Evaluating the R in RTI: Slope or Student Progress Percentiles

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National Association of School Psychologists
Annual Convention
Orlando, FL
February 17, 2015

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Agenda

- Rationale for progress monitoring
- Metrics used to evaluate progress
- Issues with slope
- Student Progress Percentiles: Pathways of Progress™
- Procedures
- Results
- Discussion & Questions

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Essential Elements of RTI

Although there is no specific definition of RTI, essential elements can be found when we take a look at how states, schools, and districts fit RTI into their work. In general, RTI includes:

- **screening** children within the general curriculum,
- tiered instruction of **increasing intensity**,
- evidence-based **instruction**,
- close **monitoring of student progress**, and
- informed **decision making** regarding next steps for individual students.

http://www.parentcenterhub.org/repository/rti/#elements
Accessed: 1/22/2015

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How does progress monitoring work?

To implement progress monitoring, the student's **current levels of performance** are determined and **goals are identified** for learning that will take place over time. The student's academic performance is **measured on a regular basis (weekly or monthly)**. Progress toward meeting the student's goals is measured by **comparing expected and actual rates of learning**. Based on these measurements, **teaching is adjusted** as needed. Thus, the student's progression of achievement is monitored and instructional techniques are adjusted to meet the individual students learning needs.

http://www.studentprogress.org/progresmon.asp#2
Accessed: 1/22/2015

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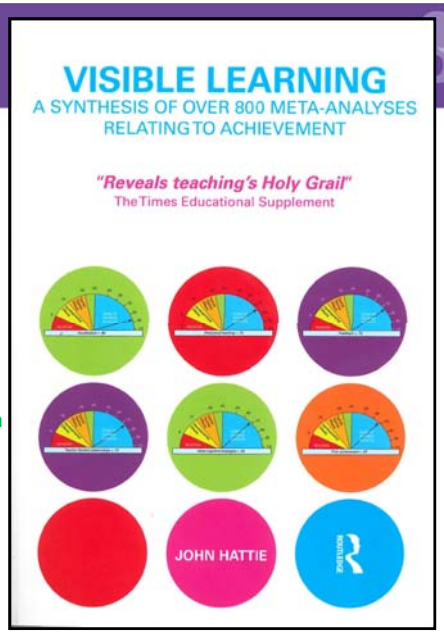
John Hattie evaluated more than 800 meta-analyses of 138 influences on student achievement:

- Student
- Teacher
- Teaching
- Curricula
- School
- Home

Influences on achievement we can do something about.



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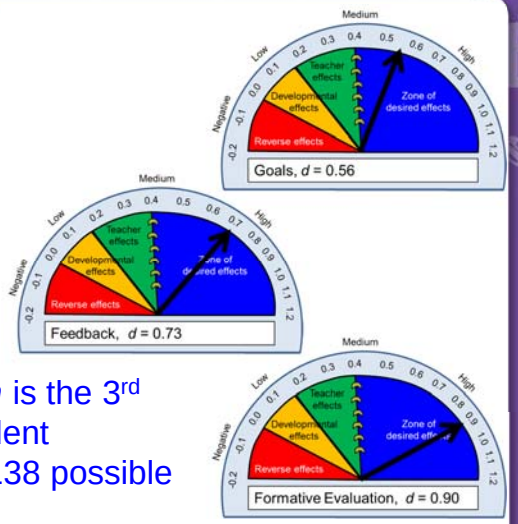
Hattie's (2009) Findings...

Desirable *Goals* are:
Meaningful,
Attainable,
Ambitious

Feedback to teachers & students: Is what we are doing working?

Formative evaluation is the 3rd largest effect on student achievement out of 138 possible influences.



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DIBELS®, Formative Assessment, Progress Monitoring, and RTI

DIBELS® and the Outcomes Driven Model were developed from the ground up to inform Response to Intervention Decisions with frequent progress monitoring toward meaningful goals.

From the very first DIBELS research proposal:

"…Research is needed on curriculum-based measurement procedures that are valid and reliable for monitoring progress, evaluating the effectiveness of instruction, and identifying kindergarten and first grade students who are at-risk for academic problems." ***(Kaminski & Good, 1988)***

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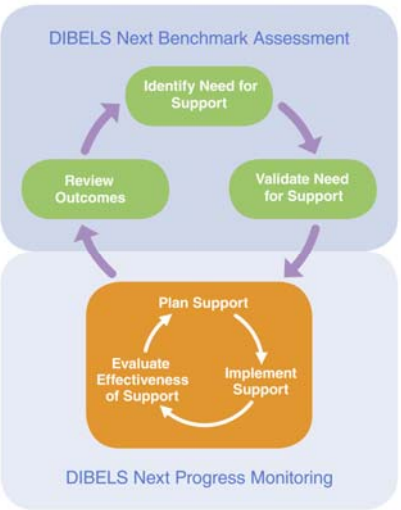
Progress Decisions in an Outcomes-Driven Model

- Outcomes Driven Model Steps:
- Identify need for support.
- Validate need for support.
- Plan and implement support.
- Evaluate and modify support.
- Review outcomes.

Progress decisions assist in *setting goals* and *evaluating progress* (our focus for today).



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Elements of Defensible Progress Monitoring...

- Accurate measurement at the individual student level
- An interpretive framework within which to determine if progress is adequate or not.
- Progress decisions that demonstrate:
  - ✓ reliability (decision stability) **Focus for today**
  - ✓ evidence of validity (including decision accuracy)
  - ✓ appropriate normative comparisons
  - ✓ decision utility (improved outcomes)

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Methods/Metrics for Evaluating Progress

1. Scatter plot (with/without aimline)
2. Scatter plot with aimline & 3 – 5 data point rule
3. Scatter plot with aimline & trendline/slope
4. *Slope* with ROI norms
5. *Level of student skills at a point in time* with Pathways of Progress

Focus for today

What have you seen commonly used in practice?

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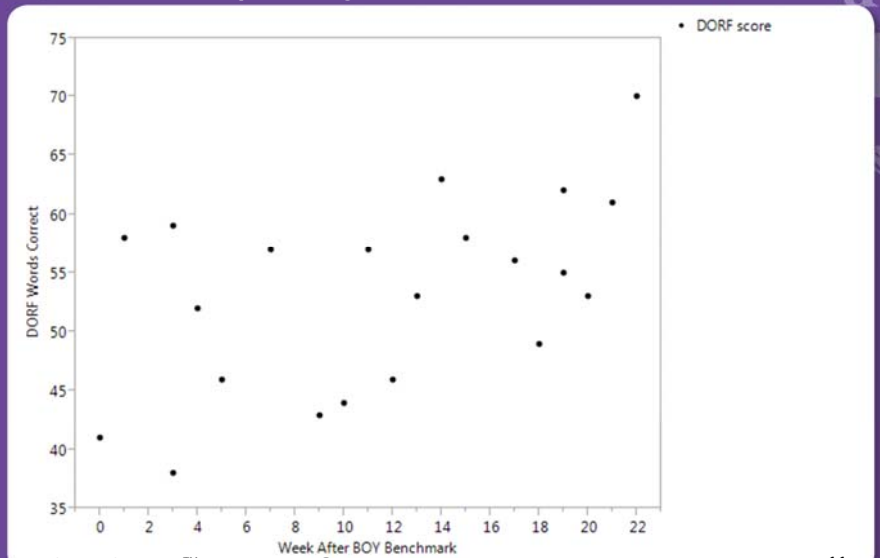
Student Progress Decisions Example: Ryan



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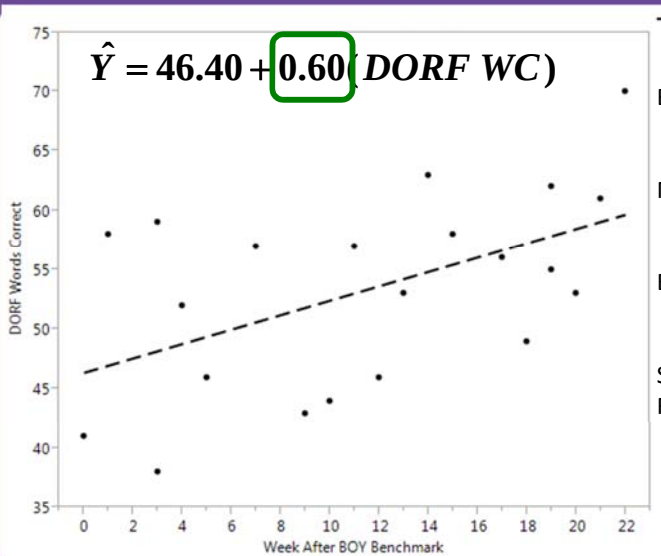
Slope Example: Ryan



BOY:
DORF WC= 41;
DCS = 85
MOY:
DORF WC = 49;
DCS = 161
EOY:
DORF WC = 62;
DCS = 246
Slope = .60
RMSE = 7.13

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Interpreting Slope: Rate of Improvement (ROI)

Rate of improvement provides one framework for interpreting slope (AIMSweb®, 2012).

- Ryan's beginning of year DORF Words Correct was low, between the 11th and 25th percentile.
- Compared to other students with similar low initial skills, Ryan's slope of 0.60 was between the 20th percentile and 40th percentile using rate of improvement norms.
- Using slope and rate of improvement, an individual student progress decision for Ryan would be:

Below typical progress

Concerns with Slope

- Reliability of slope at the individual student level has been questioned
  - Good (2009) found estimates of .64 with 16 data points over a 5 month period
  - When the sample was restricted to include only students with RMSE 10.36, reliability increased to .78
  - Thornblad & Christ (2014) found reliability ranged from .21 at two weeks to .61 at 6 weeks. Even with daily monitoring over 6 weeks, the reliability of slope was only .61.

Concerns with Slope

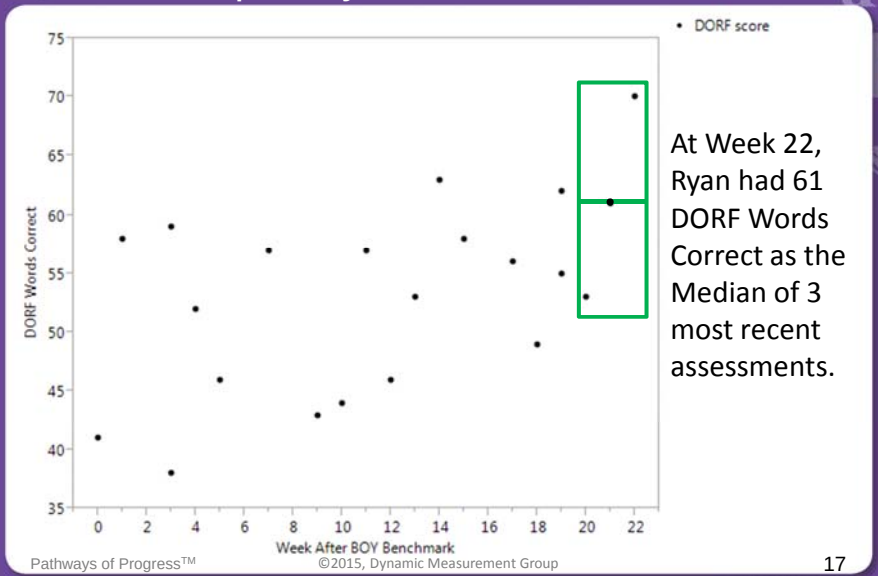
- Length of time and number of data points needed to achieve a stable slope is of concern for practical reasons.
  - Early work argued for at least 10 data points (Gall & Gall, 2007; Good & Shinn, 1990; Parker, Tindal, & Shinn, 2002).
  - Christ (2006) argued for a minimum of 2 data points per week for 10 weeks for low-stakes decisions, more for high-stakes decisions.
- If even minimally stable decisions about progress can only be made after three or more months of data collection, such decisions may be of too little practical benefit.

"The conclusion across multiple studies seems apparent: CBM-R progress monitoring is not an evidence-based practice for modeling growth of individual students' gains in reading. Substantial research is necessary to guide progress monitoring implementation, if it is to be established as an evidence-based practice."

Ardoin, Christ, Morena, Cormier, & Klingbeil (2013)

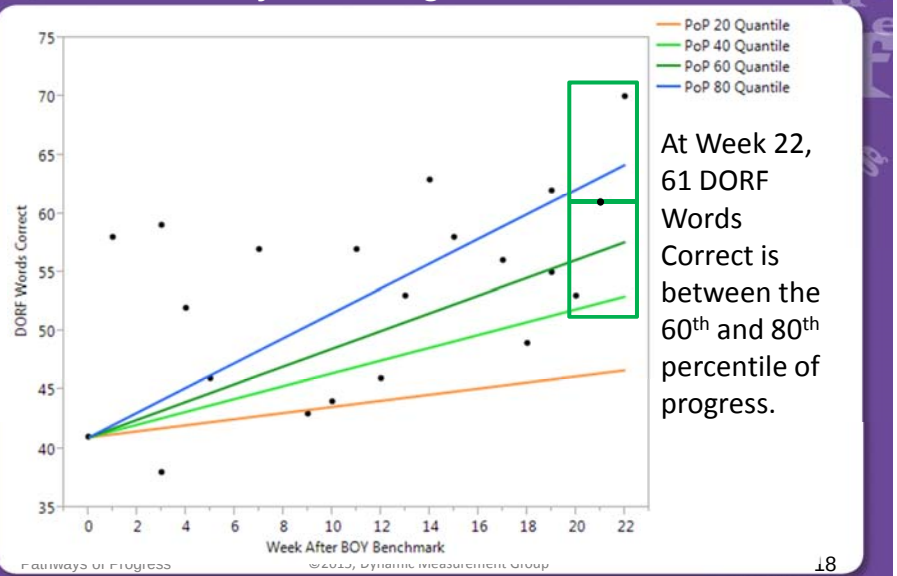
At the very least, caution is warranted when considering slope of student progress.

Level of Performance Example: Ryan



At Week 22, Ryan had 61 DORF Words Correct as the Median of 3 most recent assessments.

Interpreting Level: Pathways of Progress™



At Week 22, 61 DORF Words Correct is between the 60th and 80th percentile of progress.

Pathways of Progress™ based on Student Growth Percentile

Student growth percentiles provides a measure of "how (ab)normal a student's growth is by examining their current achievement relative to their academic peers -- those students beginning at the same place" (Betebenner, 2011, p. 3).

- Compared to other students with the same BOY DCS of 85, at 22 weeks Ryan's level was between the 60th percentile and 80th percentile of student growth.
- Using Pathways of Progress, an individual student progress decision for Ryan would be:

Above typical progress

Advantages of Pathways of Progress

1. Pathways of Progress decisions are based on the level of student performance at a point in time.
2. Level can be estimated with high reliability using
   - A single assessment.
   - The mean of the most current 3 assessments.
   - The median of the most current 3 assessments.
3. Slope of student performance is not required and not estimated.

Reliability of Slope Metric and Level of Performance Based on the Last 3 Data Points

- Initial analysis of students who had at least 14 assessments over widely varying lengths of time.

		OLS Slope of Progress			Moving Mean Pathways of Progress™		
Grade	*N*	*M*	*SD*	Reliability	*M*	*SD*	Reliability
First	356	1.09	0.58	0.818	38.60	19.50	0.959
Second	2051	1.16	0.45	0.770	63.79	21.54	0.946
Third	843	0.61	0.27	0.550	70.85	21.84	0.947
Fourth	1010	0.55	0.29	0.566	87.43	20.83	0.944
Fifth	610	0.45	0.26	0.496	96.50	23.64	0.956

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Good Progress Monitoring Decisions

Good progress monitoring decisions are ones that enable educators to improve outcomes for students.

1. Good decisions about progress provide timely information to inform instruction.
2. Good decisions about progress are reasonably stable and reliable.
3. Good decisions about progress provide instructionally relevant information for individual students.
4. Good decisions about progress provide instructionally relevant information at a systems level to inform classroom instruction.

Research Questions

1. Does the type of metric (slope or level of performance) and number of weeks of assessment (6, 10, 14, 18, or 22) affect the reliability of the individual student measure used to quantify progress for third-grade students?
2. Does the progress monitoring approach (level with Pathways of Progress or slope with ROI) and number of weeks of assessment (6, 10, 14, 18, or 22) affect the stability of individual progress decisions for third-grade students?
3. What is the minimum number of weeks needed to make an individual progress decision with adequate reliability and stability?

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Apples to Apples Comparison

This study was designed with the primary goal of conducting an apples-to-apples comparison of (a) slope of progress with ROI band, with (b) level of performance with Pathways of Progress.

1. The same participants were used for slope and level.
2. The same scores were used for slope and level.
3. The same procedure was used to estimate the reliability of the student measure.
4. The same basis was used to make a progress decision (i.e., 20th, 40th, 60th, 80th percentile of progress).

Methods: Participant Sample

Selected from 151,138 third-grade students from 4,434 schools in 1,145 school districts across the United States who met the following criteria:

- ✓ tested with DIBELS Next® during the 2012-2013 academic year
- ✓ data entered into the DIBELSnet® or mCLASS® data management systems
- ✓ complete data for the beginning-of-year and end-of-year benchmark assessments
- ✓ had at least one progress monitoring assessment using DIBELS

Subsets were selected based on the number of weeks and the number of data points of progress monitoring.

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Descriptive Statistics

Descriptive Statistics for DIBELS Next Oral Reading Fluency-Words Correct by Number of Weeks and Number of Progress Monitoring Assessments

		Number of progress monitoring assessments				BOY DORF Words Correct	
Subset of data	*N*	*M*	*SD*	Min	Max	*M*	*SD*
All students	151,138	8.72	4.75	2	59	68.93	32.86
6 weeks, 5+ points	6785	5.62	0.95	5	16	48.62	22.65
10 weeks, 9+ points	2813	9.72	1.2	9	22	46.47	20.69
14 weeks, 13+ points	1087	13.85	1.68	13	27	45.87	18.88
18 weeks, 17+ points	218	18.67	2.82	17	33	46.15	17.98
22 weeks, 21+ points	99	23.68	3.99	21	40	43.44	18.59

Note. Data were divided into subsets based on a minimum data requirement: for six weeks, students with at least five data points were included; for 10 weeks, students with at least nine data points were included; for 14 weeks, students with at least 13 data points were included, and so on.

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Procedures: Estimating Slope

- Slope of progress was estimated using ordinary least squares regression and the HLM 7 software. A random slopes and random intercepts model was used.
- DORF-Words Correct was the outcome variable, and number of weeks after the BOY benchmark was the predictor variable.
- Number of weeks after the BOY benchmark was used to provide a stable and interpretable zero point across multiple disparate school calendars.

```
Level-1 Model
      SCORE = P0 + P1*(WEEK) + e

Level-2 Model
      P0 = B00 + r0
      P1 = B10 + r1
```


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Procedures: Rate of Improvement Bands

- Rate of Improvement (ROI) bands were based on a prior analysis of 43,094 third-grade students whose DIBELS Next scores were entered in DIBELSnet during the 2012-2013 academic year.
- ROI bands were developed using procedures adapted from AIMSweb®, 2012. Students were grouped by their BOY DORF-Words Correct into one of five categories from "very low" (1-10th percentile), to "very high" (91-99th percentile). The ROI per week was calculated for each student by dividing the difference in the student's beginning- and end-of-year DORF-Words Correct by 36 weeks.
- For each category of initial skill the 20th, 40th, 60th, and 80th percentile of rate of improvement was estimated.

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ROI Bands

Rate of Improvement (ROI) in DIBELS Oral Reading Fluency-Words Correct (DORF-WC) by Initial Skill

BOY DORF-WC initial skills	Percentile range	BOY DORF-WC range	*N*	ROI quantile			
				20th ptile	40th ptile	60th ptile	80th ptile
Very low	1-10	9-39	3,955	0.389	0.611	0.833	1.083
Low	11-25	40-58	6,061	0.528	0.722	0.944	1.194
Average	26-75	59-105	21,202	0.444	0.694	0.917	1.194
High	76-90	106-132	6,991	0.361	0.639	0.861	1.139
Very high	91-99	133-186	4,500	0.111	0.417	0.667	0.944

Note. ROI is the weekly DORF-WC growth from BOY to EOY (36 weeks).

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Procedures: Estimating Level of Performance

Level of current student performance can be estimated with mean of the last 3 data points or the median of the last 3 data points.

- In this data set, the mean and the median of the final three DORF-WC scores for each student were highly correlated, r = .999, so it seems reasonable to use them interchangeably.
- The median was used to evaluate the stability of progress decisions to match recommendations for practice.
- To enable a direct comparison to slope, level was estimated using the mean computed using HLM 7.01 to fit an intercept only (0 slope) model to the final 3 data points only.

```
Level-1 Model
       SCORE = P0 + e

Level-2 Model
       P0 = B00 + r0
```


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Procedures: Pathways of Progress

Pathways of Progress were based on a prior analysis of 43,094 third-grade students whose DIBELS Next scores were entered in DIBELSnet during the 2012-2013 academic year.

1. Students were grouped by BOY DCS for scores between one and the 99.5th percentile rank. For each unique BOY DCS, the 20th, 40th, 60th, and 80th quantiles were calculated for DORF WC.
2. A stiff, spline quantile regression model was fit to each quantile using BOY DCS as the predictor.
3. The predicted quantile scores from the regression model corresponding to each unique BOY DCS were rounded to the nearest one, forming the end-of-year pathway borders.
4. Pathway borders were linearly interpolated for each week after BOY benchmark using the BOY DORF WC at week zero and the EOY Pathways of Progress border at week 35 (the median end-of-year week).

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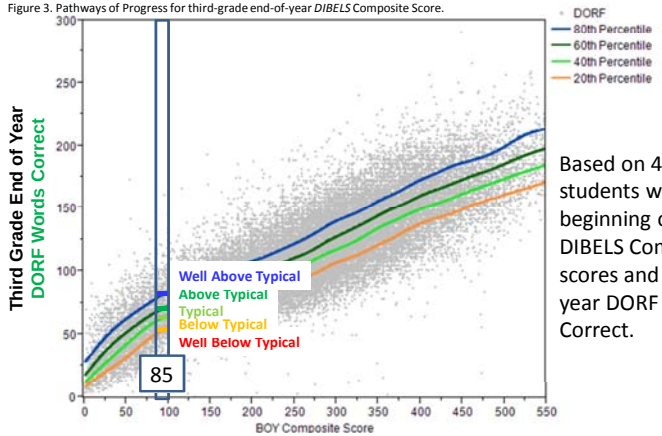
Pathways of Progress: Spline Quantile Regressions

Figure 3. Pathways of Progress for third-grade end-of-year *DIBELS* Composite Score.



Based on 43,094 students with beginning of year DIBELS Composite scores and end of year DORF Words Correct.

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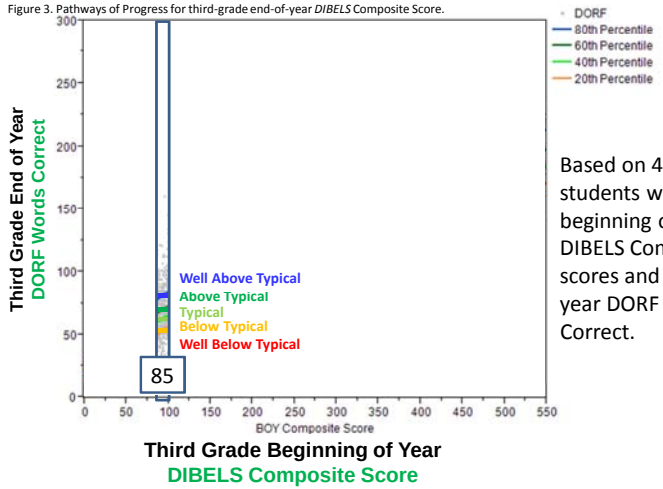
Pathways of Progress: BOY DCS Comparison

Figure 3. Pathways of Progress for third-grade end-of-year *DIBELS* Composite Score.



Based on 43,094 students with beginning of year DIBELS Composite scores and end of year DORF Words Correct.

Pathways Lookup Table Excerpt

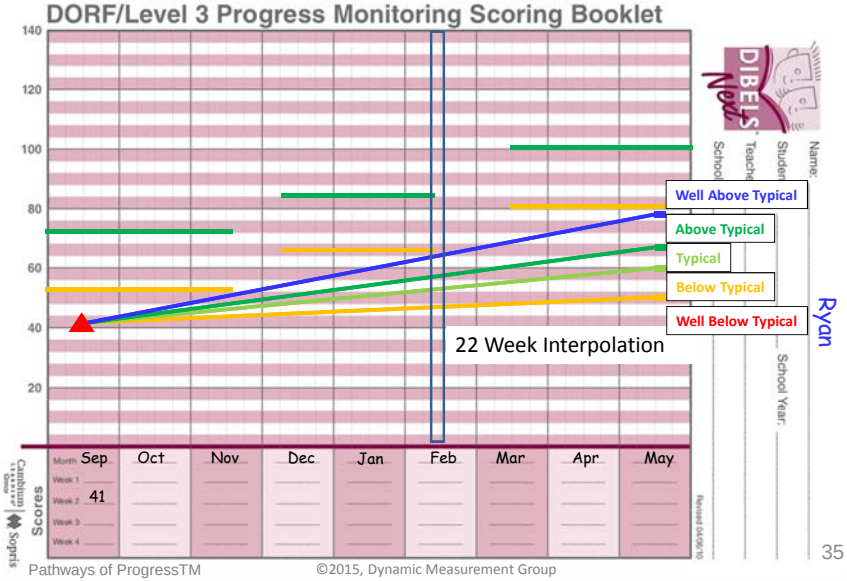
Excerpt from the Pathways of Progress Look-Up Table for DORF-Words Correct by Beginning-of-Year DIBELS Composite Score

Beginning-of-year DIBELS Composite score	Pathways of Progress quantiles for end-of-year DORF-Words Correct			
	20th ptile	40th ptile	60th ptile	80th ptile
83	49	59	67	77
84	50	60	67	78
85	50	60	67	78
86	51	60	68	78
87	51	61	68	79

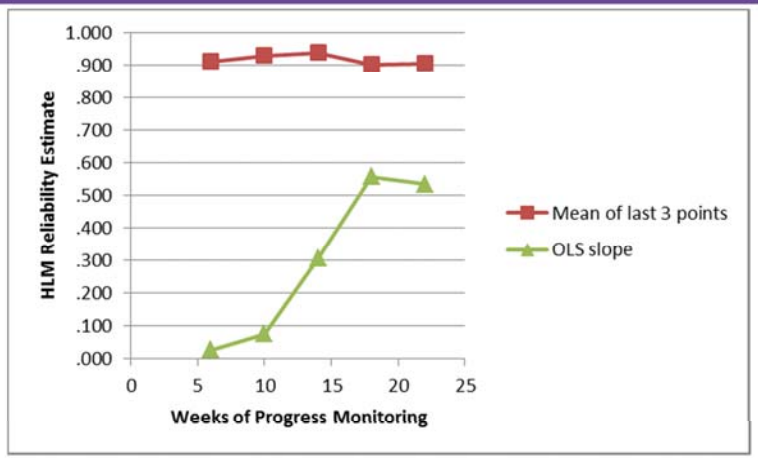
Progress Monitoring

DORF LEVEL 3

DORF/Level 3 Progress Monitoring Scoring Booklet

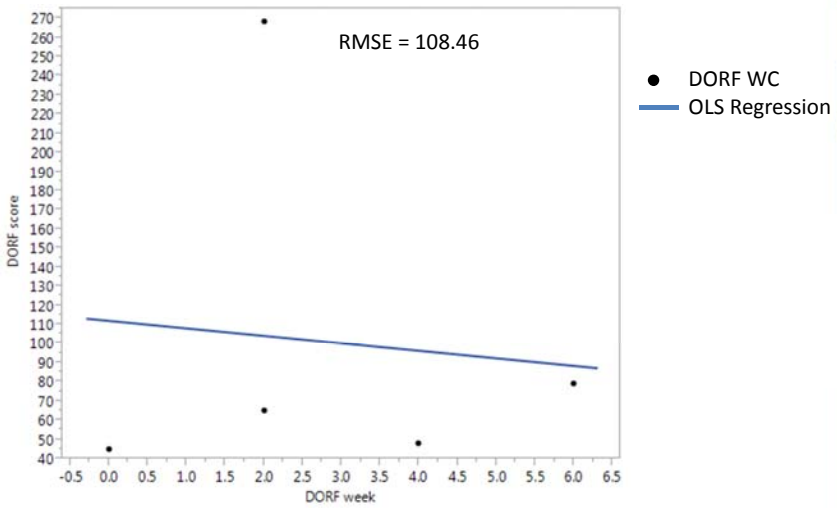


Results: Reliability of Individual Student Decision Metric

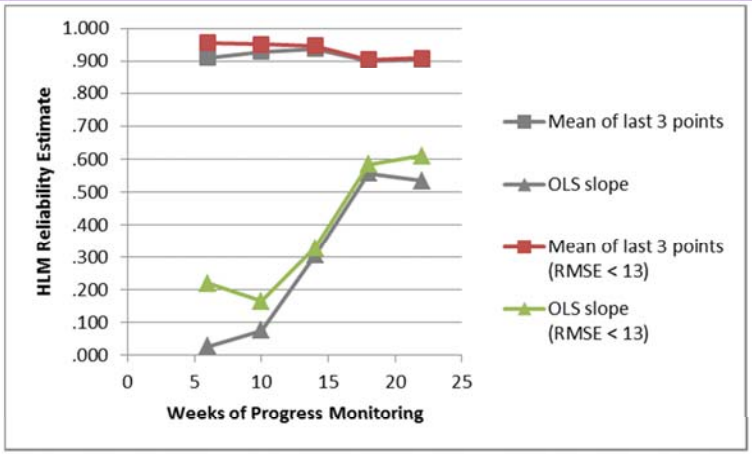


HLM estimates of the reliability of the individual student measure used to evaluate student progress at 6, 10, 14, 18, and 22 weeks.

High variability can play havoc with OLS slope estimates

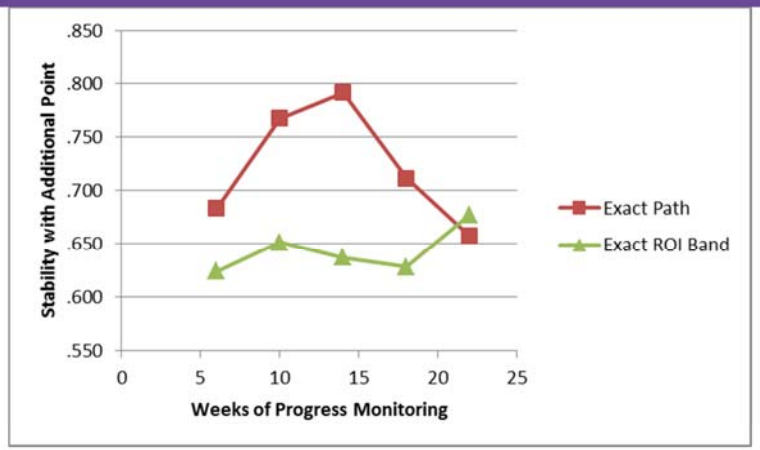


Results: Reliability of Individual Student Decision Metric for RMSE < 13



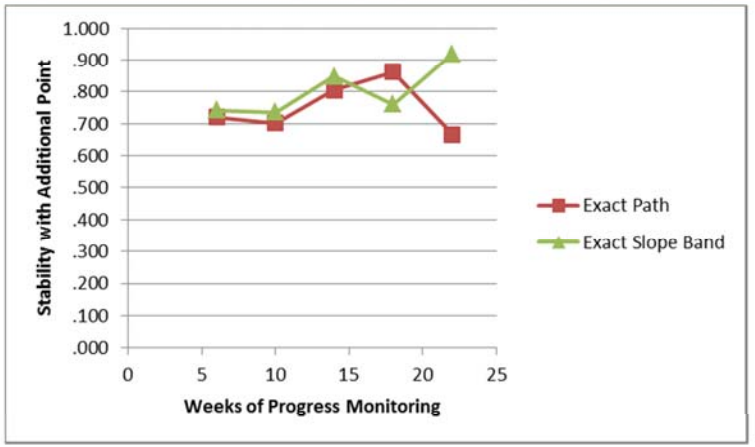
Filtering for RMSE < 13 increases the reliability of slope estimates modestly, and has little change in level based on the mean of the last 3 data points.

Results: Stability of Progress Decisions for All Students



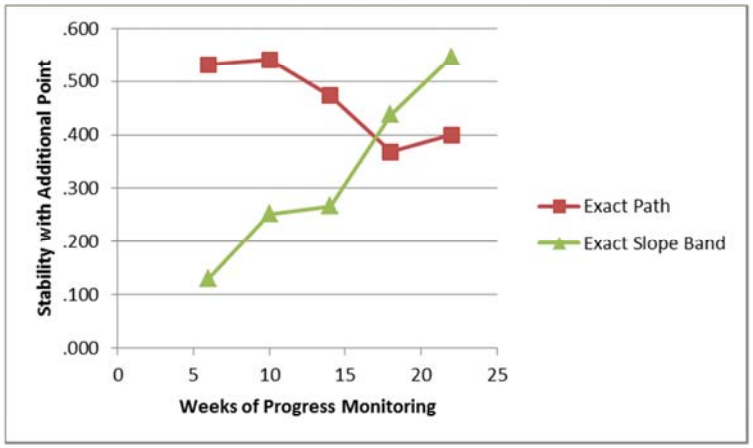
Overall stability of progress decisions as proportion of exact matches between the *j*th week decision and the corresponding decision based on the *j*th week plus one additional data point, where *j* = 6, 10, 14,18, & 22.

Stability of Progress Decisions: Well Below Typical Progress Only



Decisions about well below typical progress are much more stable for both slope with ROI band and level with Pathways of Progress.

Stability of Progress Decisions: Below Typical Progress Only



Decisions about below typical progress are more stable for Pathways of Progress with less than 18 weeks and are more stable for slope with ROI band with 18 and 22 weeks of progress monitoring.

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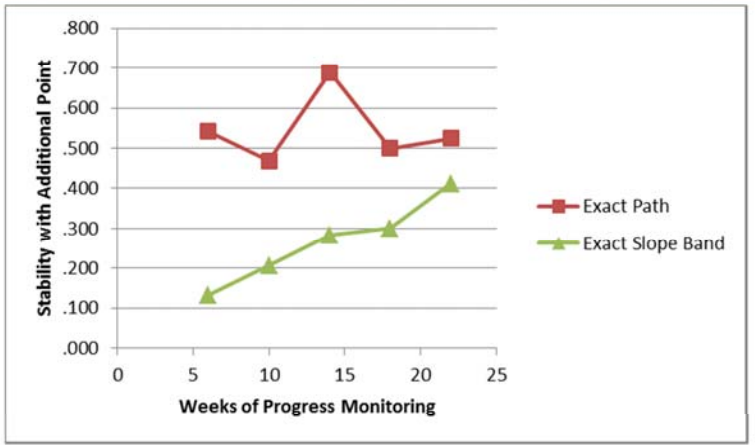
Stability of Progress Decisions: Typical Progress Only



Stability of typical progress decisions is higher for Pathways of Progress for all lengths of progress monitoring.

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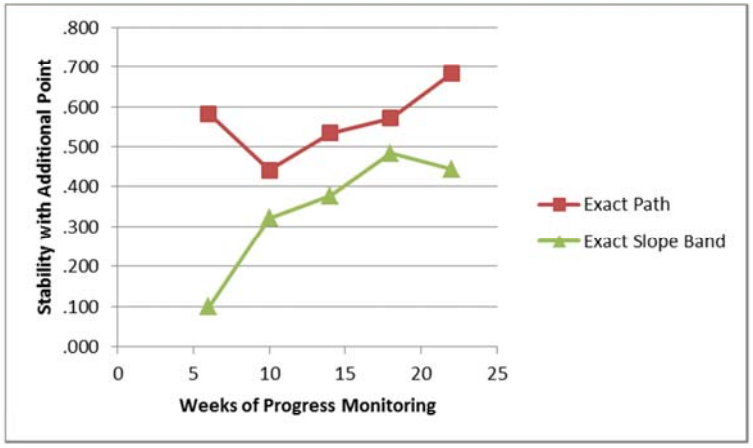
Stability of Progress Decisions: Above Typical Progress Only



Stability of above typical progress decisions is higher for Pathways of Progress for all lengths of progress monitoring.

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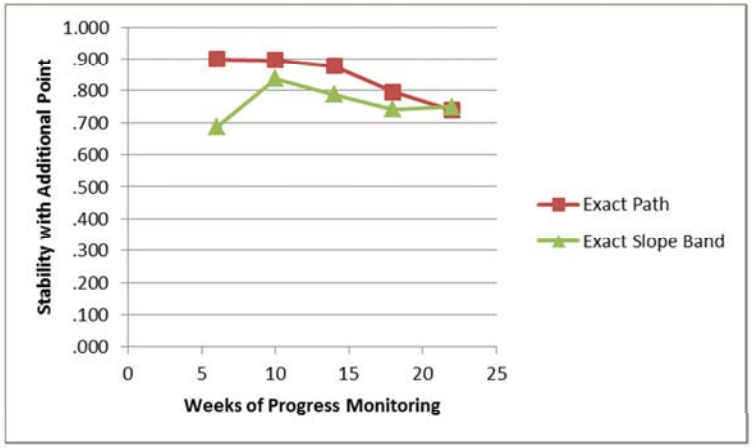
Stability of Progress Decisions: Well Above Typical Progress Only



Stability of well above typical progress decisions is higher for Pathways of Progress for all lengths of progress monitoring except 22 weeks.

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Conclusions

1. The reliability of the individual student measure upon which progress decisions are based is much higher for Pathways of Progress than for OLS slope.
2. Progress decisions based on Pathways of Progress are consistently more stable and require fewer weeks of progress monitoring than corresponding decisions based on OLS slope and ROI band.
3. Decisions about extreme performance (well below typical or well above typical) are generally more stable than when progress is typical.

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Limitations

- We do not have information on assessment fidelity & we do not know the level of assessor training. However, these data do represent the way *DIBELS Next* is used in practice.
- We do not know the level of instructional support provided to the students, or if there were changes in the level of support.
- The week after the BOY benchmark represents a straight calendar week. We were not able to model instructional weeks accounting for school holidays or breaks.

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Implications

- When making individual educational decisions, the fidelity of assessment procedures should be evaluated before interpreting progress.
- Also, consider the conditions at the time of assessment, including student attendance, level of support, and any other factors that would affect student performance.
- Examine the amount of variability in student performance and investigate potential sources for such variability.
- Evaluate the reliability and stability of progress in the context of the educational decision we are making.

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Evaluating the R in RTI: Slope or Student Progress Percentiles

Re-view from 30,000 feet

Looking back at the data source

The data used in this study are not just a sample but a large **population** of students, educators, LEAs, SEAs.

Results are based on a collaboration across DIBELS Next data management systems (DIBELSnet® and mCLASS®)

Data include **151,138 students** from **4,434 schools** in **1,145 districts**.

Lends power to the results as the data represent actual classroom use in wide variety of educational contexts (i.e., geographic, economic, political, technological).

Looking back at the design

This study reflects actual classroom use of DIBELS Next and did not benefit from experimental control.

Under an experimental study, stronger interventions would likely result in larger performance improvements.

Under and experimental study, stronger fidelity control would have likely increased stability of the progress monitoring data points.

Looking back at the research questions

Does the type of metric and number of weeks of assessment affect the reliability of the individual student measure used to quantify progress for third-grade students?

•Yes they do.

•The use of traditional slope and ROI information demonstrates suppressed reliability compared to the windowed-mean and Pathways approach.

•Suggesting that decisions about student progress based on traditional statistics are likely to be based on inappropriate information.

Looking back at the “Research Questions”

Does the progress monitoring approach and number of weeks of assessment affect the stability of individual progress decisions for third-grade students?

•Yes it does.

•The traditional slope and ROI approaches demonstrate a sensitivity to the number of weeks of assessment, or available data points, typically increasing across weeks. The alternate approaches, however, demonstrate greater stability regardless of the number of weeks or data points available.

Looking back at the "Research Questions"

What is the minimum number of weeks needed to make an individual progress decision with adequate reliability and stability?

•Traditional slope and ROI approaches are shown to maximize reliability and stability around 20 weeks – or 5 months!

•The windowed-mean and Pathways of Progress approaches, however, demonstrate fairly consistent stability across 6 weeks to 22 weeks of progress monitoring.

Looking back at "Good Progress Monitoring Decisions"

This study demonstrates that by focusing on the most immediate and actionable progress monitoring information (i.e., last 3 data points), stable information about student performance is obtained.

Good decisions about progress require:

•Timely information in order to meaningfully inform instruction; and

•Stable information about student performance.

However, reliability is a foundational or low-level issue. These findings must be used to further the discussion and increase the focus on decision accuracy.

Looking forward to "Good Progress Monitoring Decisions"

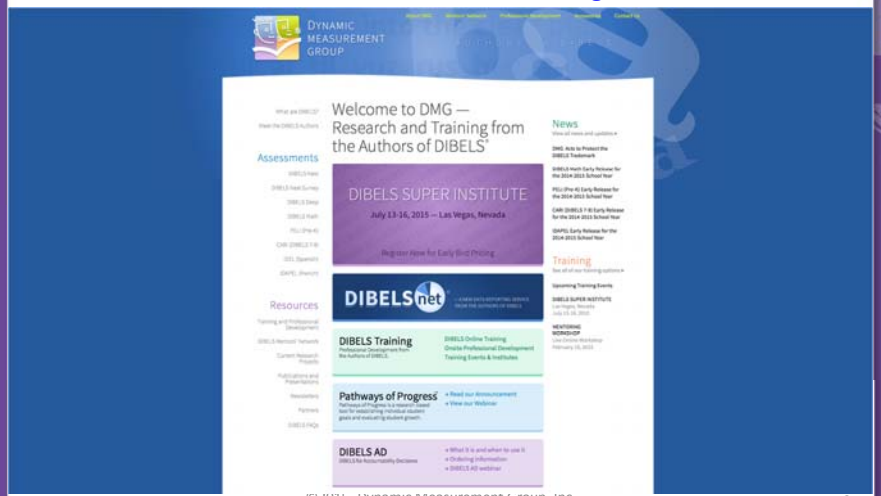
With more stable information about student performance, it must now be demonstrated that use of such information for decisions about progress is:

•Relevant for **students** – does the use of this information lead to improved student outcomes?

•Relevant for **teachers** – does the availability of stable progress information lead to instructional changes?

Where Can I Get More Information?

DMG website: www.dibels.org



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