Synthesizing Evidence in a Comprehensive Assessment System

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Reidy Interactive Lecture Series
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Students within a comprehensive assessment system can take hundreds of items across multiple assessments.
However, assessment results are often summarized poorly.
The Goal: find a way to combine information across multiple assessments
The Goal: find a way to combine information across multiple assessments for all assessment given in an academic year.
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using a

Statistical Model
However, the results of such a model can’t be understood in isolation.
Interpretive Framework

Instruction

Assessments

Use

Statistical Model
Presentation Structure

1. Instruction
2. Assessments
3. Use
4. Statistical Model
We examine these elements generally, & in terms of a specific hypothetical example.
We examine these elements generally, & in terms of a specific hypothetical example.
Context

Large District In a Southern State

4th Grade Mathematics

Quarterly Interim Assessments & End of Year Summative Assessment
1 Instruction
Instruction
Scope & sequence of instruction, as captured by the ordering the Common Core State Standards.
Instruction

Scope & sequence of instruction, as captured by the ordering the Common Core State Standards.

We show this as a Curriculum Map.
# Curriculum Map

## Operations & Algebraic Thinking

### Division & Multiplication LT
- Section 1: Factors and Multiples
- 4.OA.1
- 4.OA.2

## Number & Operations in Base Ten

### Addition & Subtraction LT
- Section 3: Addition and Subtraction Within 1000
- 4.NBT.4

### Place Value & Decimals LT
- Section 4: Multi-digit Whole Numbers
- 4.NBT.1
- 4.NBT.2
- 4.NBT.3

### Division & Multiplication LT
- Section 5: Multiplication and Division Problems Involving Multi-digt Whole Numbers
- 4.NBT.4
- 4.OA.3

## Number & Operations-Fractions

### Fractions LT
- Section 2: Equivalence and Comparison of Fractions
- 4.NF.1
- 4.NF.2

### Fractions LT
- Section 3: Operations with Fractions
- 4.NF.3b, 4.NF.3c
- 4.NF.4a, 4.NF.4b, 4.NF.4c

### Division & Multiplication LT
- Section 5: Multiplication and Division Problems Involving Non-Whole Rational Number Operators
- 4.NF.4a, 4.NF.4b, 4.NF.4c

## Measurement & Data

### Shapes & Angles LT
- Section 3: Angles
- 4.G.1
- 4.MD.5a, 4.MD.5b, 4.MD.6, 4.MD.7

## Geometry

### Shapes & Angles LT
- Section 1: Shapes and Properties
- 4.G.2
- 4.G.3

### Shapes & Angles LT
- Section 4: Symmetry
- 4.MD.3

### Length, Area & Volume LT
- Section 3: Area and Perimeter
- 4.MD.1, 4.MD.2

### Elementary Data & Modeling LT
- Section 2: Data Representations
- 4.MD.4

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16%  
1  
3  
25%  
1  
2  
5  
6  
29%  
3  
4  
3  
2  
16%  
6  
1  
3  
2  
14%  
2  
2  
2  
5%
Let’s examine the key parts of this map by looking at Quarter 1.
School Quarters & Assessment Schedule

Operations & Algebraic Thinking

Division & Multiplication LT
Section 3: Factors and Multiples

Number & Operations in Base Ten

Addition & Subtraction LT
Section 3: Addition and Subtraction Within 1000

Place Value & Decimals LT
Section 3: Multi-digit Whole Numbers

Division & Multiplication LT
Section 4: Multiplication and Division Problems Involving Multi-digit Whole Numbers

4.OA.4

4.NBT.4

4.NBT.1
4.NBT.2
4.NBT.3
4.NBT.5
Quarter & Assessment Administration

School Quarters & Assessment Schedule

Operations & Algebraic Thinking

Division & Multiplication LT
Section 3: Factors and Multiples

4.OA.4

Number & Operations in Base Ten

Addition & Subtraction LT
Section 3: Addition and Subtraction Within 1000

Place Value & Decimals LT
Section 3: Multi-digit Whole Numbers

4.NBT.1 4.NBT.2 4.NBT.3

Division & Multiplication LT
Section 4: Multiplication and Division Problems Involving Multi-digit Whole Numbers

4.NBT.5
Each box is a 4th Grade CCSS.

Number & Operations in Base Ten

Addition & Subtraction LT
Section 3: Addition and Subtraction Within 1000

Place Value & Decimals LT
Section 3: Multi-digit Whole Numbers

Division & Multiplication LT
Section 4: Multiplication and Division Problems Involving Multi-digit Whole Numbers
E.g., is Numbers & Operations in Base Ten, Standard 1.

Number & Operations in Base Ten

Addition & Subtraction LT
Section 3: Addition and Subtraction Within 1000

Place Value & Decimals LT
Section 3: Multi-digit Whole Numbers

Division & Multiplication LT
Section 4: Multiplication and Division Problems Involving Multi-digit Whole Numbers
Each row is a section of a Learning Trajectory (LT). These LT sections are Drawn from Confrey et al.’s mapping of the CCSS.
School Quarters & Assessment Schedule

**Operations & Algebraic Thinking**

Division & Multiplication LT
Section 3: Factors and Multiples

- 4.OA.4

**Number & Operations in Base Ten**

Addition & Subtraction LT
Section 3: Addition and Subtraction Within 1000

- 4.NBT.4

Place Value & Decimals LT
Section 3: Multi-digit Whole Numbers

- 4.NBT.1
- 4.NBT.2
- 4.NBT.3

Division & Multiplication LT
Section 4: Multiplication and Division Problems Involving Multi-digit Whole Numbers

- 4.NBT.5

Summative Assessment

Q1

Interim #1

- 16%
  - 1
  - 3
  - 1

Summative

- 25%
  - 2
  - 5
  - 6

2% 7% 2% 11% 14%
The first row shows the number of items per LT section.
The second row shows the percent of items per LT section.

<table>
<thead>
<tr>
<th>Number &amp; Operations in Base Ten</th>
<th>Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Addition &amp; Subtraction LT</strong></td>
<td>25%</td>
</tr>
<tr>
<td>Section 3: Addition and</td>
<td>5%</td>
</tr>
<tr>
<td>Subtraction Within 1000</td>
<td>11%</td>
</tr>
<tr>
<td><strong>Place Value &amp; Decimals LT</strong></td>
<td>14%</td>
</tr>
<tr>
<td>Section 3: Multi-digit Whole</td>
<td></td>
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<tr>
<td>Numbers</td>
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<tr>
<td>**Division &amp; Multiplication LT</td>
<td></td>
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<tr>
<td>Section 4: Multiplication and</td>
<td></td>
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<tr>
<td>Division Problems</td>
<td></td>
</tr>
<tr>
<td>Involving Multi-digit Whole</td>
<td></td>
</tr>
<tr>
<td>Numbers</td>
<td></td>
</tr>
</tbody>
</table>
2 Assessment
Assessment
The LT Sections on each assessment, the number of items per LT, the scores reported, & when the assessments are given.
Assessment
The LT Sections on each assessment, the number of items per LT, the scores reported, & when the assessments are given.
Assessment

The LT Sections on each assessment, the number of items per LT

Issues of design that cut across “types” of assessments.
The LT Sections on each assessment can be selected based on

- The summative assessment.
- Instruction.
- A Post/Pre Design.
The LT Sections on each assessment can be selected based on the summative assessment.

Instruction, for this example.

A Post/Pre Design.
The number of items per LT section can be:

- Equal.
- Unequal.
The number of items per LT section can be:

- Equal.
- Unequal, with emphasis based on Summative Assessment.
- District Judgment.
The number of items per LT section can

Equal.

Unequal, with emphasis based on

Summative Assessment.

District Judgment.
Let's look at what these choices look like for Interim #1.
LT Sections: Instruction from Prior Quarter

Item Distribution: Unequal, based on Summative Assessment

School Quarters & Assessment Schedule

Operations & Algebraic Thinking

Division & Multiplication LT
Section 4: Multiplication and Division Problems Involving Multi-digit Whole Numbers

Place Value & Decimals LT
Section 3: Multi-digit Whole Numbers

Number & Operations in Base Ten

Addition & Subtraction LT
Section 3: Addition and Subtraction Within 1000

Interim #1

Summative

4 OA.4

4.NBT.4

4.NBT.1
4.NBT.2
4.NBT.3
4.NBT.5

16%

2%

7%

2%

25%

5%

11%

14%
School Quarters & Assessment Schedule

Operations & Algebraic Thinking

Division & Multiplication LT
Section 3: Factors and Multiples
4.OA.4

Number & Operations in Base Ten

Addition & Subtraction LT
Section 3: Addition and Subtraction Within 1000
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Place Value & Decimals LT
Section 3: Multi-digit Whole Numbers
4.NBT.1 4.NBT.2 4.NBT.3

Division & Multiplication LT
Section 4: Multiplication and Division Problems Involving Multi-digit Whole Numbers
4.NBT.5

Interim #1
Summative

16%
2%
7%
2%
25%
5%
11%
14%
Use
Use

The purpose of the assessment system and the theory of action that supports it.
Purpose

Prediction of Student Performance on Summative Assessment based on Interim #1 & Interim #2
Purpose

Prediction of Student Performance on Summative Assessment based on I1 & I2
What is P?
is a prediction of performance on the summative assessment.
P is a prediction of performance on the summative assessment, based on a statistical model, e.g., linear regression, Bayesian network, or tree model.
Teachers use P to inform their instructional decisions.
Teachers use P to inform their instructional decisions.

Extra support within the classroom
Extra support outside the classroom
Extended support outside of the classroom
Intensive support outside of the classroom

see the work of Phil Daro.
Teachers use 📊 to inform their instructional decisions.

- Extra support within the classroom
- Extra support outside the classroom
- Extended support outside of the classroom
- Intensive support outside of the classroom

See the work of Phil Daro.
Theory of Action

Inputs

Prediction

Action Mechanisms

Teachers identify students predicted to perform poorly
Theory of Action

Inputs

Prediction

Action Mechanisms

Teachers identify students predicted to perform poorly

Teachers identify what LT sections these students are having trouble with
Theory of Action

Inputs

Prediction (P)
Interim #1 (I1)
Interim #2 (I2)
Add’l Information

Action Mechanisms

Teachers identify students predicted to perform poorly

Teachers identify what LT sections these students are having trouble with
Let's look at the map for quarters 1 & 2.
Teachers need to figure out what LT Sections students with low P are having trouble with.
Let’s say it’s the Shapes & Angles LT, Section 3: Angles.
Theory of Action

Inputs

- Prediction (P)
- Interim #1 (I1)
- Interim #2 (I2)
- Add’l Information

Action Mechanisms

- Teachers identify students predicted to perform poorly
- Teachers identify what LT sections these students are having trouble with
- Teachers provide extra support within the classroom to these students on the relevant LT sections
Regular Instruction for Quarter 3.
School Quarters & Assessment Schedule

Operations & Algebraic Thinking
Early Equations & Expressions LT
Section 1: Exploring arithmetic and geometric patterns/sequences

Number & Operations-Fractions
Fractions LT
Section 2: Equivalence and Comparison of Fractions

Fractions LT
Section 3: Operations with Fractions

Division & Multiplication LT
Section 5: Multiplication and Division Problems Involving Non-Whole Rational Number Operators

Measurement & Data
Length, Area & Volume LT
Section 3: Area and Perimeter

Q3

Interim #3

4.OA.5

4.NF.1
4.NF.2

4.NF.3b, a & c
4.NF.5
4.NF.3d

4.NF.4a, b, c

4.MD.3

2
5
6
5
2
Instruction for students with low P.
School Quarters & Assessment Schedule

Operations & Algebraic Thinking

Early Equations & Expressions LT
Section 1: Exploring arithmetic and geometric patterns/sequences

Number & Operations-Fractions

Fractions LT
Section 2: Equivalence and Comparison of Fractions

Fractions LT
Section 3: Operations with Fractions

Division & Multiplication LT
Section 5: Multiplication and Division Problems Involving Non-Whole Rational Number Operators

Measurement & Data

Length, Area & Volume LT
Section 3: Area and Perimeter

Shapes & Angles LT
Section 3: Angles
These students must be taught all of the third quarter LT sections plus an extra LT section.
Theory of Action

Inputs

- Prediction
- Interim #1
- Interim #2
- Add'l Information

Action Mechanisms

- Teachers identify students predicted to perform poorly
- Teachers identify what LT sections these students are having trouble with
- Teachers provide extra support within the classroom to these students on the relevant LT sections
Even if a teacher does these actions, attaining the ultimate effect relies on additional steps & related assumptions.
Theory of Action

Effects

Intermediate

These students master relevant LT sections

Ultimate

Students predicted to perform poorly do not perform poorly
Statistical Model
The model used and their benefits.
Some Possible Models

Regression

Bayesian Networks

Tree Models
Despite their differences, these models have many of the same benefits.
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Better coverage of LT Sections  
Parameterization Relationships between Assessments  
Incorporate Additional Information  
Increased Accuracy
E.g., by including scores from interims #1 & #2 the model better covers the LT Sections.
Recap

1. Instruction
2. Assessments
3. Use
4. Statistical Model
Modeling results from multiple assessments can add value, but interpretation depends on the other elements.
Modeling results from multiple assessments can add value, but interpretation depends on the other elements.

However,

the articulation of each element is valuable in its own right.
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