Data Analysis Tips: Low-Tech Environments

Field Guides to RtI Prepared by

Wayne County RtI/LD Committee

2007

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Low Tech Response to Intervention

Progress monitoring requires new skills for data management and data analysis. The preferred method of managing the progress monitoring data is to use a data management service or program created for this purpose. The data management technology is an important tool for teachers that will make the record keeping and analysis timely and efficient.

Our reality is that individuals may be asked to make pilot or trial attempts of RtI in the absence of a technology system. Data analysis is still possible using graphing paper, calculators, and EXCEL. These methods are not practical for classroom teachers.
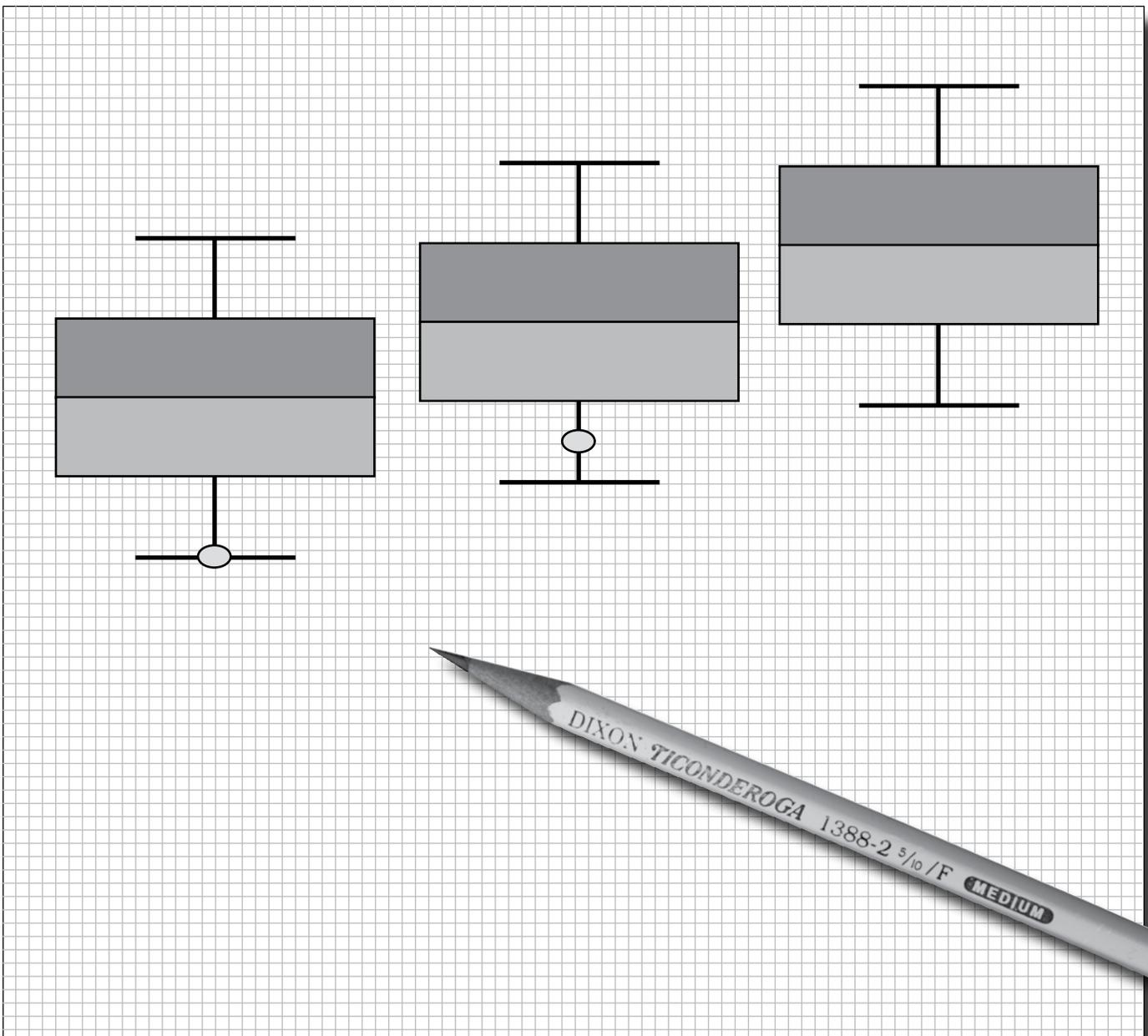
Implementing Decision Rules with Percentile Data

Percentile data provides a way to compare student test scores and to consider the child's performance relative to what is typical or normal for the class. Standardized tests commonly report the percentiles that correspond to the test scores. When working with curriculum measures, it is easy to calculate your own percentiles to estimate the central tendency of your data. A percentile tells how the student ranked in comparison to others. For example, if a child scored at the 50th percentile, the teacher would say, "The student scored at the 50th percentile, meaning one-half of the students taking the test performed as well as this student."

Develop local norms for your school using the data from curriculum-based evaluations administered in the fall, winter, and spring. The local norms will consist of a chart, for each grade of the range of scores organized into percentiles.

Basically the student scores will be listed from lowest to highest score. Each score will be given a rank, which is a number for the order of the scores from lowest to highest. (The number of scores (N) in this example is 10)

Rank	Score	Percentile
10	15	
9	12	
8	10	75=10.5
7	10	
6	9	50=8.6
5	8	
4	7	25=4.25
3	5	
2	2	
1	2	

The first step is to compute the Rank (R) of the 25th percentile. This is done using the following formula:

$$R = P/100 \text{ x } (N + 1)$$

where P is the desired percentile (25 in this case) and N is the number of scores (8 in this case). Therefore,

$$R = 25/100 \text{ x } (10 + 1) = 11/4 = 2.75$$

$$R = 2.75$$

Implementing Decision Rules with Percentile Data—continued

Next Steps to Calculate Percentile

1. Define IR as the integer portion of R (the number to the left of the decimal point). For this example, IR = 2.

2. Define FR as the fractional portion or R. For this example, FR = 0.75.

3. Find the scores with Rank IR and with Rank IR + 1. For this example, this means the score with Rank 2 and the score with Rank 3. The scores are 2 and 5.

4. Interpolate by multiplying the difference between the scores by FR and add the result to the lower score.

For these data, this is

$$((0.75)(5 - 2)) + 2 = 4.25$$

Therefore, the 25th percentile is 4.25.

Example for 50th Percentile

$$R = 50/100 \times (10 + 1) = 11/2 = 5.5$$
$$((0.50)(9-8))+8 = 8.5$$

Example for 10th Percentile

$$R = 10/100 \times (10 + 1) = 11/10 = 1.1$$
$$((.1)(2-2) + 2 = 2$$

Example for 75th Percentile

$$R = 75/100 \times (10 + 1) = 8.25$$
$$((.25)(12-10)) + 10 = 10.5$$

Source: http://onlinestatbook.com/chapter1/percentiles.html

Note: A free Curriculum Based Evaluation Percentile Calculator is available for download at: http://www.dataimpactsoftware.com/demos/html.

Aimlines

The child's performance on the curriculum based probes is charted against the Aimline as a tool for analyzing progress. Below is an example of a progress monitoring chart.

The student's performance is analyzed by the following 3 dimensions:

1. Level of Performance

2. Slope of Performance (Trajectory)

3. Variability of Performance

The team then determines the next steps in intervention planning based on data-based decision rules. Common recommended decision rules are:

1. If student performance is well below the aimline for 3 data points, a different strategy or intervention is needed.

2. If student performance is well below the aimline for 3 data points, but the slope or trajectory is in parallel with the aimline, the team may decide to monitor the student closely and continue with the existing instruction plan.

3. If the data points are above the line and parallel to the slope of the aimline, continue with the existing plan.

This example of progress monitoring is a research-based practice that is used to measure academic performance and evaluate the effectiveness of instruction. Progress monitoring can be implemented with individual students or an entire class.

Student's Name _____ Teacher's Name _____ Baseline _____

Grade _____ Age _____ School _____ Long Range Goal / Weeks _____ / _____ STO _____

Baselines

Baselines represent the student's performance at the start of the problem solving process. Administer 3 probes to the student, score the probes, and plot the scores on the graph. Probes can be administered on three different days, e.g., Monday, Wednesday and Friday. Draw a vertical line on the graph following the last baseline data point.

An example of a graph for charting student performance with the probes is above.

Baselines—continued

I   Find the Starting Baseline Point.

A   Select the median baseline point. If all the scores are listed from highest to lowest, the median is the score in the middle. The median divides the distribution of scores in half. Half of the distribution is above the median, and half is below.

For example the baseline scores for a student may be 28, 45 and 35. The median is 35, half the distribution is above, (45), and half is below, (28), the median.

II   Steps for using the Peer Norm Method to determine a student's expected rate of growth:

A.   To apply this method, identify three average achieving students in the same academic domain (e.g. reading) as the target student.

B.   Test the average achieving students with the same three probes that were administered to the target student.

1.   Score the probes

2.   Find the median score for each student

3.   Find the median score of the three different student scores.

C.   Plot the median peer score on the graph above the student baseline scores. This peer median score can be used as a Long Range Goal (LRG) for the target student. With very low achieving students, the average score of peers may set a target that is too high. It may be preferable to use the second option.

D.   Plotting the Aimline with Peer Norm Data and Long Range Goals

1.   To draw in the aimline, place an X on the vertical baseline at the point of the median baseline score.

2.   Next, determine a date for the Long Range Goal (LRG). This could be the date of the annual IEP meeting or the end of the school year. Place a second X on the level of the peer performance at the date that was selected.

3.   Connect the baseline X to the goal date X with a line. This line is the aimline and represents the student's estimated or expected rate of growth per week.

III Expected Rate of Growth Adjusted for Special Education Status. For example, one large urban school district has determined that special education students grow at a rate of about 1-2 words per week in reading. This can then guide the teacher's decisions.

A.   Determine the number of weeks to the goal date. This can coincide with the annual review or the end of the year.

B.   Set the long range goal (LRG).

1.   Multiply the number of weeks by the expected rate of growth per week.

2.   Add this total to the median baseline point.

For example: To calculate the LRG, find the median of the baseline data (28, 45, and 35) based on a predicted rate of growth of 2 words per minute per week (wpm/pw) for 10 weeks. Repeat for predicted rate of growth of 1.5 wpm/pw.

Baselines—continued

Bar and Whisker Plots

| 2.0 wpm/pw	1.5 wpm/pw
Median 35	Median 35
2.0 X 10 = 20 + 35 = 55	1.5 X 10 =15 + 35 =50
LRG = 55	LRG = 50

At this point, a new teaching strategy or intervention should begin. Ideally, student progress data should continue to be collected, scored, and graphed three times per week. When 9-12 data points have been plotted, a trend (slope) can be calculated and data utilization rules (see using data tool) can be used to guide teacher's decision.

**Source:** Special Connection University of Kansas

http://www.specialconnections.ku.edu/cgi-bin/cgiwrap/spec-conn/index.php

Bar and whisker plots graph the data in a way that makes it easy for the RtI team to analyze the percentile data to identify a student's discrepancy from classmates and rate of learning in comparison to peers. The "bar" in the graph represents the average range or scores between the 25th to 75th percentiles. The "whiskers" represent the scores that are beyond the average range. The bar and whisker graphs may be plotted by hand, using web-based scoring programs like AIMSWeb, or using statistical analysis software. Place an X on the graph to portray the score of the student on concern. By comparing bar and whisker graphs over time, the student's distance from classmates and rate of learning is readily apparent. An example follows:
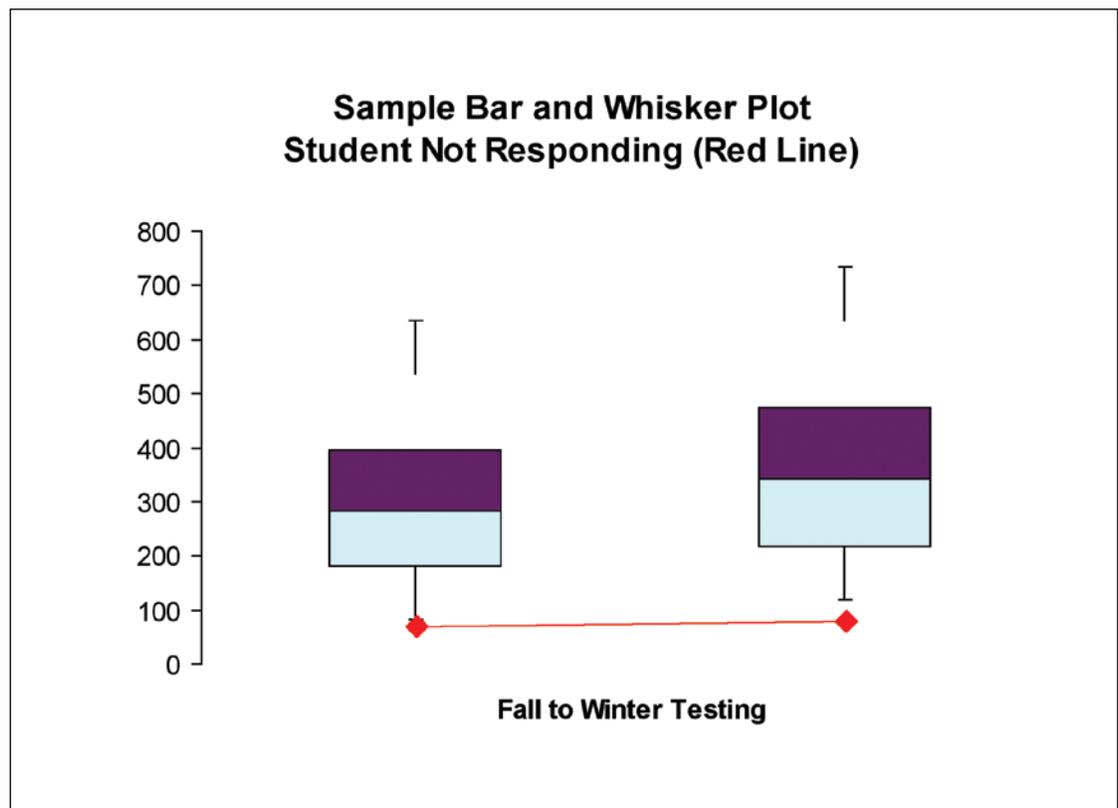
How to Make Box and Whisker Plots with Excel
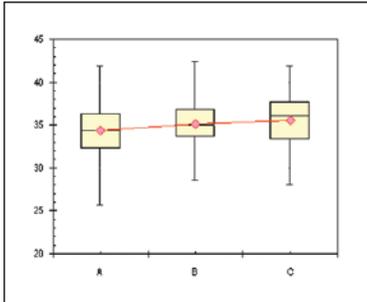
Microsoft Excel does not have a built in Box and Whisker chart type. You can create your own custom Box and Whisker charts, using stacked bar or column charts and error bars, in combination with line or XY scatter chart series to show additional data.

In this example, the boxes show medians and upper and lower quartiles of the data, while the whiskers indicate the minimum and maximum values. There are additional steps on how to add another series (the scores from an individual student).

Start with your data. Below is a table that includes the percentile, lowest score, highest score, mean, and median.

A	B	C	D	E
	A	B	C	
Mean	34.34	35.11	35.55	
Median	34.37	35.00	36.10	
Q1	32.33	33.78	33.37	
Q3	36.33	36.85	37.67	
Minimum Score	25.70	28.53	28.00	
Maximum Score	41.90	42.40	41.87	
25th Pct	32.33	33.78	33.37	Box 1
50th Pct	2.04	1.22	2.73	Box 2
75th Pct	1.96	1.85	1.57	Box 3
Min	6.63	5.25	5.37	Box 1 Minus
Max	5.57	5.55	4.20	Box 3 Plus

Average of the data to be plotted, AVERAGE({data})
Standard deviation, STDEV({data})
Median of the data, MEDIAN({data})
First quartile, PERCENTILE({data},0.25)
Third quartile, PERCENTILE({data},0.75)
Minimum value, MIN({data})
Maximum value, MAX({data})
Plotting value of first quartile = Q1
Plotting value of median = Median - Q1
Plotting value of third quartile = Q3 - Median
**Lower error bar length = Q1 - Minimum**
**Upper error bar length = Maximum - Q3**
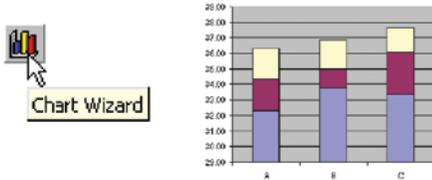
Select the Green cells (A2:D2), hold down Ctrl while selecting the Yellow cells (A10:D12). A discontiguous range is now selected. Run the Chart Wizard and create a stacked column chart
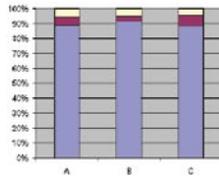
DON'T select a stacked 100% column chart, which normalizes values to a total stack height of 100%.
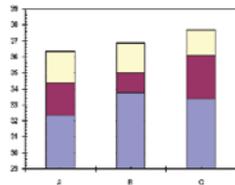
Let's do a little simple formatting. Format the plot area: White fill, Black border. Remove the gridlines. Remove excess decimal digits in the value axis number format.
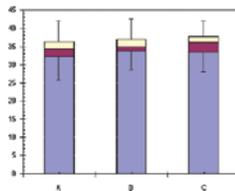
Now we'll add the error bars for min and max values. Select the "75th Pct" Series (light yellow), and press Ctrl-1 (numeral "one") to open the Format Series dialog. Select the Y Error Bars tab. Click in the Custom + (plus) box, and with the mouse choose the Orange colored range (B14:D14). Select the "25th Pct" Series (dull blue), press Ctrl-1 (numeral "one") to open the Format Series dialog. Select the Y Error Bars tab. Click in the Custom - (minus) box, and with the mouse choose the Pink colored range (B13:D13).
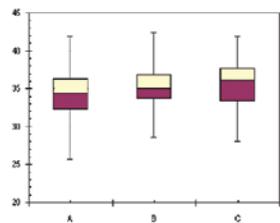
Set the minimum scale of the value axis to 20 to better fit the display. Make the "25th Pct" series invisible: format it (Ctrl-1) to have No Border, No Area Fill.
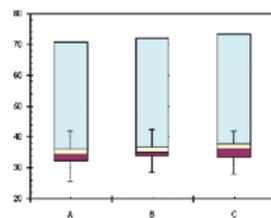
Select the Green and Blue ranges (A2:D3), Copy. Select the chart (not a series), Paste Special with the following options: Add Series, By Row, Series Names in First Column, Categories in First Row.
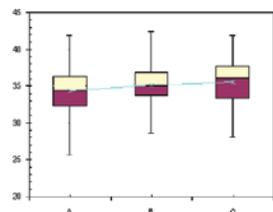
Right click the new series, select Chart Type… and Choose the Line Chart style, Line with Markers substyle.

Format the remaining series according to your favorite formats.

Adapted from: Peltier Technical Services. http://peltiertech.com/Excel/Charts/BoxWhiskerH.html

Reliability of CBM Measures and SEM

Student performance in any assessment may vary for a variety of reasons, ranging from aspects of the test difficulty, test administration, or student affect. Typically, CBM methods control for variability in performance by taking a minimum of 3 samples. In other words, the CBM probe is administered three times. The median performance from each administration is plotted to establish the typical level of performance. The data are graphically depicted to make the variability in performance readily apparent.

Measurement reliability refers to the stability of a test score or test data. Research has established that quality CBM procedures have high reliability coefficients. Estimates typically range from .90 to .97 (Howe & Shinn, 2002). The reliability of a CBM probe is increased by controlling the difficulty of the task. Higher levels of reliability can be assumed when probes are controlled for difficulty (.95 - .97) while CBM probes that are not carefully controlled for difficulty have lower reliability (.90 - .94). Less reliable CBM probes (e.g., r < = .70) may be acceptable for screening purposes but not for high stakes decisions, such as special education eligibility.

There are three ways to estimate and report the dispersion and variability of student performance with CBM measures.

1. Repeatedly assess students across days with multiple probes and report performance in a graph that support visual analysis of level and variability (e.g., bar and whisker plots, aimlines, scatter plots);

2. Repeatedly assess and report the range of performance across days and probes (e.g., "When administered three CBM probes on each of three days, the student performed an average of 20 words correct per minute with a range between 13 and 27 words correct per minute.")

3. Administer fewer assessments and report the standard error of measurement (SEM).

Test score interpretation may be enhanced with the calculation of the standard error of measure (SEM) to derive a confidence interval (Christ, Davie, & Berman, 2006). Recent research with probes of reading fluency indicates that the likely range for values of SEM is 6 - 12. Lower SEM values coincide with probe sets that are well controlled for task difficulty and administration procedures. Higher SEM values coincide with less controlled probe sets whose probes are more likely to vary with difficulty.

Two statistics are required to calculate the SEM from local normative data:

1. Standard Deviation (SDx) for performance across the students in the sample.

2. An estimate for the reliability of measurement (rxx).

   a. The reliability for a CBM may be available from the research or publisher (e.g., AIMSweb).

$$SEM = SD \times \sqrt{1 - rxx}$$

Reliability of CBM Measures and SEM—continued

Christ, Davie, & Berman (2006) have outlined the steps to take to formulate SEM and confidence interval calculations:

Table 1.
Sample Descriptive Statistics (Mean, Standard Deviation, Reliability)

	Fall	Winter	Spring		Delayed Test-Retest Reliability [a]
Grade	*M (SD)*	*M (SD)*	*M (SD)*		*Range*
First		32 (27)	60 (33)		
Second	50 (32)	77 (37*)	95 (38)		.90 − .94
Third	74 (37)	95 (41*)	108 (43)		.90 − .95
Fourth	93 (39)	113 (41*)	125 (43)		.90 − .96
Fifth	112 (41)	130 (42*)	139 (45)		.93 − .96
Sixth	123 (44)	139 (45*)	151 (47)		.91 − .94

[a] Estimates of reliability based on delayed administrations (fall to winter & winter to spring). These estimates tend to be .01 to .04 less than test-retest reliability estimates so they should be adjusted before they are used to calculate SEM
*median SD for each grade

These data are used to illustrate how to calculate the SEM. Instead of manually calculating the SEM for each grade, a Microsoft® Excel spreadsheet is provided below (page 14).

Figure 1 illustrates the spreadsheet outcomes that resulted from the data presented in Table 1. The median values of Standard Deviations (SD) were used to compensate for the variability across assessment occasions (fall, winter, spring).

Here are the steps which may be used to create a spreadsheet of your own with local normative data:

1. Enter column labels (Grade, SD, Reliability, & SEM) in columns A, B, C, D.

2. Enter row labels (Grades 1, 2, 3, 4, 5, 6) in column A.

3. Enter standard deviations observed for each grade in column B.

4. Enter reliabilities for each grade in column C.

5. Enter formulas to calculate SEM in column D (refer to explanation in Figure 1).

6. Changing values in the SD and Reliability columns will automatically update the corresponding SEMs based on the formulas entered in step 5.

The resulting estimates of SEM can be used to guide interpretation and construct confidence intervals.

Reliability of CBM Measures and SEM—continued

Figure 1.
Excel spreadsheet to calculate *SEM* from estimates of the standard deviation *(SD)* and reliability (r_{xx}).

Grade	SD	Reliability	SEM	
1				
2	37	0.96	7	⟵ =B4*SQRT(1-C4)
3	41	0.96	8	⟵ =B5*SQRT(1-C5)
4	41	0.96	8	⟵ =B6*SQRT(1-C6)
5	42	0.96	8	⟵ =B7*SQRT(1-C7)
6	45	0.96	9	⟵ =B8*SQRT(1-C8)

Explanation for Formula for cell D4

D4	=B4*SQRT(1-C4)	intact formula
	"="	initiates formula function
	"B4"	captures cell B4, which is the SD of the sample
	"*"	multiplication function
	"SQRT(…)"	squareroot function (for items within the parentheses)
	"1-C4"	captures cell C4, which is the test-retest reliability (.90), and subtracts it from 1.00

Steps

1. Enter column labes (Grade, SD, Reliability, & SEM) in columns A, B, C, D row 2
2. Enter row labels (1st, 2nd, 3rd, 4th, 5th, 6th) in column A rows 3 - 8
3. Enter standard deviations that were observed for each grade in column B rows 3 to 8
4. Enter reliabilities for each grade in column C rows 3 to 8
5. Enter adjacent formulas into column D rows 4 to 8
6. SDs and reliabilities can be changed. SEMs will be automatically updated

Steps to Calculate Confidence Interval

SEM values can be used to devise a confidence interval (CI).

Confidence Interval	Multiply	Example: If SEM = 10	Confidence Interval	Example Score Range (Score = 80)
68%	1.00	(.68 * 1.00) = .68 (10 * .68) = 6.8	CI = ±6	80 ± 6 True Score: 74 - 86
90%	1.68	(.90 * 1.68) = 1.5 (10 * 1.5) = 15	CI = ±15	80 ± 15 True Score: 65 - 95
95%	1.96	(.95 * 1.96) = 1.8 (10 * 1.8) = 18	CI = ±18	80 ± 18 True Score: 62 - 98

The confidence intervals provide both a likely range of performance across repeated administrations and an interval to estimate the true level of typical performance (i.e., true score).

Sample Data Collection Forms

The following forms were developed to help schools record data using different assessment systems. These forms will be available soon in the next version of Accommodate Pro (website: http://www.dataimpactsoftware.com).

DATA COLLECTION SUMMARY OF CURRICULUM BASED DATA

Student Name: _____

Date: _____

☐ Tier 1 ☐ Tier 2 ☐ Tier 3

Grade: _____ School: _____ Teacher: _____

What is being measured: _____
(in specific, observable/measurable terms e.g. two digit multiplication problems, decoding single syllable words)

How will the data be collected?: _____
(e.g. probe, work samples, running records, basic fact sheets, exit cards etc.)

How often and for how long will the data be collected?: _____
(e.g. 3 times per week over 8 weeks)

Who will be collecting the data: _____

GRAPH OF ASSESSMENT RESULTS

RAW SCORE axis: 50, 45, 40, 35, 30, 25, 20, 15, 10, 5, 0

Assessment Description (each point labeled F / L / U), numbered 1–25:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Score	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Max. Score	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
Percentage	0	4	8	12	16	20	25	29	33	37	41	45	50	54	58	62	66	70	75	79	83	87	91	95	100
Date																									
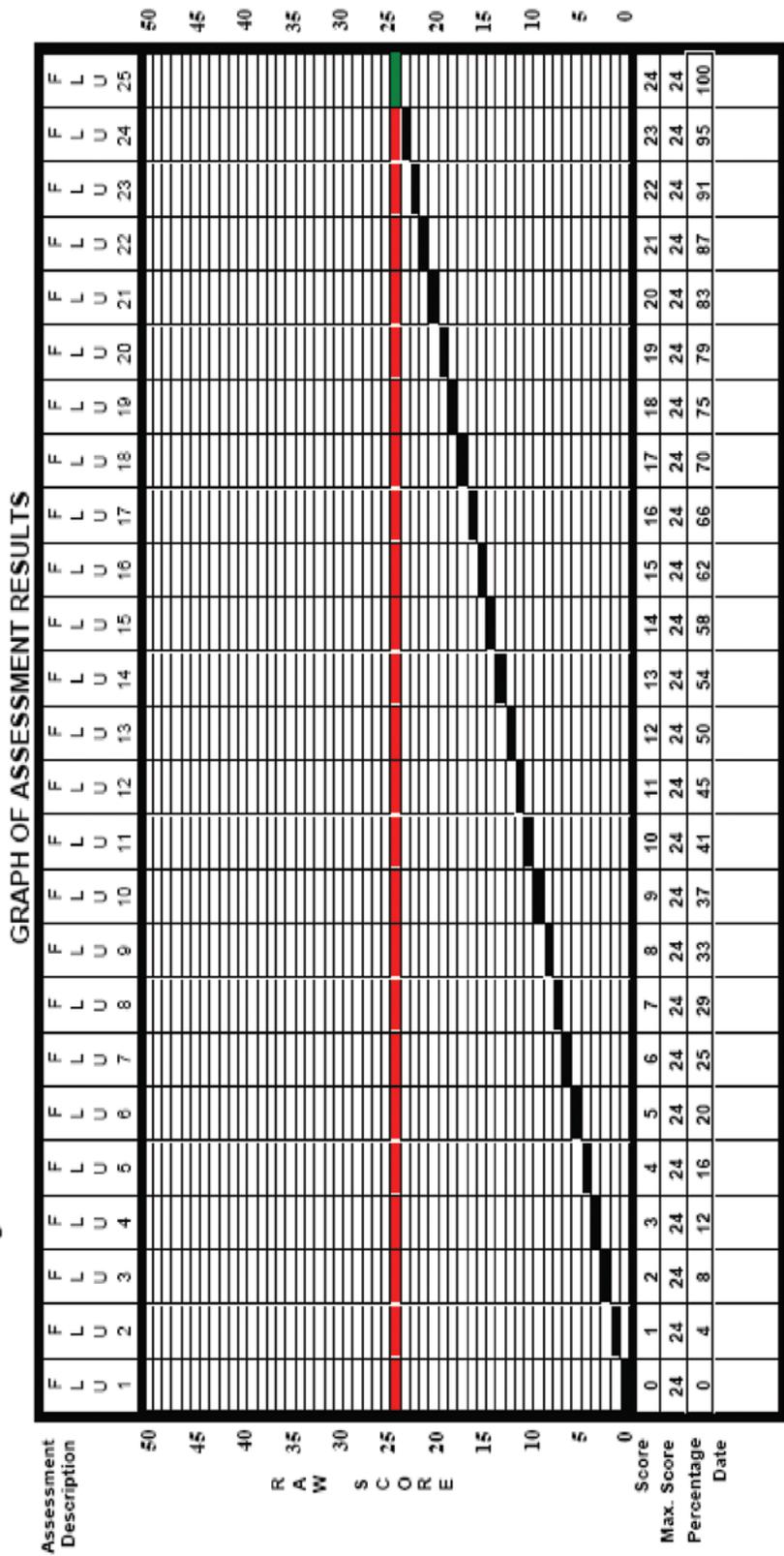
FORMATIVE ASSESSMENT

Report Date: _____

☐ Tier 1   ☐ Tier 2   ☐ Tier 3

Student Name: _____

Grade: _____   School: _____

Teacher: _____

Define what is being measured: _____
(in observable/measurable terms)

How will the data be collected?: _____
(e.g. tallies, work samples, running records, basic fact sheets, exit cards etc.)

How often and for how long will the data be collected?: _____
(e.g. 3 times per week over 8 weeks)

Who will be collecting the data: _____

Enter Code to Indicate Achievement or Lack of Task Achievement (e.g. +/-)

Educational Task																	
Dates:																	
Dates:																	
Dates:																	
Dates:																	
Dates:																	
Dates:																	

DATA COLLECTION SUMMARY
OF STANDARD SCORES

Student Name: _____   Grade: ___   School: _____   Date: _____

Teacher: _____

☐ Tier 1   ☐ Tier 2   ☐ Tier 3

What is being measured: _____
(in specific/observable/measurable terms)

How often and for how long will the data be collected?: _____

Who will be collecting the data: _____

Record **S**tandard **S**cores and Plot on Graph

Baseline

Assessment Description

SS
>112, 112, 110, 108, 106, 104, 102, 100, 98, 96, 94, 92, 90, 88, 86, 84, 82, 80, 78, 76, 74, 72, 70, <70

AVERAGE | AT RISK

%ile
>79, 79, 75, 70, 66, 61, 55, 50, 45, 39, 34, 30, 25, 21, 18, 14, 12, 9, 7, 5, 4, 3, 2, <2

Score

Date
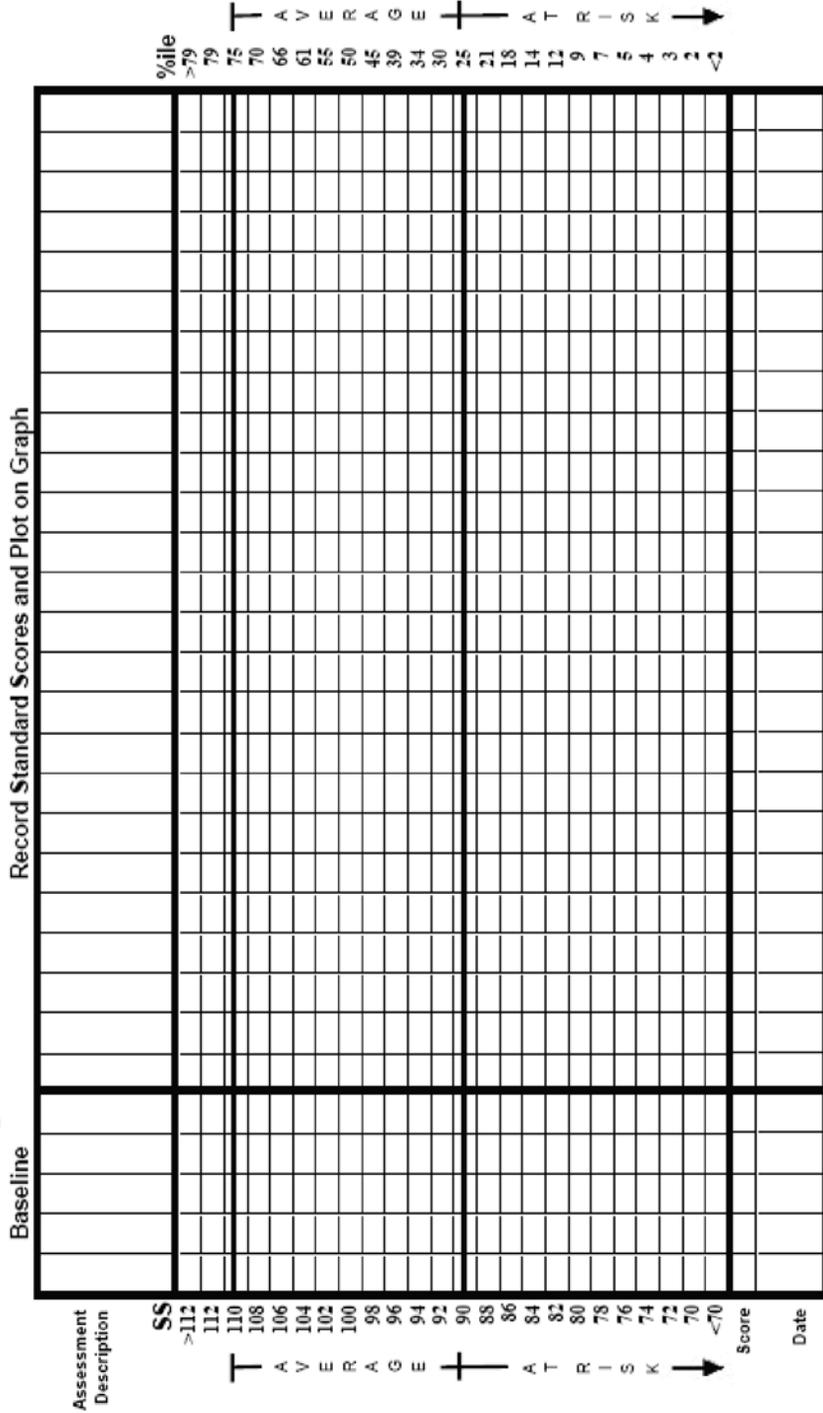
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Committee Members

The individuals listed below contributed their time and talents to developing recommendations for approaching Response to Intervention in Wayne County schools. Initial conversations began in June, 2005.

Dr. John Cellitti, Teacher Consultant
Lincoln Park Public Schools

Dr. Kathleen Grodus, School Psychologist
Plymouth-Canton Public Schools

Lisa Khoury, School Psychologist
Grosse Pointe Public Schools

Dr. Dona Beach-Johnson, School Psychologist
Grosse Pointe Public Schools

Dr. Delia Laing, Administrator
The Leona Group

Diane Lesley, School Psychologist
Detroit Public Schools

Valerie McNeece, Teacher Consultant
Melvindale-Northern Allen Park Public School

Dr. Maria Sella, School Psychologist
Flat Rock Public Schools

Anne Sheehan, Office of Student Support Services, Supervisor
Detroit Public Schools

Kathleen Sykes, Curriculum Consultant
Plymouth-Canton Public Schools

Dr. Stephen Taylor, School Psychologist
Livonia Public Schools

Rebecca Uribe, Director of Special Education
Dearborn Heights Public Schools

Shirley Veldhuis, Speech Pathologist
Lincoln Park Public Schools

Pearl Weiss, School Psychologist
Detroit Public Schools

Linda Wheeler, Consultant
Detroit Public Schools

Deborah Williamson, Office of Student Support Services, Supervisor
Detroit Public Schools

Estelle Wright-Alexander, Teacher Consultant
Detroit Public Schools

Marcy Yee, School Psychologist D
Detroit Public Schools

Dr. Patricia Drake, Special Education Data Consultant, Wayne RESA

Acknowledgements for Contributions:
Jeffrey Crockett, Teacher Consultant, Plymouth Canton Schools
Dr. Kathleen Storchan, ELL Consultant, Wayne RESA

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Kevin D. Magin, Executive Director Special Education and Early Intervention Services, Wayne RESA

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33500 Van Born Road • P.O. Box 807
Wayne, MI 48184-2497
734.334.1300 • 734.334.1620 FAX
www.resa.net