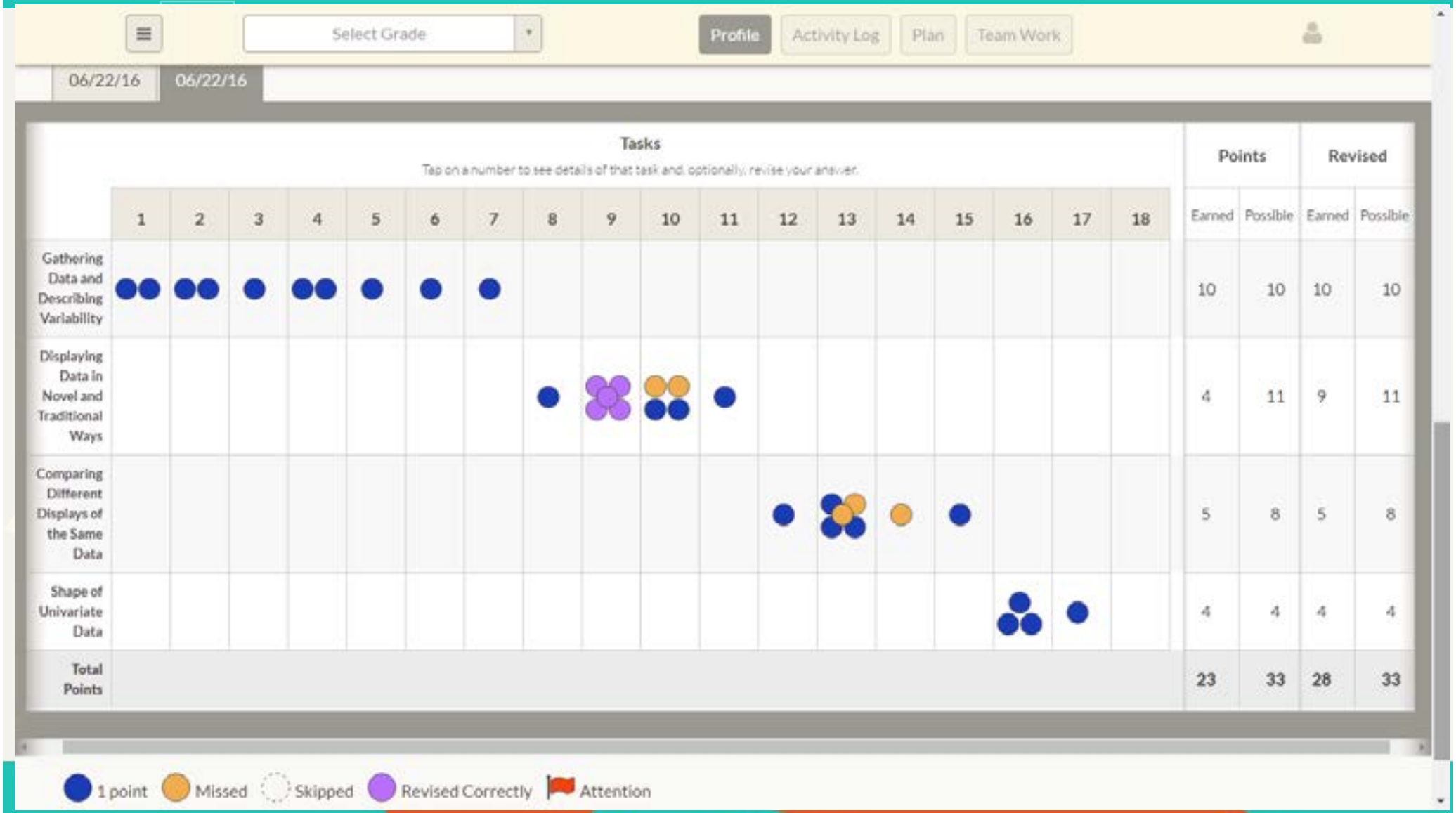
Reveal the Key, Revise or Defend an Answer, Give and Receive Commentary



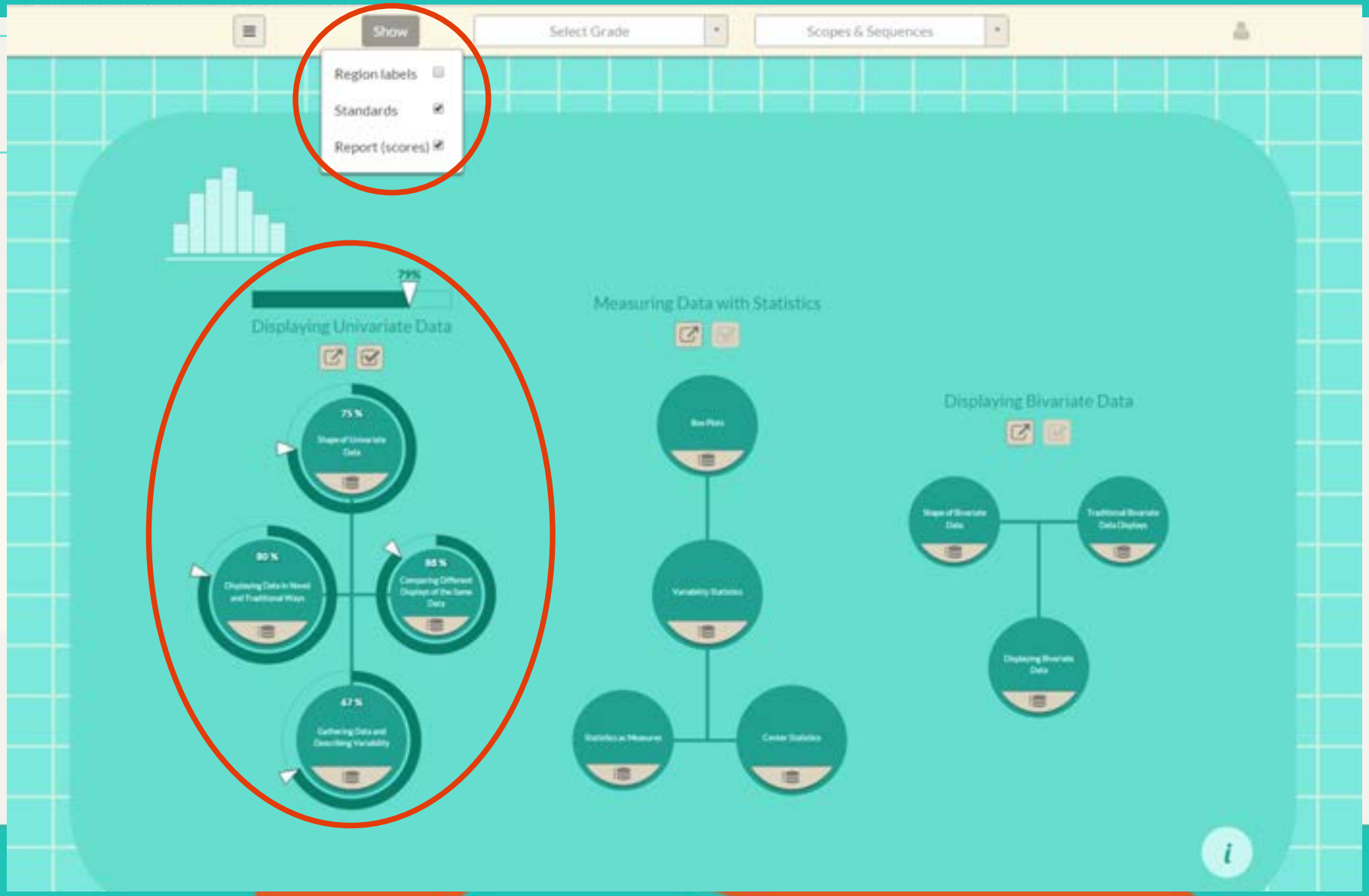
Give and Receive Commentary



See the Results of Revisions



Visualize Score Profiles on the Map



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Locating Student Position in the Learning Trajectories

- LTs give a foundation on which we can place our IRT models
- Data modeling is confirmatory in nature
- Theories can be disconfirmed, theories can be improved, and retested through a research agenda
- The LT provides an interpretive framework for scores

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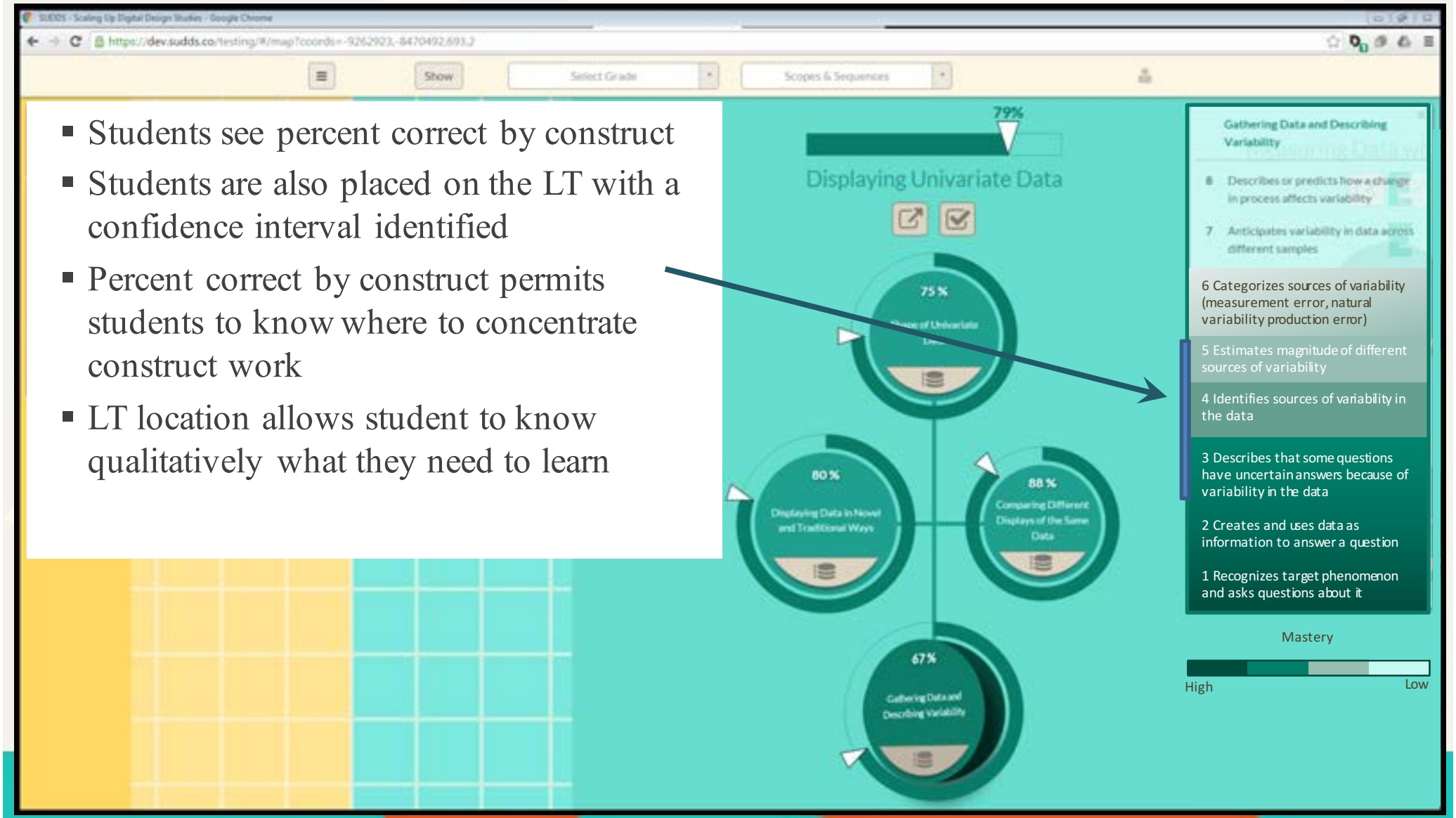
Locating Students in the Learning Trajectories

- Students see percent correct by construct
- Students are also placed on the LT with a confidence interval identified
- Percent correct by construct permits students to know where to concentrate construct work
- LT location allows student to know qualitatively what they need to learn



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Assessments: Teacher Reports. Using Data to Monitor Class Progress and Guide Instruction and Grouping

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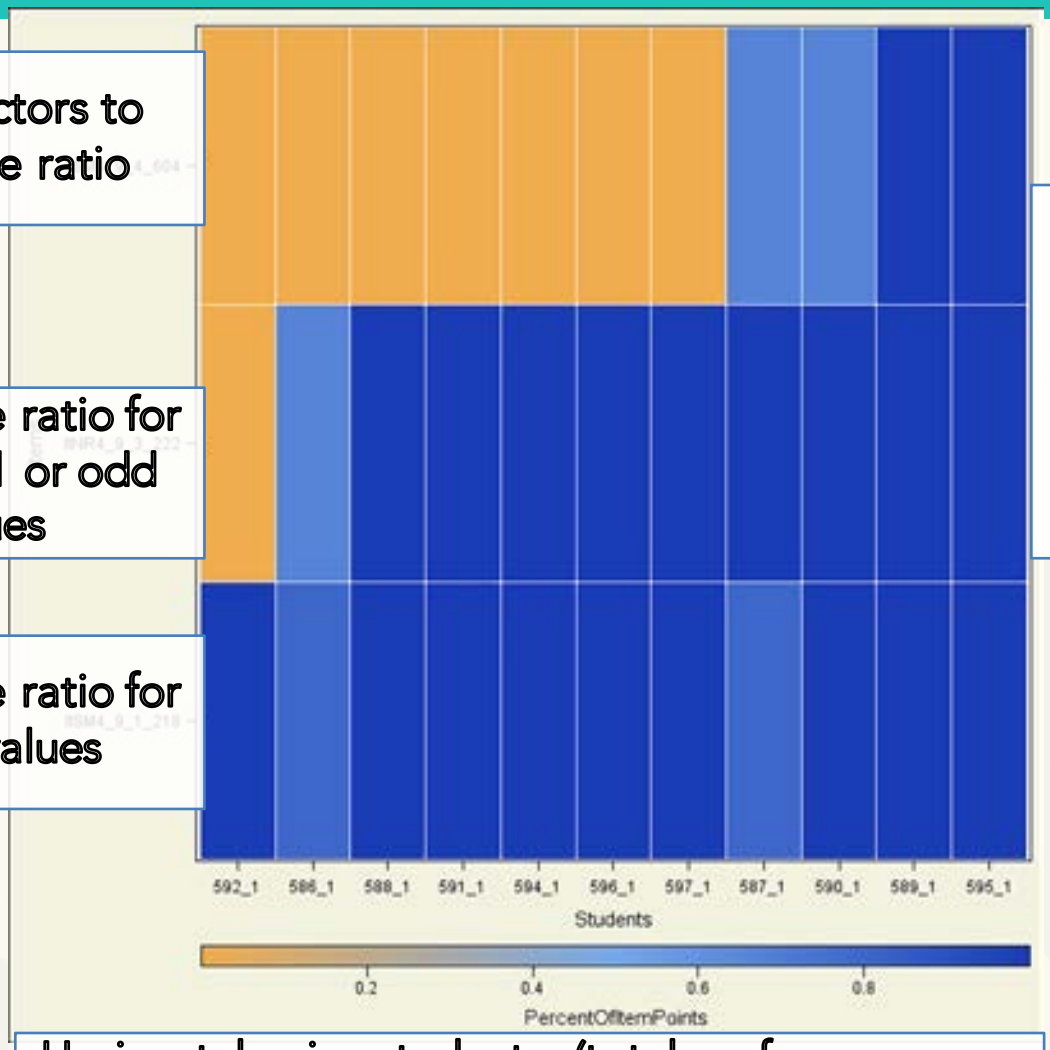
Math-Mapper 6-8: Teacher Reports ("Heat Maps")

Vertical axis: Levels and Items

Prime factors to find base ratio

Finds base ratio for even/odd or odd values

Finds base ratio for even values



Horizontal axis: students, (total performance on all items from left to right)

Teacher Reports: visual display of entire class's performance on all items for a single construct

Color Code:

Shades of blue:
partially/fully correct

Orange:
incorrect

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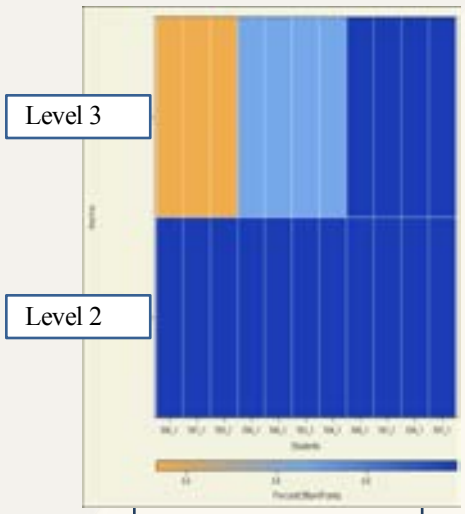
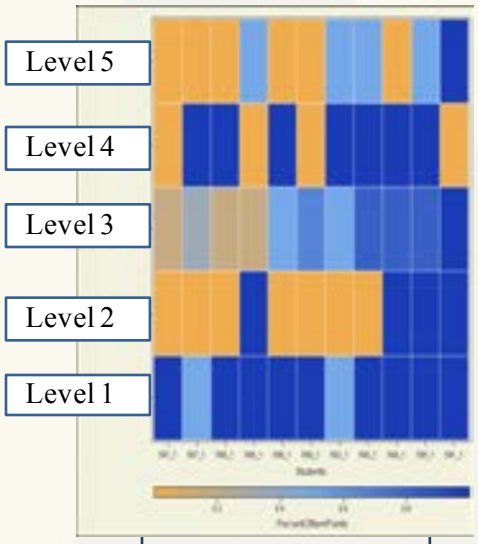
Results for One Sixth Grade Class Across 2 RLCs

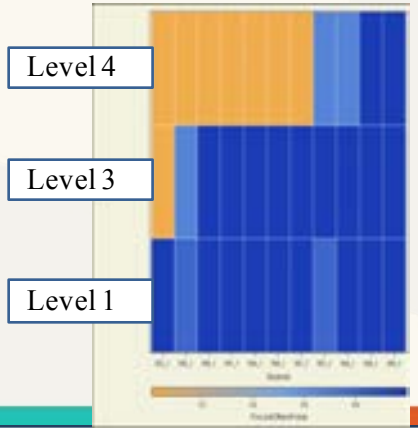
1. Finding Key Ratio Relationships



Base ratios

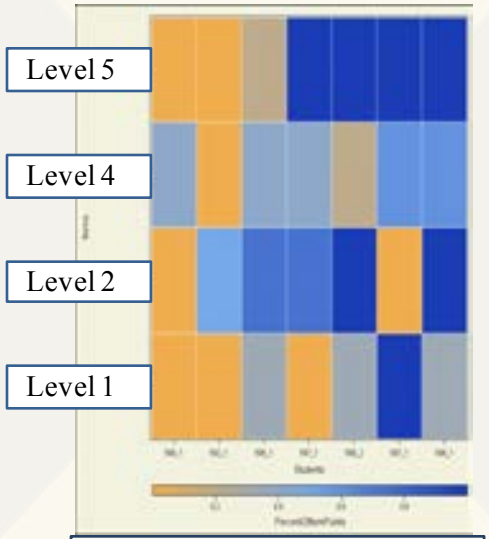


Unit ratios

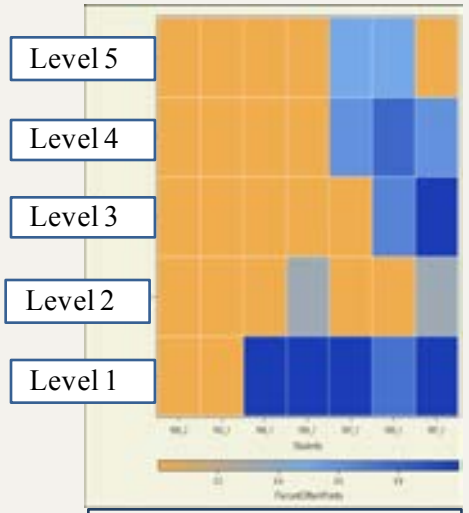


Equivalent ratios

2. Comparing Ratios and Solving Missing Values in Proportion



Comparing Ratios



Finding Missing Values

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School Level Results for a Single Construct

Construct 15
(Benchmark Percents)

Learning Trajectory Levels

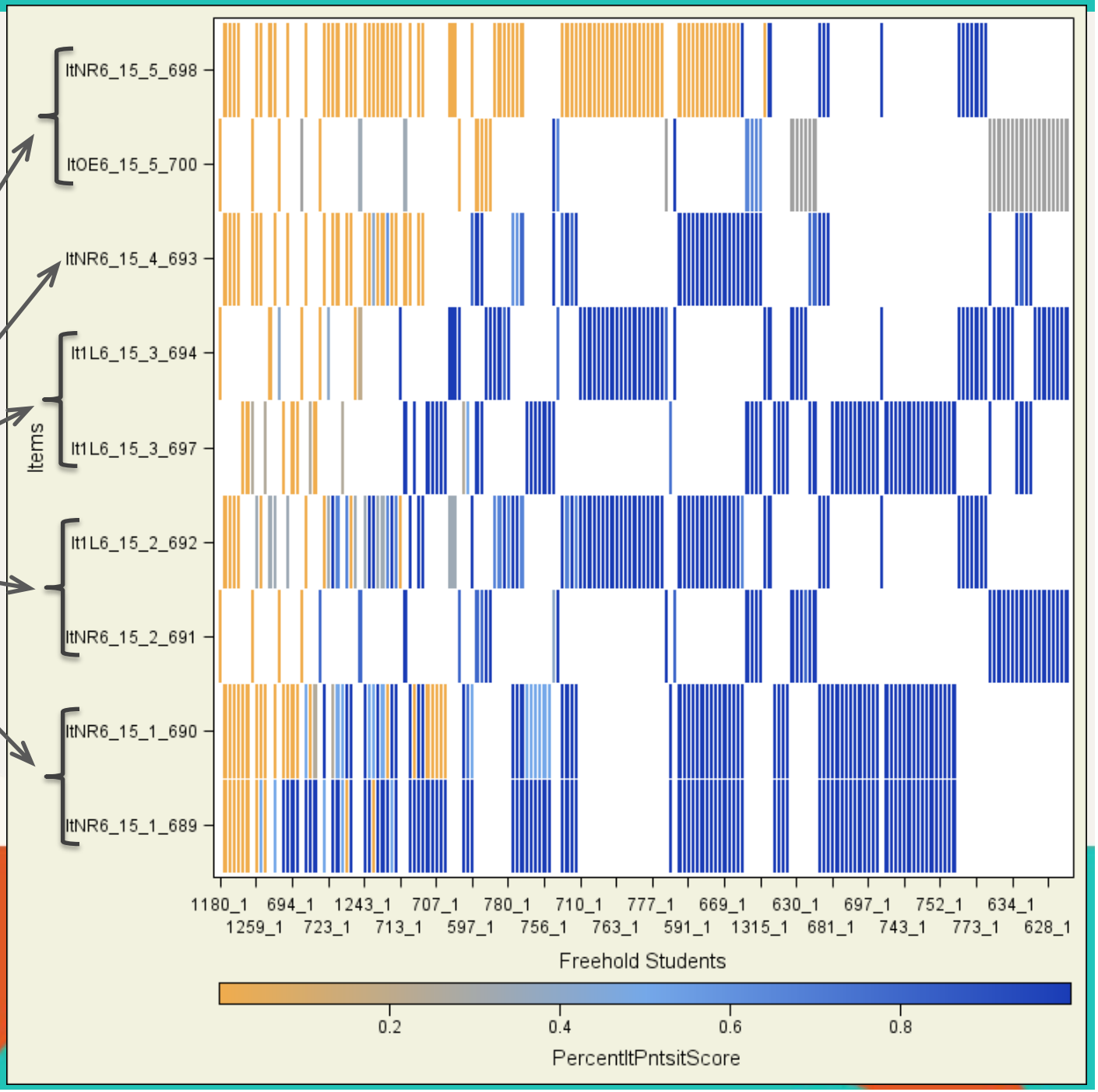
5) From percent and its value, finds number in a collection

4) Finds percentage of a number with benchmarks

3) Understands 25%, 75%, 10% and 1%

2) Understands 50%

1) 100% is all; 0% is none



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- Challenges and Dilemmas. A New Approach
- Components of a Digital Learning System (DLS)
- Demonstration: Math-Mapper 6-8 DLS
- What we have learned from our partnerships
- Opportunities for Future Partnerships

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Using LTs to Drive Professional Development

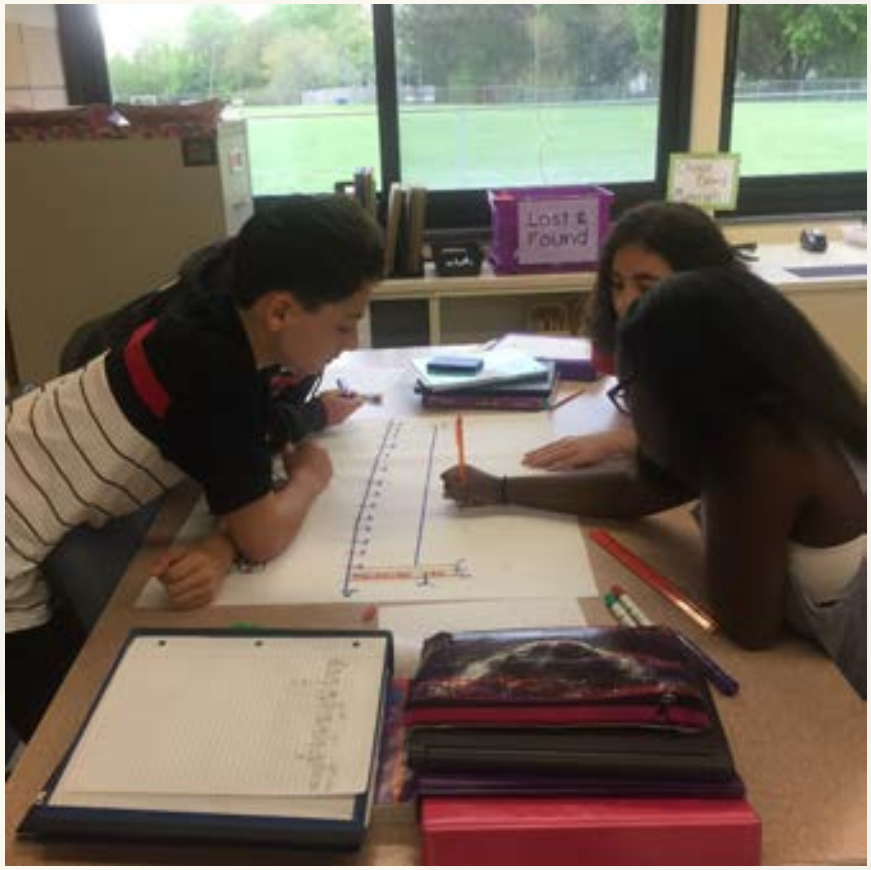
- Teacher training on the learning map
- Students took diagnostic assessments
- Teachers reviewed results
- A two-week collaborative design study on the introductory clusters in statistics
  - Displaying Univariate Data
  - Measuring Data with Statistics

Impact on Student Engagement

- Provide students with open-ended tasks that elicit ideas
- Shift the classroom environment to allow students to express and explore their ideas
- Trust the students
- Include opportunity to learn for all students

Positive Classroom Culture (Margaret Heritage)

- Mutual trust
- Intellectual rigor
- Expectation that ALL students learn
- Shared responsibility for learning
- Models of positive interactions
- Supportive, collaborative relationships



Impact of Immediate Feedback to Students

- Students take ownership of their results

Teacher Collaboration Around LTs

- Teachers discussed evidence of student learning through the LTs
- This impacted their planning the next day's instruction
- The LTs framed their conversations around student learning

Lab Sites

THE MATH DOOR

MATH-MAPPER 6-8

How Kids Create Their Own Knowledge

- The main topic of the debriefing session
- Questions
  - How you pose the question?
  - How do you support students without giving the answer?
  - How do you NOT say too much?
  - How do you help students hear each other's contributions?
  - How do you make sure your mathematical goal is being met?

- Challenges and Dilemmas. A New Approach
- Components of a Digital Learning System (DLS)
- Demonstration: Math-Mapper 6-8 DLS
- What we have learned from our partnerships
- Opportunities for Future Partnerships

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Summary: How our DLS Can Help to Close Gaps

Learning trajectories…

- ….coupled with professional development, can better prepare less-experienced teachers to plan, prepare for, and instruct students.
- …and the tests span below-grade giving teachers good leads on foundational gaps that need to be addressed if progress is stymied.
- … and the tests span above-grade giving teachers the freedom and support to move advanced students above grade.
- …are aligned with the common core state standards in Mathematics, but *are meaningful without reference to the CCSS*.
- Links provide previously vetted, high-quality open-ed (free) learning materials that align with Learning Trajectories.

Summary: How our DLS Can Help to Close Gaps

- Variety of item types: interesting contexts, engaging visuals, and partial credit scoring that are sensitive to a wide range of student ability levels, keeping students motivated when grappling with challenging problems.
- Item readability is at or below the targeted grade levels. (Items will undergo a bias and sensitivity review in the near future.)
- Growth mindset is supported throughout our design.
- Heatmaps provide a means for teachers to group students according to instructional need.

Partnership Opportunities: and Committments Piloting Math-Mapper 6-8 during 2016-2017

1. Align curriculum
2. Get student and teacher lists in the system
3. Provide fundamental professional development in use of system (1 day)
4. Commit to give assessments and share data
5. At no cost during pilots

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To see the Map with one embedded assessment: sudds.co