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Graphing Single-Case Data in Microsoft Excel 2007

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ABSTRACT: An important component of the school-based practitioner's role involves collecting, graphing, and analyzing quantitative data to evaluate student progress. This article highlights advantages of using computer spreadsheet programs for storing and graphing single-case data. Every few years Microsoft launches a new version of Excel. The most recent release was in 2007. This article outlines several new features of the most recent version of Excel as they relate to school-based practice. Several commonly used tasks are outlined, including graphing ABA and multiple baseline designs, applying linear trendlines, the use of templates, and inserting graphic displays into other programs including Microsoft Word and PowerPoint. Templates for these tasks will be made available online.

School practitioners are expected to use empirically supported interventions and utilize formative data when making instructional and behavioral programming decisions. They are held accountable for these programming decisions, and should be able to provide quantitative data concerning student progress (Stecker & Fuchs, 2000; Kratochwill & Shernoff, 2004; McDougal, Clark, & Wilson, 2005). Fortunately, assessment technology exists to frequently measure both academic and social behaviors. However, for these assessment data to be useful they must be graphed and analyzed to evaluate whether students are making adequate progress (Shinn, 2007; Wright, 2008) and whether modifications to interventions are warranted (Stecker & Fuchs).

Summarizing student data in graphic form allows for clear and concise interpretation and evaluation of intervention-related information. One way to process progress-monitoring data is by plotting the data on a graph where it can be visually inspected (Cooper, Heron, & Heward, 2007). Trendlines, aimlines, and goal lines are useful visual analysis aids for determining whether a student is making adequate progress (Stecker & Fuchs, 2000; McDougal et al., 2005) and whether such progress can be attributed to intervention (Cooper, Heron, & Heward).

Paper and pencil graphs are convenient and easy tools for tracking student progress. Though this method of graphing data may be appropriate in certain cases, it can become a difficult and cumbersome process when tracking multiple students and imposes limits on the analysis and dissemination of data. Computer programs such as Microsoft Excel provide practitioners with a time-efficient and practical way to report data and allow for easy manipulation, storage, creation of local norms, and transportability of raw and graphed data among stakeholders (Marston, Lau, & Muyskens, 2007). Visual analysis of computer-stored data is more convenient and accurate, where

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data points and trendlines can be easily modified without disrupting the cosmetics of the graphic presentation. Using spreadsheet programs such as Microsoft Excel also permits statistical analysis of single-case data (see Franklin, Alison, & Gorman, 1996). Student progress can be managed and viewed in real time with indicators of student progress (e.g., data series, trendlines, goal lines) changing automatically when data are entered (Stecker & Fuchs). Graphic information also can be exported to other computer software programs (word processing and/or presentation software) for convenient reporting (Carr & Burkholder, 1998).

Every few years Microsoft launches a new version of Excel. The most recent release was in 2007 and includes many useful modifications. However, often changes in functionality involve learning how to access new functions and, sometimes, learning how to perform previously mastered tasks.

NEW FEATURES IN EXCEL 2007

According to Microsoft, new features in the 2007 version of Excel include conditional formatting, increased row and column capacity, new visual effects, and shared formatting features. Practitioners can utilize conditional formatting features (e.g., using a formula to highlight cells meeting a particular condition) to quickly identify students meeting a prescribed criterion (e.g., students at risk or those not responding to intervention). This version also has a modified graphing interface, making formatting and graphing tools more accessible. Practitioners can use these improved features to create table and graphing templates for behavioral and academic progress monitoring. Once created, these templates can be used repeatedly or exported to other applications for clear reporting.

Once the spreadsheet and graph are formatted, the Excel workbook can be used as a working document. Specifically, as data are entered into the spreadsheet, the graph will update automatically. This facilitates monitoring student progress in real time and timely decision making.

The purpose of this article is to highlight the advantages of using computer spreadsheet programs for storing and graphing single-case data and to facilitate a smooth transition to the most recent version of Excel. To that end, several commonly used tasks will be outlined following the style guidelines set forth by the 2001 *Publication Manual of the American Psychological Association*. In addition, templates for commonly used graphing projects, such as multiphase single-case design and multiple baseline design, along with Macintosh-specific instructions, will be made available online. The following instructions have been broken into easy-to-follow steps and are intended to make everyday use of computerized graphing in Excel by school-based practitioners more efficient.

GETTING STARTED

Common formatting functions, including cutting, copying, and pasting, are useful tools for duplicating or relocating text, pictures, and chart objects. These functions can be accessed using a variety of keyboard, mouse, and toolbar shortcuts. Below is a brief outline of commonly used formatting functions and their shortcuts.

Common Formatting Shortcuts

Cutting: Once highlighted, text, pictures, and chart objects can be cut from a document and placed on the document's clipboard in the following ways:

- *Mouse:* Right click, select CUT.
- *Keyboard:* Key and hold the CTRL key, then press the X key (i.e., CTRL+X).
- *Toolbar:* Open the HOME tab and click on CUT in the top left corner of the tab.

Copying: Once highlighted, text, pictures, and chart objects can be copied from a document and placed on the document's clipboard in the following ways:

- *Mouse:* Right click, select COPY.
- *Keyboard:* Key and hold the CTRL key, then press the C key (i.e., CTRL+C).
- *Toolbar:* Open the HOME tab and click on COPY in the top left corner of the tab.

Pasting: Position the cursor in the location the text, picture, or chart object is to be pasted and single click. Once the cursor is in place, the following shortcuts may be applied to paste items from the clipboard:

- *Mouse:* Right click, select PASTE.
- *Keyboard:* Key and hold the CTRL key, then press the V key (i.e., CTRL+V).
- *Toolbar:* Open the HOME tab and click on PASTE in the top left corner of the tab (tip: clicking on the arrow below the paste button allows the user to choose other pasting options including PASTE, PASTE SPECIAL, and PASTE AS HYPERLINK).

Creating an ABA Design Graph

Entering data into the spreadsheet:

1. Beginning with column A (the column to the far left of the spreadsheet), label columns to reflect data collection schedule and phases of data collection (e.g., dates, baseline, intervention, return to baseline).
2. In the first column, enter the dates of data collection or otherwise label measurement occasions.
3. In the second column (e.g., baseline) enter the data for the first phase.
4. Continue data entry on the next row in the column to the right (e.g., intervention). Repeat this step for each new phase (e.g., return to baseline).

Data should be staggered across columns (see Table 1). Entering data this way will prevent the lines of the graph from being connected between phases (see Figure 1). Staggering the data also allows the practitioner to add trendlines for convenient visual analysis of individual phases.

Creating and customizing the graph:

1. Once data are entered, make LINE WITH MARKERS the default chart type by opening the LINE option (under the INSERT tab) and choose SET AS DEFAULT CHART. Changing the default chart type need only be performed one time and will eliminate time-consuming steps when creating frequently employed graphs.
2. Next, right click on the tab at the bottom of the active spreadsheet (the default is SHEET 1) and select INSERT; double click on CHART from the pop-up menu. A new chart will be inserted into the workbook utilizing the data entered in SHEET 1. The new graph will be formatted to match the default chart setting, previously applied in step 1.
3. To change the layout of the graph, choose LAYOUT 1 under CHART LAYOUT in the DESIGN tab. This layout will display a legend, vertical axis title, and chart title.
4. Add a Horizontal Axis Title by opening the LAYOUT tab, selecting AXIS TITLES – PRIMARY HORIZONTAL AXIS TITLE – TITLE BELOW AXIS. Highlight and edit the Vertical Axis Title, Horizontal Axis Title, and Chart Title to reflect the data being graphed (e.g., frequency, days, or hand-raising behavior). The legend can be removed by opening clicking LEGEND – NONE under the LAYOUT tab.
5. Each data series will be displayed with a different color and marker. To create a unified graphic display, right click on the second data series (i.e., intervention phase) and choose FORMAT DATA SERIES. A formatting box will appear allowing the user to modify MARKER OPTIONS, MARKER FILL, LINE COLOR, and MARKER LINE COLOR to match the first data series (i.e., baseline phase). Repeat this step for all subsequent data series (i.e., return to baseline).

Table 1. Sample Spreadsheet Data for Graphing an ABA Design

Day	Baseline (A1)	Intervention (B)	Verification (A2)
1	1		
2	3		
3	1		
4	2		
5	3		
6		4	
7		6	
8		7	
9		5	
10		8	
11		7	
12		9	
13		10	
14		8	
15			7
16			6
17			5
18			3
19			2
20			2

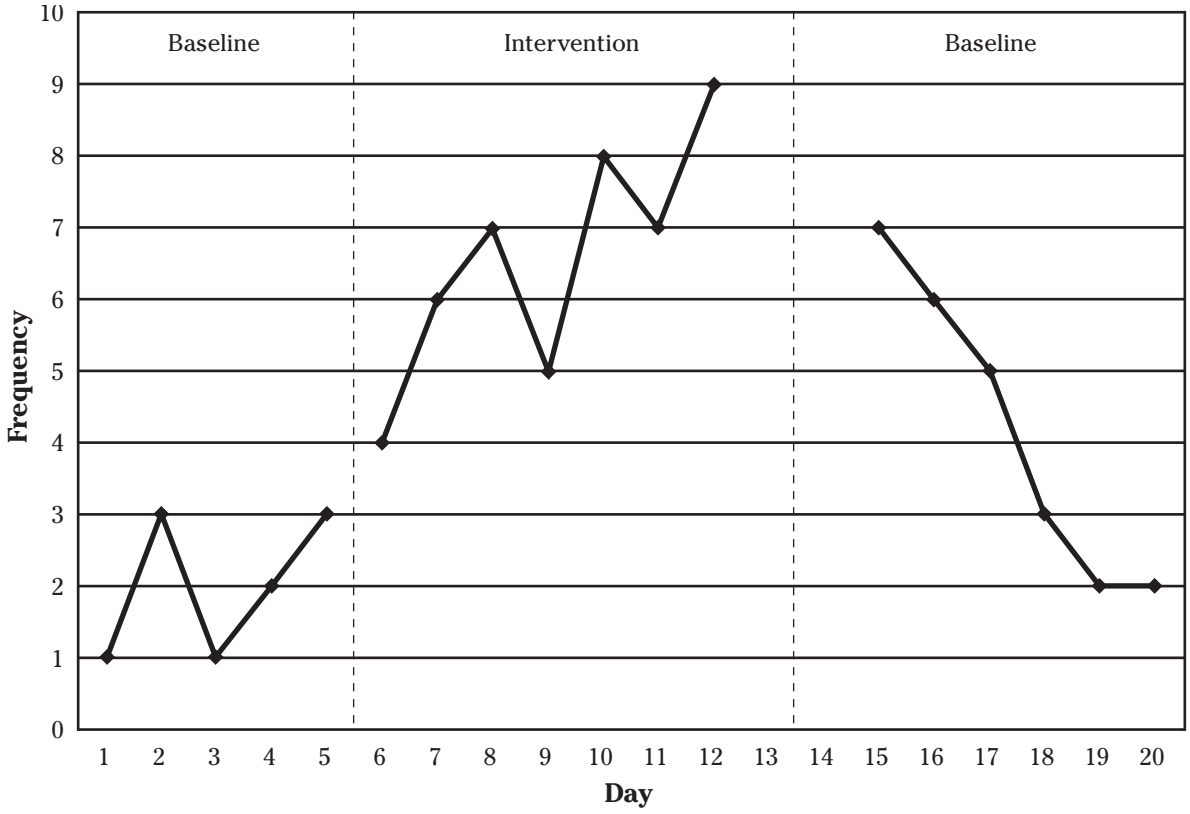
6. Phase change lines can be added. Open the LAYOUT tab and click on SHAPES; select LINE. Use the mouse to draw a vertical line between phases by clicking and dragging the cursor from the bottom of the horizontal axis to the top. Once the line is drawn, the FORMAT tab will open automatically. Click on SHAPE OUTLINE to edit the weight and style (i.e., dashes) of the line. Repeat for each subsequent phase.

Creating a Multiple Baseline Design Graph

Entering data into the spreadsheet:

1. Beginning with column A, label columns to reflect data collection schedule and phases of data collection (e.g., dates, baseline 1, baseline 2).
2. Under the first column enter the dates of data collection.
3. In the second column (e.g., baseline 1) enter the data for the first phase.
4. Continue data entry in the next row in the column to the right (e.g., intervention 1). Repeat this step for each new data series (e.g., baseline 2, intervention 2).

Figure 1. Hand raising behavior.



As is the case for ABA designs, the data for multiple baseline designs should be staggered (see Table 2). This format creates a discontinuous line between phases when graphed (see Figure 2). Trendlines can be easily applied to individual phases allowing the user to quickly perform a visual analysis of progress over time.

Creating and customizing the graph:

1. Once data have been entered, open SHEET 2 of the Excel workbook. Change the orientation of the sheet by opening the PAGE LAYOUT tab and selecting ORIENTATION and LANDSCAPE (tip: change the page view option to PAGE LAYOUT under the VIEW tab; this option allows for easy viewing of the printable area).
2. Open the INSERT tab and select LINE WITH MARKERS; resize the graph area by clicking and dragging the corners of the graph.
3. From the DESIGN tab choose SELECT DATA.
4. Add data by selecting ADD from the pop-up window. Name the series A1 or Baseline1. Highlight data from column 2, including all empty cells, (e.g., baseline 1) in SHEET 1 of the spreadsheet. Click OK.
5. Click ADD to enter intervention 1 data. Name the series B1 or Intervention1. Highlight data from column 3, again including all empty cells (e.g., intervention 1) in SHEET 1 of the spreadsheet. Click OK.
6. The graph should have two data series, one for A1/Baseline1 and one for B1/Intervention1. B1/Intervention1 needs to be edited so that the formatting matches that of A1/Baseline1. To do this, right click on one of the data points and select FORMAT DATA SERIES.
7. Change the MARKER OPTIONS, MARKER FILL, LINE COLOR, and MARKER LINE COLOR to match A1/Baseline1. Click CLOSE.
8. Remove the legend by opening the LAYOUT tab, clicking on LEGEND, and selecting NONE.
9. A Vertical Axis Title should be added by selecting AXIS TITLES – PRIMARY VERTICAL AXIS TITLE – ROTATED TITLE. Highlight and edit the title to reflect the data collected (e.g., frequency).

Table 2. Sample Spreadsheet Data for Graphing an ABA Design

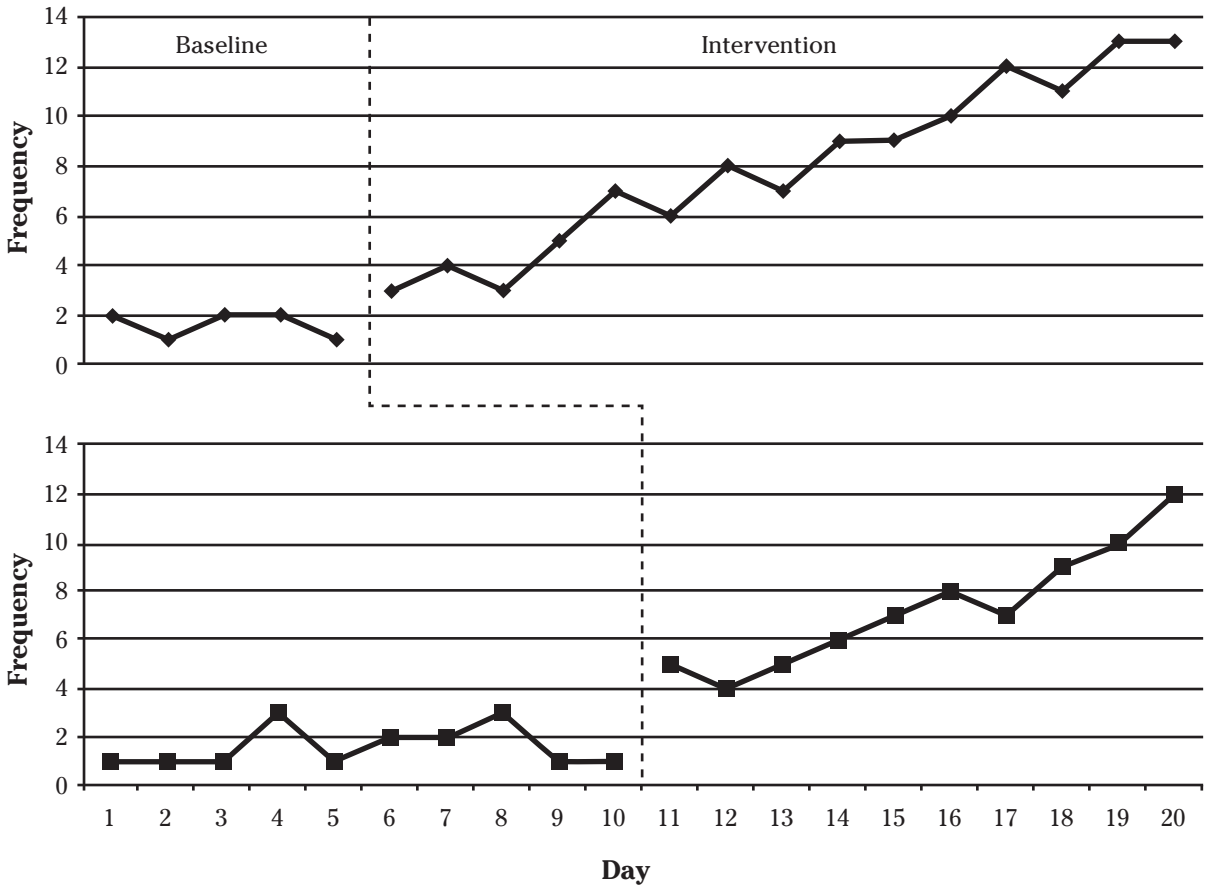
Day	Baseline 1 (A1)	Intervention 1 (B1)	Baseline 2 (A2)	Intervention 2 (B2)
1	2		1	
2	1		1	
3	2		1	
4	2		3	
5	1		1	
6		3	2	
7		4	2	
8		3	3	
9		5	1	
10		7	1	
11		6		5
12		8		4
13		7		5
14		9		6
15		9		7
16		10		8
17		12		7
18		11		9
19		13		10
20		13		12

10. Copy the graph by right clicking on the graph area and selecting COPY. Next, right click on a cell below graph 1 and select PASTE. Repeat this step as necessary to accommodate the required number of baseline phases. Space should be left between graphs to allow for phase change lines across graphs to be added.
11. Repeat steps 4–9 to display A2/Baseline2 and B2/Intervention2 data. Data should be changed to match that of A2/Baseline2 and B2/Intervention2. This edit can be made by selecting graph 2 and clicking on SELECT DATA from the DESIGN tab. Choose A1/Baseline1 from the list of LEGEND ENTRIES and click EDIT. From here, the user will be able to edit the SERIES NAME and highlight different SERIES VALUES. Repeat this step for all subsequent phases of data collection.

Completing the multiple baseline design graph:

1. To complete the graph, certain aesthetics need to be changed. First, the Horizontal Axis Labels should be removed from graph 1 (note: *do not* remove the Horizontal Axis Labels from graph 2). This action can be accomplished by clicking on graph 1, opening the LAYOUT tab and selecting AXES – PRIMARY HORIZONTAL AXIS – SHOW AXIS WITHOUT LABELING.

Figure 2. Hand raising behavior.



2. A Horizontal Axis Title needs to be added to graph 2. Click on graph 2, open the LAYOUT tab, and select AXIS TITLES – PRIMARY AXIS TITLE – TITLE BELOW AXIS. The text of the title can be altered using the steps for editing the Vertical Axis Title in step 9 above.
3. Next, phase change lines are needed. Again, from the LAYOUT tab, click on SHAPES, and select ELBOW CONNECTOR.
4. Using the cursor, draw a line between A1/Baseline1 and B1/Intervention1, extending between graph 1 and graph 2. Two circles will appear with a yellow triangle in the middle; the shape of the line will resemble the letter *Z*. Move the lower circle down and over until it is between A2/Baseline2 and B2/Intervention2. Click and drag the yellow triangle until it is between graph 1 and graph 2.
5. Make sure the FORMAT tab is open and click on SHAPE OUTLINE; select DASHES and choose the fourth dash option. Click on SHAPE OUTLINE to change the line color to AUTOMATIC or BLACK.
6. To add labels for each phase, open the LAYOUT tab and click on TEXT BOX. Insert the text box above A1/Baseline1 and type *baseline*. Right click on the text box and choose COPY. Move cursor about B1/Intervention1, right click and choose PASTE (note: a text box may appear in the top left corner of the page; move it by clicking and dragging it to desired area). Edit the text by highlighting and then typing *intervention*.
7. The last step is to add a title to the graph. Click on graph 1, open the LAYOUT tab, and select CHART TITLE – ABOVE CHART. Highlight and edit the text to customize the graph (e.g., hand raising behavior).
8. Tip: To ensure that graphs are within the printable area, open the PRINT PREVIEW from OFFICE BUTTON in the top left corner of page.

VISUAL ANALYSIS OF DATA

As mentioned previously, Excel permits the creation of trendlines, which are useful aids in visual analysis of graphed data. Trendlines are also known as lines of regression and, when applied to a chart, can be used to forecast the degree of effectiveness of an intervention. Several types of trendlines are available, including linear, exponential, linear forecast, and two period moving average. Trendlines may be applied to an entire dataset or to individual phases of the graph. The following instructions describe how to apply a linear trendline to individual phases of data. Instructions are also included to modify the formatting of trendlines.

Applying linear trendlines:

1. Open the graph and click on a data point within the phase to which the trendline will be applied.
2. Open the LAYOUT tab; click on TRENDLINE and choose LINEAR TRENDLINE.
3. To edit the formatting of the trendline, click on the trendline and choose MORE TRENDLINE OPTIONS from the TRENDLINE dropdown menu in the LAYOUT tab. TRENDLINE OPTIONS (e.g., LINE TYPE, LINE NAME), LINE COLOR, LINE STYLE, and SHADOW will be made available in a pop-up window.
4. Repeat these steps to apply trendlines to other phases of the graph.

Saving as a template:

Once an Excel graph has been created and edited to the user's preferences, it can be saved as an Excel template. Saving the document as a template allows for repeated use of the file. The template can be easily inserted into a new or existing workbook while formatting automatically adjusts to new data. Instructions for this time-saving tip follow:

1. Click on the OFFICE BUTTON in the top left corner of the workbook.
2. Choose SAVE AS. A pop-up window will appear where naming and file type must be determined.
3. Type a name in the FILE NAME field (tip: choose a file name that will be easily recognizable for future use).
4. Select EXCEL TEMPLATE from the SAVE AS TYPE drop-down menu. (tip: be sure the template is saved in TEMPLATES; this location will be indicated at the top of the pop-up window in the SAVE IN field).

Opening the template:

1. In an existing or new Excel workbook, right click on a SHEET. Choose INSERT.
2. Options for insertion will appear in a pop-up box. In this box, saved templates should appear. Double click on the template to be inserted into the workbook.
3. The template, along with all saved formatting preferences, will be inserted into the workbook.
4. Data previously entered and saved in the template file will appear in the inserted template. This preexisting data should be altered from template spreadsheets to reflect the current subject and intervention.
5. Graphing, trendlines, and plot area formatting should automatically adjust to match the new data entered into the template spreadsheet.

INSERTING GRAPHS INTO WORD AND POWERPOINT

Inserting graphs created in Excel into other Microsoft Office 2007 applications (e.g., Word and PowerPoint) allows practitioners to easily share progress with others involved in intervention efforts. Office 2007 provides the practitioner with several options for copying and pasting graphs across applications, including pasting as a chart linked to Excel data, chart linked to the entire workbook, or picture. The following section provides instructions for copying and pasting graphs created in Excel into other Microsoft applications.

1. Open the source (i.e., Excel) and destination documents (e.g., Word, PowerPoint).
2. Right click on the graph to be pasted into the destination document; choose COPY.
3. Toggle over to the destination document, right clicking in the position the graph is to be pasted; choose PASTE.
4. Once the graph has been pasted, an icon will appear in the bottom right corner of the pasted graph. Clicking on the icon allows the practitioner to change the PASTE OPTIONS of the graph to one of the following:

    - *Pasting as an Excel chart (linked to Excel data):* Pasting the graph as a chart (linked to Excel data) allows the practitioner to edit aesthetic options within the destination document. Alterations to data, however, are only possible when the Excel document containing the original data is open on the desktop.
    - *Pasting as an Excel chart (entire workbook):* Pasting the graph as a chart (entire workbook) allows the practitioner to edit data and chart options entirely within destination document. These edits are possible because data entered into Excel are copied and stored within the destination document.
    - *Pasting as a picture:* Pasting the graph as a picture creates a static image imbedded in the destination document. Phase change lines, text boxes, and other aesthetics may need to be edited once pasted. Alterations made to data and graphs must be edited within Excel and then copied and pasted into the destination document. If pasted as a picture in PowerPoint, the graph can also be saved as a picture for later use. Right click on the picture in PowerPoint and choose SAVE AS PICTURE. A box will appear allowing the user to change the LOCATION, FILE NAME, and SAVE AS TYPE (e.g., JPEG, GIF, TIFF).

CONCLUSION

Utilizing computer-based software programs like Microsoft Excel for graphing and visual analysis of student data are convenient and efficient ways for school-based practitioners to monitor instructional and behavioral progress. Once data have been collected, it can be graphed and analyzed in real time allowing practitioners to make more timely programming decisions. These data can also be easily disseminated to parents and other professionals involved by copying and pasting graphic displays into written reports or including them in PowerPoint presentations, always keeping in mind privacy standards set forth by the National Association of School Psychologists (2000) and the American Psychological Association (2002). In addition to the instructions included in this article, there are several online resources available including Microsoft (http://www.microsoft.com/excel) and Intervention Central (http://www.interventioncentral.com). Together with the Excel-specific instructions and online resources provided in this article, practitioners should be adequately prepared to utilize computer-based software programs in their school-based practice.

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