PART 4

Analyze Progress

During intervention implementation, progress monitoring and implementation data are collected to evaluate student progress and determine if implementation support is necessary. The link between collecting data and making data-based decisions is data analysis. The chapter in this section describes how to graph and evaluate treatment integrity, progress monitoring, and IBA data.

Through reading this section, you will learn how to graph and then interpret progress monitoring and implementation data.

CHAPTER 8

Graphing and Interpreting

What Will This Chapter Tell Me?

Data are only useful if they are used to make decisions. Within the PRIME Model, data are collected to (a) evaluate student progress, (b) determine intervention effectiveness, and (c) inform if and what PRIME Implementation Supports are needed. To make these decisions, treatment integrity, progress monitoring, and Implementation Beliefs Assessment (IBA) data should be graphed and interpreted. This chapter reviews what you will need to graph and interpret data and how to graph and interpret data. After reading this chapter, you will be prepared to graph treatment integrity, progress monitoring, and IBA data and interpret the graphed data.

Getting Ready for Graphing & Interpreting Data

It may sound obvious, but it worth stating; it is not possible to graph and interpret data to make decisions without regularly collecting data. Chapters 5 to 7 describe the process of collecting treatment integrity, progress monitoring, and IBA data, respectively. The process of developing a data collection plan is detailed in Chapter 5. This plan ensures that data are regularly collected by a trained data collector and reviewed on a regular basis.

Beyond the data itself, it is necessary to have information about the intervention goal. That is, what level of improvement in student

outcomes is desired? The process of selecting an appropriate, data-driven intervention goal for a student is described in Chapter 6. Make sure you have the intervention goal available when graphing and interpreting data.

How to Graph Data

Graphing is an efficient and effective way to summarize and present data. Data can be easily graphed using an electronic spreadsheet (e.g., Microsoft Excel, Google Docs) or plotting data using paper-and-pencil. Regardless of specific method, the process of graphing data includes three steps:

1. Organize data in a spreadsheet;
2. Choose the graph type that is appropriate for the data and questions being asked;
3. Add graph elements to facilitate interpretation.

Step 1: Organize data into a spreadsheet

To organize the data into a spreadsheet, you need to decide what questions you are interested in answering with the data. That is, what are the specific questions you are interested in during this period of data review. For example, are you interested in examining the percentage of adherence and quality by intervention session across time? Or are you more interested in what specific intervention steps are being implemented? The table below lists common questions of interest for treatment integrity, progress monitoring, and IBA data.

Data Source	*Question of Interest*	*X-Axis*	*Y-Axis*
Treatment Integrity	What is the percentage of adherence per session across time?	Time (i.e., dates, interventions sessions)	Percentage of adherence
	What is the percentage of quality per session across time?	Time (i.e., dates, interventions sessions)	Percentage of quality
	What intervention steps are implemented per session across time?	Intervention steps	Percentage of adherence
	To what extent is the student exposed to the intervention across time?	Time (i.e., dates, interventions sessions)	Amount of exposure (e.g., minutes, percentage of content received)

(Table continued)

Data Source	*Question of Interest*	*X-Axis*	*Y-Axis*
Progress Monitoring	How has the student performed on the progress monitoring measure across time?	Time (i.e., dates, interventions sessions	Student performance on progress monitoring measure (e.g., number of words per minute, percentage of intervals with disruptive behavior)
IBA	What is the implementer's overall IBA rating across time?	Time (i.e., dates, intervention sessions)	Overall IBA score
	How have the implementer's ratings of IBA items changed across time?	IBA items	IBA item rating

For each of your questions of interest, define the x-axis and y-axis. The x-axis is horizontal on a graph, while the y-axis is vertical. Most often, the x-axis represents time (e.g., dates of assessment, intervention sessions, weeks, months) or another variable that is measured repeatedly over time (e.g., intervention steps, IBA items). The y-axis usually includes the percentage or extent to which the variable of interest is monitored. The x-axis and y-axis for the common questions of interest are listed above.

Once you have defined your question of interest and x- and y- axes, you can organize your spreadsheet. This task can be done electronically or with paper and pencil. First, list the data for the x-axis. Next, add one or more columns for the y-axis. Add the y-axis data to the column(s) making sure the data correspond to the x-axis data. For

example, make sure the date the progress monitoring measure was administered correctly corresponds to the student's score on that measure.

In this example, the question of interest is "How has the student performed on the progress monitoring measure across time?". The x-axis represents time and a series of dates are listed in column A. The y-axis represents the student's performance on progress-monitoring measure; in this case, it's words correct per minute. The number of words the student reads per minute are listed (in the y-axis) with the corresponding dates (in the x-axis).

	A	B
1	Date	Words Per Min
2	9/15	50
3	9/16	52
4	9/17	49
5	9/18	55
6	9/19	54
7	9/22	57

In this next example, the question of interest is "What intervention steps are implemented per session across time?". The x-axis represents intervention steps so the specific interventions steps (by number) are listed in column A. The y-axis represents the adherence ratings. Each intervention step was rated as 1 (full adherence) or 0 (no adherence) and then an overall percentage of adherence per session was obtained. The numbers for each intervention step are listed for each intervention session (by date) in column B and C.

	A	B	C	D
1	Intervention Steps	18-Sep	23-Sep	
2	1	1	1	
3	2	0	1	
4	3	0	1	
5	4	0	0	
6	5	1	1	
7	6	1	1	
8	7	1	1	
9	8	1	1	
10	9	1	1	
11	10	0	0	
12	Overall	0.6	0.8	
13				

Step 2: Select Graph Type

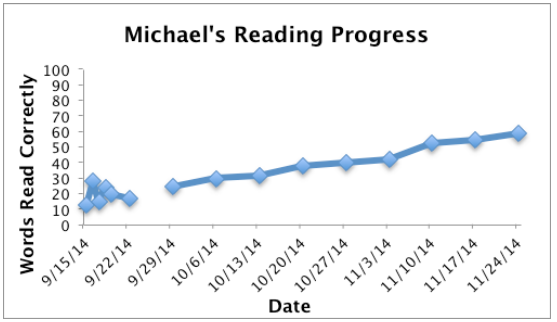
Once your data are organized, select a graph type. Two types of graphs often used are a line graph and a bar graph. Below these graphs are described along with their unique advantages, and directions for how to electronically create them.

Line Graphs

Line graphs are most often used to summarize data across time. In these cases, time (i.e., dates, sessions) is plotted on the x-axis and the extent of the variable of interest (e.g., treatment integrity, progress monitoring, IBA data) is plotted on the y-axis. In this way, in a line graph, the percentage of implementation, student progress, or IBA scores over time will be graphed.

A line graph is a useful and effective way to share data in a school setting. Its simplicity is its greatest asset. Line graphs are easy to understand and, as such, they can be valuable for communicating student progress to multiple stakeholders, such as teachers, parents, and even the student themselves (if appropriate). Line graphs also highlight trends (or patterns over time) that are very useful for data interpretation and analysis. How to consider trends and interpret graphs is more fully described later in the chapter. But, line graphs help facilitate this process because of their clean presentation and ease of interpretability.

This example line graph depicts the progress-monitoring data for Michael, a student receiving a Repeated Reading intervention to increase oral reading fluency. The x-axis depicts the dates the measure was administered. The y-axis includes the number of words read correctly. The data shows the change in Michael's oral reading fluency, or words read correctly per minute, as measured by a curriculum-based measure across time.



Now it is time to make your graph. To create a line graph electronically, highlight the relevant columns in your spreadsheet. Then select the "line graph" option in the chart tab. Your graph will appear on the page. We suggest choosing the "marked" line graph option so that each of the data points will be marked, but it is not necessary to do so. To create a line graph with paper and pencil, draw the x-axis and y-axis to make a blank graph. In doing so, make sure that the graph scale is large enough to account for the change in data across time and also small enough to notice changes in between data points. Then, plot each data point by pulling data from your spreadsheet. Last, draw a line to connect the data points to indicate the data path.

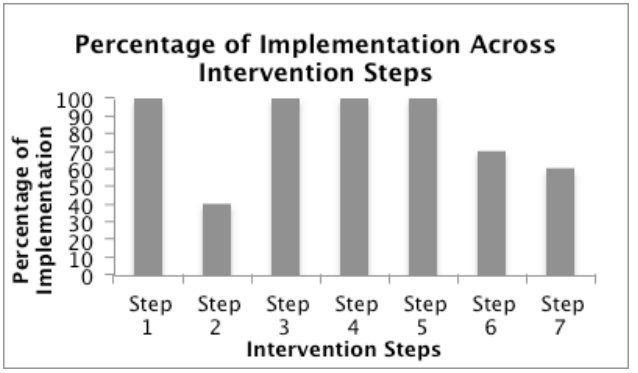
Bar Graphs

Bar graphs are a helpful way to illustrate a relative comparison across a variable of interest. For PRIME purposes, variables of interest might include the (a) implementation of specific intervention steps, (b) amount of time a student has been exposed to the intervention across time, or (c) implementer's ratings on specific IBA items. Bar graphs are a flexible way to display data. The x-axis may be intervention steps, IBA items, intervention sessions, or other variables of interest. The y-axis will show the percentage or rating for each of the variables on the x-axis. When graphed, you can compare the differences between different intervention steps, intervention sessions, or IBA items.

Bar graphs can help find specific patterns that may not be clear when looking at a line graph. Data displayed on a bar graph, such as intervention steps, are easily comparable because the relationships among the bars and the number value corresponding to each bar are clear. These data can be discussed between the consultant and implementer to decide the best approach to increase treatment integrity that will lead to improved student outcomes.

This bar graph shows an example of treatment integrity for an intervention plan that has seven steps. The x-axis represents inter-

vention steps, while the y-axis is the percentage of implementation across sessions. Each bar represents the proportion of intervention sessions in which a step was implemented according to the intervention plan.



Now it is time to make your graph. To create a bar graph electronically, highlight the relevant columns in your spreadsheet. Then select the "bar graph" option in the chart tab. Your graph will appear on the page. Sometimes a bar graph will appear incorrectly (i.e., the x- and y-axes are mixed up); in this case, simply click "switch plot" to reorient your graph. To create a bar graph with paper and pencil, draw the x-axis and y-axis to make a blank graph. Then, plot each bar of your bar graph pulling data from your spreadsheet.

Step 3: Add graph elements to interpret data

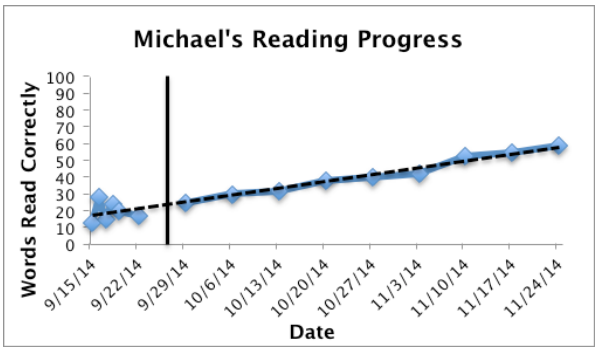
At this point, you have created a graph that corresponds to a particular question of interest. You can add graph elements to help facilitate your interpretation of the data. Graph elements to consider including are (a) phase change lines, (b) trend lines, and (c) aim lines.

Phase Change Line

A phase change line is a vertical line transposed on a graph to indicate when the data are collected during different conditions, or phases. The most common phase change line is between baseline

(or initial) data collection and intervention implementation. Other phase change lines might include any modification or adaptions in the intervention, either to increase support or systematically fade support, or when treatment integrity support was provided. Phase change lines help us interpret the data accurately and know when a change in data might be expected.

To add a phase change line electronically, simply insert a "line" shape and drag it to the correct spot on your graph. To add a phase change line to a paper-and-pencil graph, draw a vertical line where the phase change occurred.

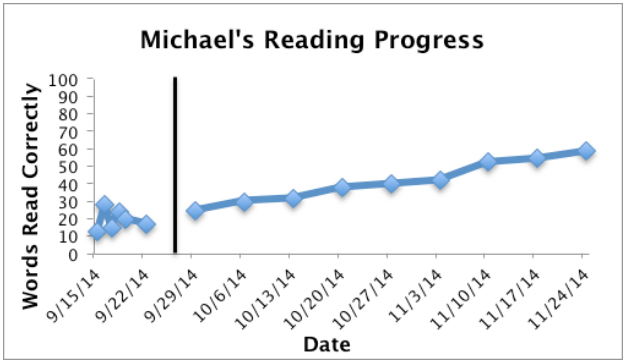


Trend Line

A trend line is a visual representation of the actual rate of progress. A trend line will indicate how quickly a student is improving per the progress monitoring measure or the rate of treatment integrity across time. A trend line is different from a data path, which is the line that simply connects the data points. A data path indicates the changes from one data point to the next, while the trend line indicates the overall rate of progress. This addition can be helpful, for example, if a student or implementer has one day with a lower rate on the progress monitoring measure or a day with lower levels of implementation. As the trend line accounts for the overall rate of progress it will be only minimally impacted by one lower (or higher!) data point.

In the graph below, a trend line was added to indicate Michael's

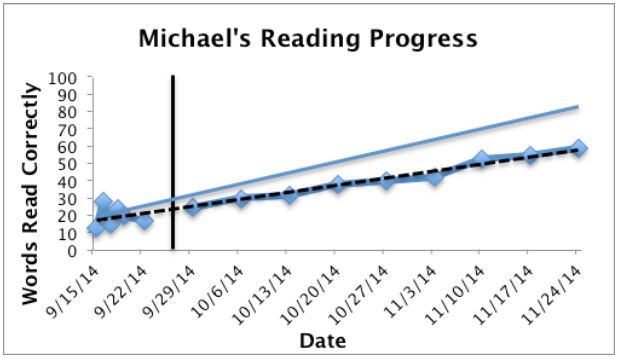
overall rate of progress. The addition of the trend line helps us to understand how Michael is doing and is expected to do across time.



To add a trend line electronically, click on your graph. Then select "trendline" in the "Chart Layout" section. Insert a "linear trendline" and it will appear on your graph. To add a trend line to a paper-and-pencil graph, use the Quickie Split Middle Technique suggested by White (1971). To do so, find the middle point and draw a vertical line. Then, find the middle point (horizontal) for each half and draw vertical line. Next, find the median point (vertical) for each half and draw a horizontal line. Mark with an X at the point where the horizontal and vertical lines meet. Last, draw a line through the Xs to find the trendline.

Aim Line

In the graph below, an aim line was added to indicate the level of progress needed for Michael to reach his goal. The addition of the aim line helps us to better evaluate Michael's reading performance data points and trend line. In this case, while his performance is improving (per the trend line), it is not sufficient per the aim line.



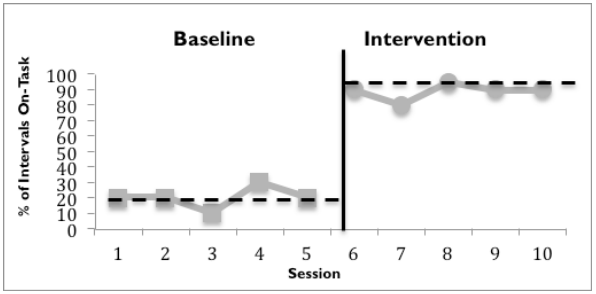
An aim line is the median baseline point and the desired intervention goal at the expected end date. Once theses two data points (i.e., median baseline and desired intervention goal) are identified, it can be added to a graph electronically or using paper and pencil. To add an aim line electronically, simply insert a "line" shape and drag it to the correct angle on your graph. To add a trend line to a paper-and-pencil graph, simply draw the line on your graph.

How to Interpret the Data

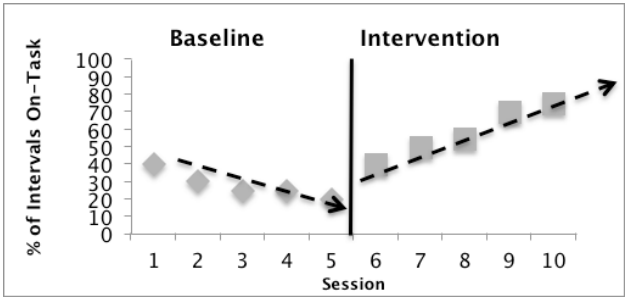
After data have been graphed, it is ready for interpretation. For PRIME, there are three primary questions of interest. For progress-monitoring data, is the student making sufficient progress to meet his or her goal? For treatment integrity data, is the implementation sufficient to support student outcomes? For IBA data, how does the IBA data enhance our understanding of implementation? Instructions on how to develop summary statements and address these questions are described further below after description of the basic rules of interpreting graphs.

Regardless of the specific question, to interpret the graphed data, use visual analysis. Visual analysis is a systematic way of examining a graph to identify patterns and evaluate change. Specifically, with visual analysis, you will review graphs for three components: level, trend, and variability.

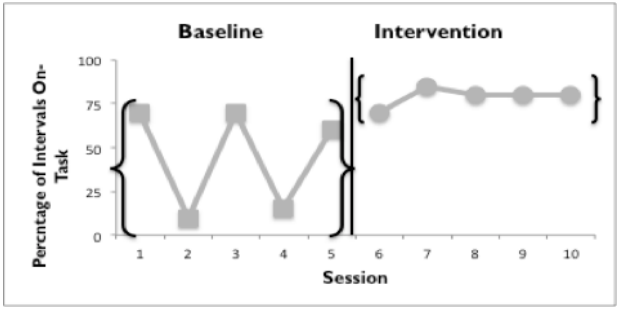
Level. The level of data is the average value of the measured outcome within a condition. A change can be shown in the data when the level of outcome is different from baseline condition compared to an intervention condition. The dashed lines in the graph show the average level across the two phases.



Trend. Trend is the pattern of change in the data over the course of the plan implementation stage, such as increasing, decreasing, or no trend in the data. Depending on the nature of the outcome variable, an increasing or decreasing trend will indicate improvement or worsening of a student's problem. The baseline phase on the left represents a decrease and worsening trend. The intervention phase on the right represents an increasing and improving trend. Shifts in trend that show improvement for the student are helpful in determining a change resulting from implementation of the intervention.



Variability. Variability is the spread of data above and below the data path. When a data path shows a relatively large amount of variability, it can be difficult to draw definitive conclusions about the effect of the intervention on the student outcome. A change in variability is sometimes the desired goal of an intervention. For example, an intervention may be designed to change a student's homework completion from greatly variable rates of completion to consistently high rates. In this case, a significant decrease in variability of the outcome may provide evidence for a successful intervention. The graph to the right shows a large amount of variability in the baseline phase and a small amount of variability in the intervention phase.



PRIME Tip

Beyond trend, level, and variability, visual analysis can incorporate many more considerations to determine if the intervention has a functional relationship with the change and summarize the effect of that intervention quantitatively. Though a thorough discussion is beyond the scope of this chapter, if interested, we encourage readers to refer to the additional resources listed below for further information.

Riley-Tillman, T. C., & Burns, M. (2009) Evaluating Educational Interventions: Single-case Designs for Measuring Response to Intervention. New York: Guilford Press.

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M & Shadish, W. R. (2010). Single-case designs technical documentation. In What Works Clearinghouse: Procedures and standards handbook (version 2.0). Retrieved from: http://ies.ed.gov/ncee/wwc/pdf/wwc_procedures_v2_standards_handbook.pdf

Check your visual analysis skills:

Visual analysis training module—www.singlecase.org

Develop a Summary Statement

To interpret the graphs, describe the overall pattern of data highlighting the trend, level, and variability. Depending on the graph, it may be appropriate to describe the data all together or describe the data patterns before and after intervention. For example, a summary statement of a progress-monitoring graph might be described as the following: "Before intervention, Johnny's words per minute were consistently low, in the 20-29 range, [variability, level] with a flat trend [trend]. Following intervention, Johnny's word per minute increased over time [trend] to 40 words per minute [level], and remained consistent [variability].

Though trend, level, and variability are most often associated with line graphs, these components can be applied to interpreting bar

graphs. If a line graph includes the steps of intervention implemented as planned, a consultant could interpret the trend across different steps, the overall level of implementation as well as specific steps, and variability across the steps. A summary statement might be "The implementer consistently delivers consequence steps more often then antecedent steps [trend, variability], though the level of both types of steps is high (i.e., above 80%) [level]".

Summary statements that describe the trend, level, and variability overall or between phases are useful to indicate the pattern of the data. Record the data and/or summary statements on the PRIME Intervention Implementation Tracking Form (Appendix D). These summary statements will be used together to make data-based decisions in Chapter 9. Before integrating these data, let's review specific considerations for describing progress-monitoring data, treatment integrity data, and IBA data.

For progress-monitoring data, the primary question of interest is, "is the student making sufficient progress to meet his or her goal?". To answer this fundamental question, make sure your summary statement accounts for (a) intervention phases, (b) the trend line, and (c) the aim line. In this way, highlight changes to trend, level, and variability across intervention phases (e.g., did the trend or level change following intervention? Did the variability decrease?) and compare the trend line to the aim line (i.e., is the student on track to meet his or her goal?). This analysis will ensure your description of the student's progress across time addresses the data and directly speaks to the primary question of interest.

For treatment integrity data, the overall question of interest is "is the implementation sufficient to support student outcomes?". There is no magic number for implementation; interventions need to be implemented to unique levels (e.g., 80%, 90%) to result in changes for the student. Implementation data need to be reviewed carefully to evaluate if (a) critical intervention steps are being implemented regularly, and (b) the extent of implementation is sufficient for

the student to make adequate progress. To determine if intervention steps are being implemented regularly, develop a summary statement that accounts for the trend, level, and variability of treatment integrity across time as well as highlights specific intervention step treatment integrity. Consider adherence, quality, and exposure data. If PRIME Implementation Supports have been provided, describe treatment integrity before and after supports. Did implementation improve after delivery of implementation support?

Next, develop an interpretation of the implementation data that also accounts for the progress monitoring data. Compare across graphs. Are patterns clear? Does the student do better on the days when the intervention is implemented? What steps must be implemented for the student to do well? For some interventions this pattern may not be clear in simply one day of implementation, but rather, the data across time (e.g., if treatment integrity is high and consistent for three days, progress monitoring data increase). Use this understanding of the relationship between progress monitoring data and treatment integrity to inform your interpretation of the treatment integrity data.

For IBA data, the primary question of interest is "how does the IBA data enhance our understanding of implementation?". As described in Chapter 9, consider overall scores on the two subscales, Outcome Expectations and Self-Efficacy, as well as ratings of individual items. If the IBA has been delivered on multiple occasions, evaluate the change over time in consideration of trend, level, and variability. Once you have developed an overall summary statement of the IBA data, consider whether the IBA data is consistent with treatment integrity data and how it might enhance our interpretation of the implementer. Does the implementer consistently skip some intervention steps and have low-self efficacy? Does the implementer have overall high self-efficacy, but inconsistent treatment integrity and low outcome expectations? Integrate your interpretation of these two data sources to enhance your understanding of implementation.

What Did I Learn About PRIME?

A graph can facilitate decision-making during implementation. With a graph, the level and rate of progress is clear. In the PRIME Model, graphing progress-monitoring and treatment integrity data can help a consultant evaluate the intervention and determine appropriate PRIME Implementation Supports. Graphing itself includes three parts (a) developing a spreadsheet, (b) selecting a graph type, and (c) adding graph elements. Next, interpret the graph highlighting trend, level, and variability as well as unique considerations for progress monitoring, treatment integrity, and IBA graphs. These graphs and interpretations are necessary for making data-based decisions (see Chapter 9).

Chapter 8 Key Terms

Aim Line
Bar Graph
Data Path
Data Point
Level
Line Graph
Phase Change Line
Summary Statement
Trend
Trend Line
Variability
X-axis
Y-axis