Teaching Graphing Using Enhanced Written Instructions: Does Chunk Size Matter?

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Abstract

Graphing is an important feature of the field of behavior analysis, not only as a job responsibility of behavioral professionals, but as a visual analysis tool as well. While graphing can be taught using various methods, perhaps self-training methods could prove both effective and efficient due to the self-guided nature of the methods. One effective self-training method for graphing is enhanced written instructions (EWI). While the literature has demonstrated EWI's effectiveness when training graphing, specific presentations of EWI have not been evaluated. To address this gap in the literature, we compared the graphing accuracy and duration to graph completion of chunked presentations of EWI, and evaluated preference for the two different chunked presentations, using a nonconcurrent multiple baseline design across five students with various degrees of graphing history. Both chunked presentations were found to be effective, with most participants clearly preferring one presentation over the other.

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Systematic Review of the Graphing Literature

Since the birth of behavior analysis, graphing has been a core feature of our field (Kranak et al., 2019; Tyner & Fienup, 2015). While data ultimately guide research and treatment interventions, a subsequent graphical display allows for easy interpretation of data (Cooper et al., 2007; Deochand et al., 2017; Kubina et al., 2017). Analysis of graphical display is imperative for determining functional relations and understanding behavioral processes (Fahmie & Hanley, 2008). Of particular importance to behavior analysis is the single subject design (SSD; also known as a within-subject design; Namboodiri, 1972) for conducting research, which allows for demonstration of a functional relation between variables within the same participant (i.e., each participant can experience all conditions of an experiment; Perone & Hursh, 2012). Furthermore, creating, maintaining, and analyzing graphical depiction of data are significant job responsibilities of board certified behavior analysts (BCBA) and registered behavior technicians (RBT; Behavior Analyst Certification Board [BACB], 2014; BACB, 2018).

In our early years, the cumulative recorder was the main source of graph creation until technological advances outdated the device (Lattal, 2004). While graphical representation of data has been around since the late 1770s (Costigan-Eaves & Macdonald-Ross, 1990), technological advances within the last 20 years have changed the way graphs are created, such as the continued development of computer applications like Microsoft® Excel (https://www.microsoft.com/en-us/microsoft-365/excel) and the creation of graphing specific programs such as SigmaPlot (https://systatsoftware.com/products/sigmaplot/) and GraphPad Prism (https://www.graphpad.com/scientific-software/prism/) (Dixon et al., 2009; Lo & Starling, 2009; Mitteer et al., 2018), and software applications designed for data collection and graphing within clinical settings, such as Catalyst (https://datafinch.com/aba-data-collection/), Thread (https://www.threadlearning.com/), PrecisionX (https://centralreach.com/precisionx/), Theralytics (https://www.theralytics.net/), ABADesk (https://abadesk.com/#/), Accupoint (https://accupointmed.com/), Total ABA (https://totalaba.com/data-collection-and-reporting/), and NPAWorks (Capterra, 2020).

Perhaps because of this reliance on technology, much of the behavior analytic literature pertaining to accurate creation of graphs consists of task analyses (TAs) and tutorials of necessary steps for creating SSD graphs with Excel (e.g., Barton & Reichow, 2012; Carr & Burkholder, 1998; Dixon et al., 2009; Grehan & Moran, 2005; Lo & Konrad, 2007; Moran & Hirschbine, 2002; Pritchard, 2008; Zasflofsky & Volpe, 2010), to include specific TAs to construct multiple baseline design (MBD) graphs (Hillman & Miller, 2004), generalized matching analyses (Reed, 2009), delay discounting analyses (Reed et al., 2012), functional analysis graphs (Chok, 2019), and phase change lines, scale breaks, trend lines, and labels (Deochand, 2015; Deochand, 2017; Dubuque, 2015; Fuller & Dubuque, 2019), and online interactive tutorials (Vanselow & Bourret, 2012).

However, not all graphs are formatted identically. After reviewing 4,318 graphs from 11 journals with a behavior analytic focus, Kubina et al. (2017) found substantial nonconformity to graphing standards. While Kubina et al. (2017) cited a variety of literature to define components of line graph “essential structure” and “quality features,” the authors specifically questioned whether data-based decisions would differ based on accurate graph creation, and whether scaling dates to the *x*-axis as opposed to sessions would affect interpretation of results (p. 584). However, a variety of additional questions about graphs remain unanswered, including what standards, such as APA guidelines or guidelines for preparation of figures outlined by our flagship journals (like the *Journal of Applied Behavior Analysis* [*JABA*]), should we adhere to not only when creating graphical displays of data but when *teaching* graphing skills? And equally important, how do we most effectively and efficiently teach this skill? While the importance of accurate graphical display is apparent, the most appropriate way to train this skill is not (Kranak et al., 2019).

The purpose of this systematic review was to identify literature within the field of behavior analysis pertaining to teaching graphing, including both training materials and experimental research. Inclusionary criteria consisted of: a) a publication that was either instruction based or an experimental study, b) with content focused on increasing/teaching graphing skills, c) that was behavior analytic in nature, and d) was published in a peer-reviewed journal. Articles and tutorials could focus on any graph design (e.g., reversal, multiple baseline, etc.) and could use any graphing program to teach skills (e.g., Excel, GraphPad Prism, etc.). Articles were excluded from review if the content focused on a) interpretation of graphs, b) analyzing features of previously published graphs, c) was a review of different types of graphs and/or SSD, d) was published in a foreign language, or e) was a reprint.

Method

Figure 1 represents a flow chart of the method used to conduct the systematic review (Tomlinson et al., 2018). In June of 2020, searches of relevant key terms in relevant databases were conducted, including PsycInfo, Eric, Web of Science, and Google Scholar. Searches were not constrained to any particular date range. Within Google Scholar, the terms “behavior analysis” combined with “graphing” and “tutorial” were searched, resulting in 333 hits with 29 articles retained. Within PsycInfo, “behavior analysis” (with a truncated spelling of behavior) combined with a truncated spelling of graph) resulted in 247 hits. Titles were reviewed, resulting in 29 retained from Google Scholar, and 23 retained from PsycInfo. All 23 articles from

PyscInfo overlapped with retained articles from Google Scholar. Next, abstracts were reviewed for inclusionary and exclusionary criteria. Four articles were excluded due to no focus on teaching and/or increasing graphing, for example, a review of graph characteristics. Overall, six articles from Google Scholar did not overlap with PsycInfo for a total of 25 included publications. Again, there were zero articles from PsycInfo that did not overlap with Google Scholar.

Results

Figure 2 displays the overall results of the systematic review. Following low numbers of publications between 1998 and 2006, a substantial increase in the number of publications beginning in 2007 is observed, with an increasing trend continuing throughout the years. Dixon and colleagues (2009) and Lo and Starling (2009), suggested that changing technology establishes a need for updated teaching materials, which may account for the increasing trend of publications in recent years.

However other variables may be at play when the cumulative number of credentialed behavioral professionals and the annual demand for BCBAs is taken into consideration, as in Figure 3. Perhaps one reason for the increasing trend of graphing literature in more recent years is the increase in demand for BCBAs. For example, with the influx of BCBAs and RBTs, comes an increased need for teaching materials.

Overall, the literature included in this review were published in eight different journals. Figure 4 shows the distribution of literature across time and journals. As identified by the date ranges included in the legend, only three out of the eight journals were in existence when the earliest article in this review was published (i.e., Carr & Burkholder, 1998). Just over half of the literature found in this review were published in *JABA* and *The Behavior Analyst Today*.

Another distinction among the literature in this review is distinguishing between teaching materials readers can use as a reference and experimental publications in which an intervention was manipulated to evaluate the effects of that intervention on graphing skills. Perhaps because of a reliance on technology, and variability of that technology discussed earlier, approximately half of publications meeting the inclusionary criteria provide materials to teach accurate graphing, whereas the rest comprise experimental evaluations of methods for teaching graphing. As shown in Figure 5, 14 of the publications were solely teaching materials and 11 publications were experimental. Many of the experimental studies publish the teaching materials within the same article or, more recently, as supplemental materials. Of note, publication of teaching materials predates experimental evaluation of teaching methods by nearly a decade. Additionally, both have shown similar patterns of growth over time.

Published teaching materials cover a wide range of topics, to include materials on constructing multiple baseline design (MBD) graphs (Hillman & Miller, 2004), generalized matching analyses (Reed, 2009), functional analysis graphs (Chok, 2019), phase change lines, scale breaks, trend lines, and labels (Deochand, 2015; Deochand, 2017; Dubuque, 2015; Fuller & Dubuque, 2019), and online interactive tutorials (Vanselow & Bourret, 2012).

One example of published teaching material is Carr and Burkholder's (1998) foundational task analysis (TA) for creating SSD line graphs in Excel, specifically graphs representing reversal, alternating treatments, and multiple baseline designs. The authors recognized that some standards of a publishable graph (particularly those published in *JABA*) were hard to achieve, for example, determining where the x-axis should cross the y-axis), therefore the TA was meant to assist those considered less fluent in Excel to create publication quality graphs.

While influential, Carr and Burkholder's (1998) TA quickly became outdated due to software updates within Excel (Dixon et al., 2009; Lo & Starling, 2009). To demonstrate the need for updated TA's, Dixon et al. (2009) compared Carr and Burkholder's (1998) TA to a new one, while also evaluating the efficacy of the newer TAs. Using a between-subjects design, participants either used Carr and Burkholder's (1998) TA or an updated TA, which reflected changes in Excel resulting from a software update in 2007, to create a series of graphs (i.e., a reversal, multielement, and multiple baseline design; Dixon et al., 2009). While participants were of various demographic backgrounds and had differing levels of experience creating SSD graphs in Excel, the groups were comparable regarding several variables, such as age, gender, self-reported rating of experience with Excel, and the number of reversal graphs created prior to the study. There were, however, significant differences in performance between the two groups; Group 1 (i.e., the group that used the updated TA) completed the entire series of graphs faster than Group 2 (i.e., the group that used Carr and Burkholder's [1998] TA), with Group 1 taking significant less time to complete the reversal and multielement design graphs and producing graphs with higher accuracy when compared to Group 2. While Group 1 completed MBD graphs in less time than Group 2 and produced higher accuracy, results were not significant. Results suggested a need for updated TAs to accommodate everchanging Excel software.

In response to Dixon et al. (2009), Lo and Starling (2009) empirically validated a detailed TA that addressed "graphing 'gaps'" of that used in Dixon et al. (2009) by implementing a multiple probe across participants design to analyze the effects of the TA on the graphing skills of three graduate students. For two of the participants, a functional relationship was observed between the graphing skills and the use of the TA (i.e., the number of correct graphing components increased following the use of a detailed TA; Lo & Starling, 2009). Overall, results of Dixon et al. (2009) and Lo and Starling (2009) demonstrate the necessity of updating TAs following software updates.

Figure 6 displays the cumulative number of publications using various graphing programs, as that is another component of the literature that varied. A substantial number of publications using Excel to teach graphing skills compared to other programs (i.e., GraphPad Prism, Microsoft Word, Microsoft PowerPoint, and Logis) was observed, which aligns with Haddock and Iwata's (as cited in Kranak et al., 2019) finding that 91% of surveyed behavior analysts used Excel in some way to display results of single subject designs, making it the most common graph-making application used by behavior analysts.

With that being said, while not as abundant as Excel other graphing programs have been used, both in teaching material publications such as Grehan and Moran's description of how to create single-subject reversal design graphs within Microsoft Word in 2005, and experimental publications such as Mitteer et al. (2018).

Specifically, Mitteer et al. (2018) utilized GraphPad Prism. Prior to Mitteer et al., there were no published tutorials targeting Prism to create publication-quality graphs. Therefore, Mitteer et al. analyzed the effects of video modeling (VM) on the graphing skills (i.e., graphing accuracy and latency to graph completion) of four undergraduate students who were either RBTs or training to become RBTs, using a concurrent MBD across participants design. Following baseline, which consisted of creating a graph with only brief written instructions (i.e., instructions stating to use the presented data table to create a graph), participants were provided a VM to follow along with while they created their graph (Mitteer et al., 2018). Immediately following the implementation of VM, Mitteer et al. (2018) observed mastery-level accuracy. Furthermore, reviewers (i.e., Ph.D.-level faculty members who reviewed the graphs created during sessions for formatting errors that would need to be edited before hypothetical publication) who had once served on the *JABA* Board of Editors reported not only fewer graphing errors during the VM condition than in the baseline condition, but fewer edits than were necessary for selected graphs that were published in the Winter 2014 issue of *JABA* (Mitteer et al., 2018).

Limitations of Mitteer et al. (2018) were addressed by Mitteer et al. (2019). The first limitation noted was not teaching data entry, which Mitteer et al. (2019) addressed by teaching participants how to enter data - a behavior that must be completed before creating a graph (i.e., Mitteer et al. [2018] provided pre-entered data tables). A second limitation was that Mitteer et al. (2018) provided a printout of a model graph for participants as a reference throughout sessions (Mitteer et al., 2019). While the model graph did not increase graphing accuracy to the point of mastery, the participants might have simply copied some graphing elements (e.g., axes ranges, when and where to include a phase change line) instead of acquiring the ability to determine those elements on their own (Mitteer et al., 2019). A third limitation was that training materials were available during maintenance sessions (Mitteer et al., 2019). Thus, Mitteer and colleagues (2019) never provided model graphs and did not provide training materials during maintenance sessions. Graphing accuracy was mastered more quickly in Mitteer et al. (2019) compared to Mitteer et al. (2018) but is unclear which manipulation(s) led to the change. The independent effects of these manipulations were not assessed, which suggests future research analyzing the specific components responsible for efficient acquisition and maintenance of graphing would be useful.

As the previous examples show, a variety of graphing programs can be used to create graphs. Furthermore, the programs themselves can vary across platforms and operating systems.

As can be seen in Figure 7, analysis of which operating system teaching materials were created for (i.e., whether they were created as stand-alone teaching materials or materials used within an experiment) shows that the majority of publications included teaching materials created for PC's, while no publications included teaching materials created solely for a Mac® (https://www.apple.com/mac/). Eight publications included teaching materials for both PCs and four publications did not specify an operating system. Also displayed in Figure 7, are years in which updates to Microsoft Office for PC and Mac operating systems occurred. It is interesting to note when these updates occurred in relation to publications, however it is unclear what impact updates have on the literature.

An example of a publication outlining instructions for both PCs and Macs is Barton and Reichow's (2012) tutorial on creating graphs within Word and PowerPoint, whereas Lo and Konrad (2007) provides an example of an experimental publication using only a PC operating system. In fact, Lo and Konrad specifically stated they did not test the effectiveness of TA on a Mac system, thus justifying the need for universal instructions. Results of Lo and Konrad's study examining the effects of a TA on MBD graph creation, indicated that participants produced an average of at least 6 steps completed correctly on their graphs following implementation of the TA. The authors stated these results were promising as participants reported a lack of knowledge of graphing within Excel and the graphing components required were considered complex.

However, while updating TAs as Excel updates software is necessary to increase graphing capabilities (Dixon et al., 2009; Lo & Starling, 2009), further manipulations to the TAs could enhance graphing capabilities even further (Berkman et al., 2019; Kranak et al., 2019; Lo & Starling, 2009; Mitteer et al., 2018; Tyner & Fienup, 2015; Tyner & Fienup, 2016). VM (Tyner & Fienup, 2015), supplemented TAs (Tyner & Fienup, 2016), behavioral skills training

(BST; Kranak et al., 2019), enhanced written instructions (EWI; Berkman et al., 2019), and video modeling with voiceover (VMVO; Berkman et al., 2019) have all been used to increase the effectiveness of instruction for graphing skills as seen in Figure 8, which depicts the distribution of teaching materials and methods across years. The majority of publications used some form of task analysis as teaching materials, with one example of programmed instruction occurring nearly a decade ago. More recently, video modeling has been used twice. BST, VMVO, and EWI have all recently been examined once as evidenced by the overlapping data paths from 2018-2019 in Figure 8.

Tyner and Fienup (2015) used a between-subjects design to analyze the effects of VM on graphing accuracy and "duration to graph completion" compared to text-based instructions with pictures and no instruction (i.e., a control group; p. 702). Randomly assigned to groups, participants created MBD graphs using instructions corresponding to the condition they were assigned (i.e., VM, text-based, or no instructions). While there were no statistical differences between the groups regarding skills and experience (i.e., completed courses, computer skills, use of Excel, and number of graphs made prior to the experiment), there were statistical differences between groups in terms of graphing accuracy; participants using VM accurately completed more graphing steps and took less time to complete the graph than those using text-based or no instructions. Also of note, while not statistically significant, participants in the text-based instructions group created more accurate graphs than the no instructions group, however there was no difference in duration to completion. Graphing accuracy and duration to completion data in the VM condition were more stable, suggesting VM might result in more "predictable behavior change" in comparison to text-based and no instructions (Tyner & Fienup, 2015, p. 704).

To address the aforementioned limitations, Mitteer et al. (2019) implemented a concurrent multiple-probe-across-behavior design to determine the effects of VM on not only graphing, but data input as well. In baseline, participants were introduced to the three conditions (i.e., data input, graphing, and data input plus graphing) in a quasi-random order, encountering each condition one time (Mitteer et al., 2019). Following baseline, participants were introduced to the data input VM condition (as data input occurs before graphing in the natural environment, regardless of who inputs data) while graphing and data-entry plus graphing were probed following mastery in the previous condition (i.e., mastery in the data input condition resulted in a baseline probe in the graphing condition and then introduction of VM for graphing and data input plus graphing was probed following mastery of graphing in the graphing VM condition; Mitteer et al., 2019). Data input VM and graphing VM resulted in mastery-level responding in the respective conditions, and once participants were exposed to both VM conditions, responding in the data input plus graphing condition increased to mastery-levels (i.e., a separate video was not needed for the data input plus graphing condition, skills transferred from the other conditions; Mitteer et al., 2019).

In an attempt to evaluate substitutes for TAs (i.e., a mode of instruction other than written), Kranak et al. (2019) evaluated the effects of BST on the graphing skills (i.e., the percentage of accurately formatted graph elements and session duration) of three graduate students, two of whom were first year graduate students in a master's program in special education/applied behavior analysis and one of which was a third year doctoral student in a school psychology program. Using a multiple probe design across behaviors and following a baseline condition consisting of creating a graph from a data set (i.e., the only instruction provided was to make a SSD graph), the lead researcher implemented BST by sitting next to the participant and providing vocal instructions on how to complete each graphing element, as well as modeling correct behavior, while the researcher created a graph (Kranak et al., 2019). When the researcher had completed the graph, the participant then created a graph, receiving specific vocal-verbal feedback upon correct completion of a step, and corrective feedback in the form of prompting (i.e., a prompt hierarchy of verbal, gestural, and physical prompts) for steps completed incorrectly. After the BST session, the following sessions were identical to baseline (i.e., the participants were provided a data set and told to create a graph) with one participant requiring a feedback session following their eighth session to address an issue with the *x*-axis of her permanent product (Kranak et al., 2019). Mean percent correct across participants ranged from 0% to 53% across all graph types (i.e., reversal, alternating treatments, and MBD), increased to 100% during the BST condition, and maintained at 100% during maintenance sessions, suggesting BST was an effective intervention to increase graphing accuracy (Kranak et al., 2019). Average session duration decreased throughout BST sessions and maintenance sessions, suggesting BST resulted in more efficient graphing (i.e., it took less time to create an accurate graph; Kranak et al., 2019).

Berkman et al. (2019) compared the effects of EWI and VMVO on the creation of graphs within GraphPad Prism. One of the training procedures used by Berkman et al. (2019) was VM (however, voiceover was added), with the addition of the use of EWI in a separate condition. Participants consisted of 11 teachers who were either enrolled in or had graduated from an applied behavior analysis graduate program or a related field (Berkman et al., 2019). To analyze the effects of EWI and VMVO on graphing accuracy and duration to completion, Berkman et al. (2019) implemented an MBD design across behaviors (i.e., two different tasks split into chunks) for each participant. EWI and VMVO were alternately presented over sessions and task chunks, with the chance to choose which training procedure to use at the conclusion of each tier of the MBD (Berkman et al., 2019). Overall, both EWI and VMVO were effective training procedures (i.e., graphing performance improved) with slightly higher accuracy and decreased durations to completions observed in the VMVO conditions.

Participants were another variable that differed across publications as can be seen in Figure 9. Analysis of participant demographics was important as it will guide generalization of teaching materials across populations while also exposing underrepresented populations. The majority of experimental publications used participants categorized as students, both undergraduate and graduate. Three publications included post-bac students as participants, two included RBTs as participants, and one publication included a doctoral-level faculty member.

Besides participants, another aspect of the methods used in the graphing literature important to analyze are the experimental designs used to study graphing skills. As shown in Figure 10, designs varied somewhat across experimental publications, with six studies using an SSD (specifically multiple baseline, multiple probe, and an AB design), and five studies employing between-subjects designs, which relied on statistical comparisons to analyze results. Of note, use of between-subject designs to evaluate graphing acquisition preceded SSD, however, of late, use of SSDs is increasing.

Dependent variables within the literature were also analyzed to determine how the researchers are defining and assessing the acquisition of graphing skills (see Figure 11). Within the experimental publications, dependent variables were relatively consistent across studies, as evidenced in previous examples. The majority of experimental publications used graphing accuracy as a dependent variable, with some aspect of time measurement regarding graph completion as a secondary dependent variable. Specifically, two studies (Mitteer et al. [2018]

and Mitteer et al. [2019]) reported latency to completion identically to how all others reported graphing duration.

Discussion

This systematic review of the behavior analysis literature pertaining to teaching graphing contributes to the field by: (a) documenting important trends across publications and years, (b) summarizing and synthesizing published teaching materials and experimental studies on teaching graphing, and (c) suggesting future directions of research (as described below). One major finding resulting from the review included the recent increasing trend in the publication of studies on teaching graphing. Other important results include the observation that graphing is successfully taught using a variety of procedures across both Excel on a PC, and that, to date, emphasis has been placed on teaching publication-quality graphs to individuals within academia.

Next steps for the systematic review include further analysis and discussion of variables within the graphing literature, including the types of graphs taught within experimental publications (see Figure 12), how the number of necessary steps in teaching materials compare not only across publications, but within the TA itself, quantifying outcomes (see Figure 13), and, finally, assessment of social validity, generalization, and maintenance (e.g., while social validity measures were assessed in eight of the eleven experimental publications, generalization was not explicitly assessed in any of the studies, and maintenance was only assessed in three studies; see Figure 14 of which the asterisk denotes that generalization was not explicitly assessed, but was arguably incorporated into the experimental design). Additionally, limitations of the review must be addressed including the fact that additional analyses are necessary (as described above), and that not all search engines were searched and intercoder agreement was not assessed (both of which will be completed soon).

Overall, the results of this review can guide future directions of research in the area of increasing graphing skills. For example, the discrepancy between operating system and graphing program usage demonstrates the need for universal teaching materials across operating systems, as well as creating teaching materials for the less targeted graphing programs, such as Prism and SigmaPlot. Furthermore, the majority of teaching materials have been text-based instructions of some form. While further analysis of these methods is warranted, some focus could shift to materials beyond text-based instructions such as online tutorials, BST, and VM. Additionally, delineating different approaches to graph creation is warranted (e.g., graphical display and analysis for research and publication purposes versus graphical display and analysis in a clinical setting). As all graphing methods studied were effective, emphasis can also be placed on efficiency and preference moving forward. Regardless of where future directions of research takes us, efficiently and effectively teaching graphing skills is an important responsibility of our field.

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*Indicates studies included in the systematic review (*n* = 25)

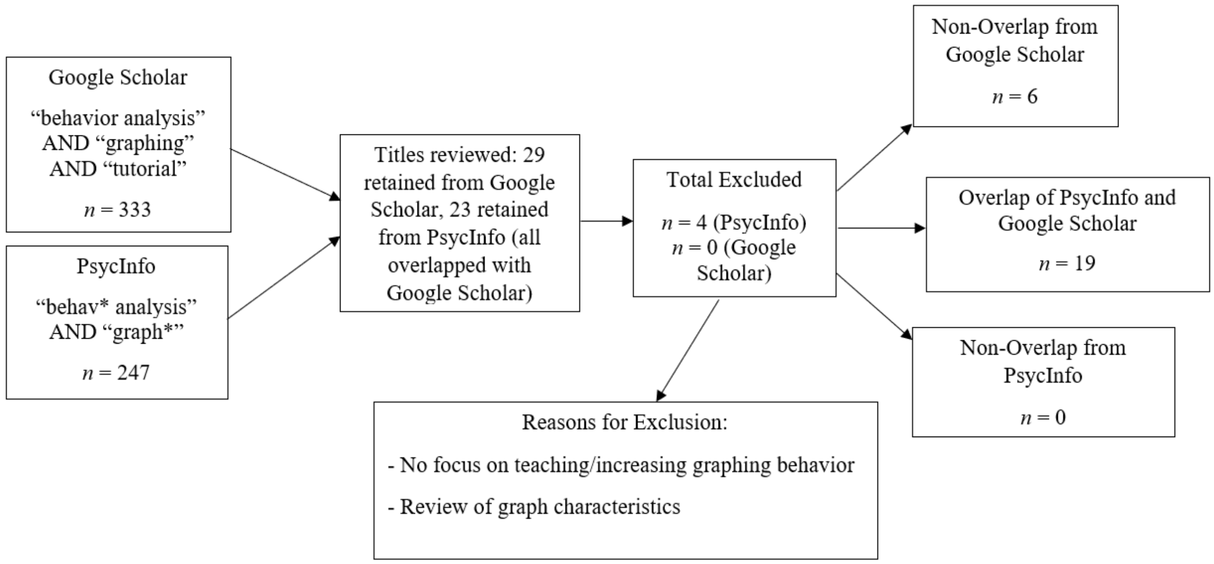

Figure 1. A flow chart depicting the method for the systematic review.

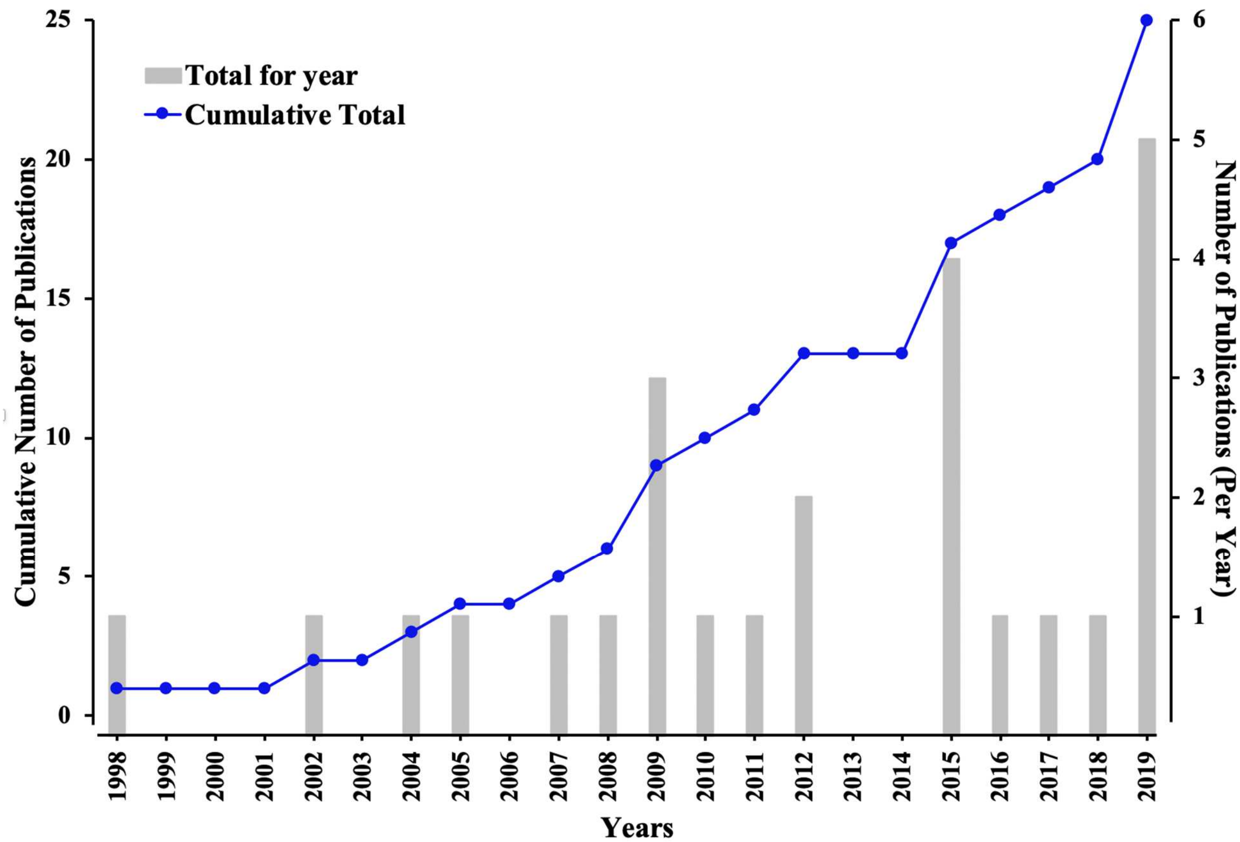

Figure 2. The overall cumulative number of graphing publications and the number of graphing publications across consecutive years.

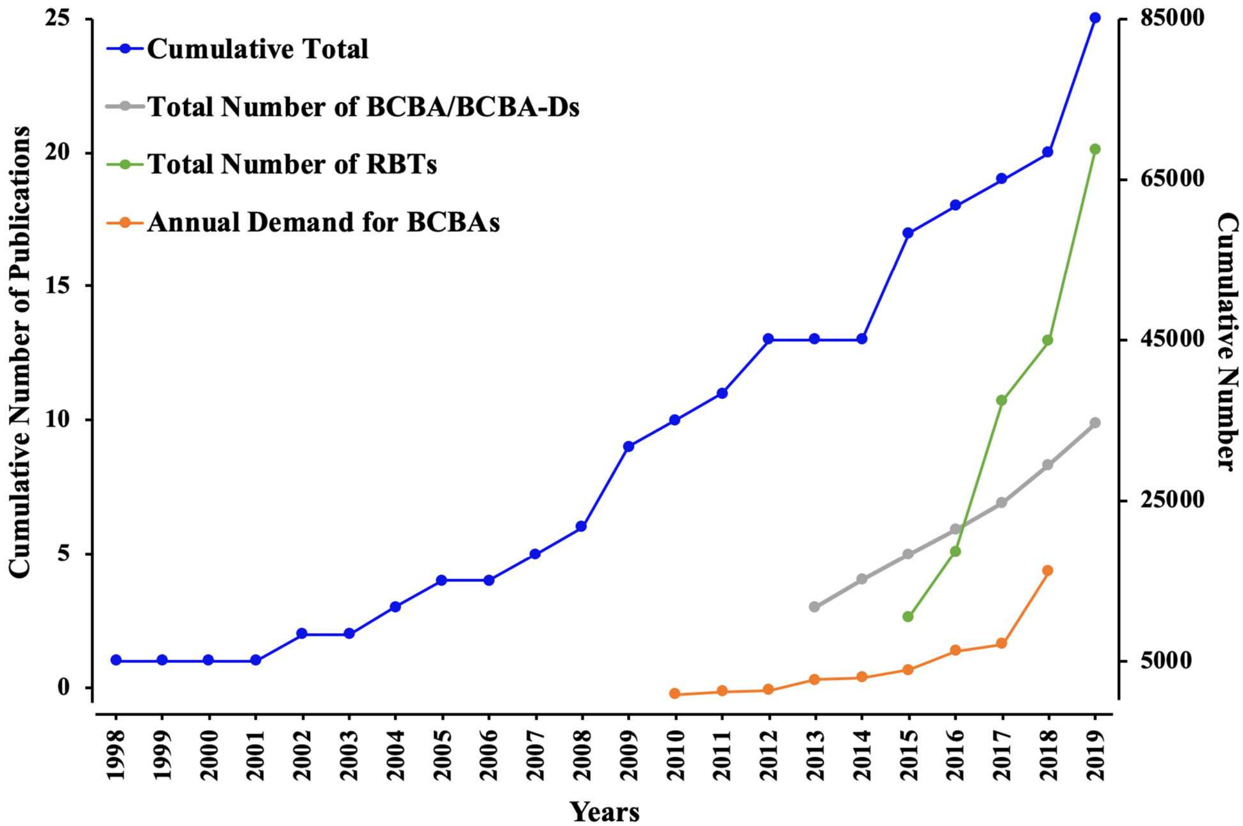

Figure 3. The cumulative number of publications in relation to the total number of behavioral professionals and the annual demand for BCBAs across consecutive years.

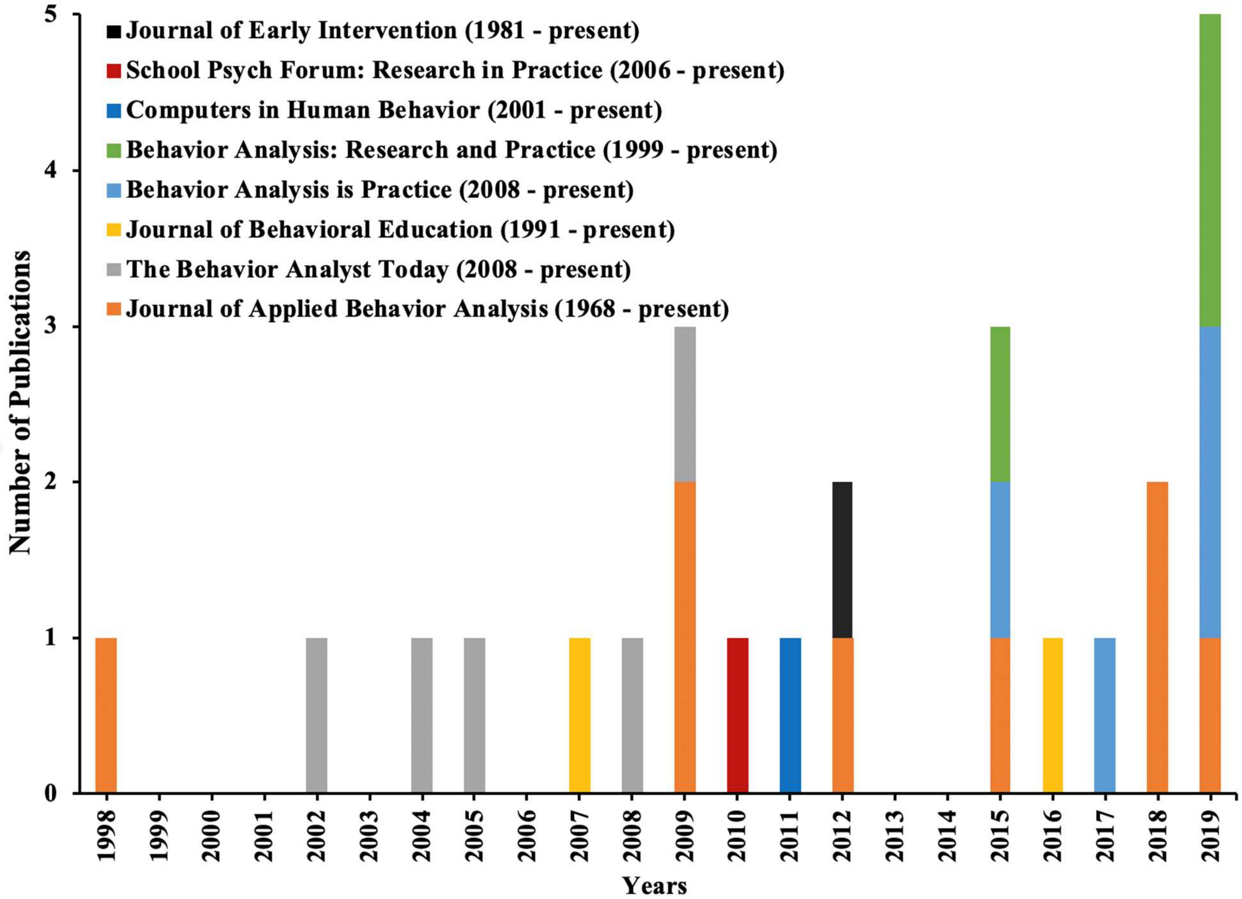

Figure 4. The number of graphing publications per journal across consecutive years.

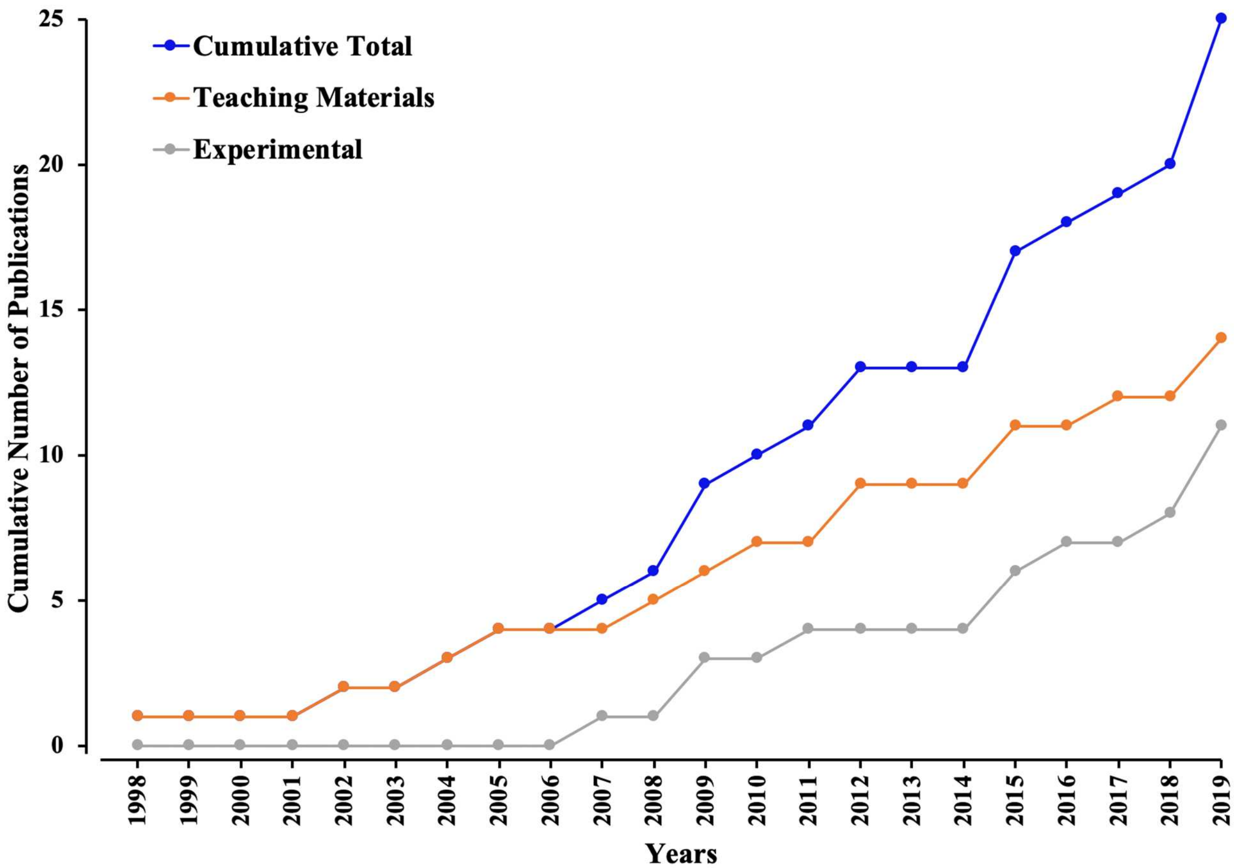

Figure 5. The number of teaching material publications and experimental publications in relation to the overall cumulative number of graphing publications across consecutive years.

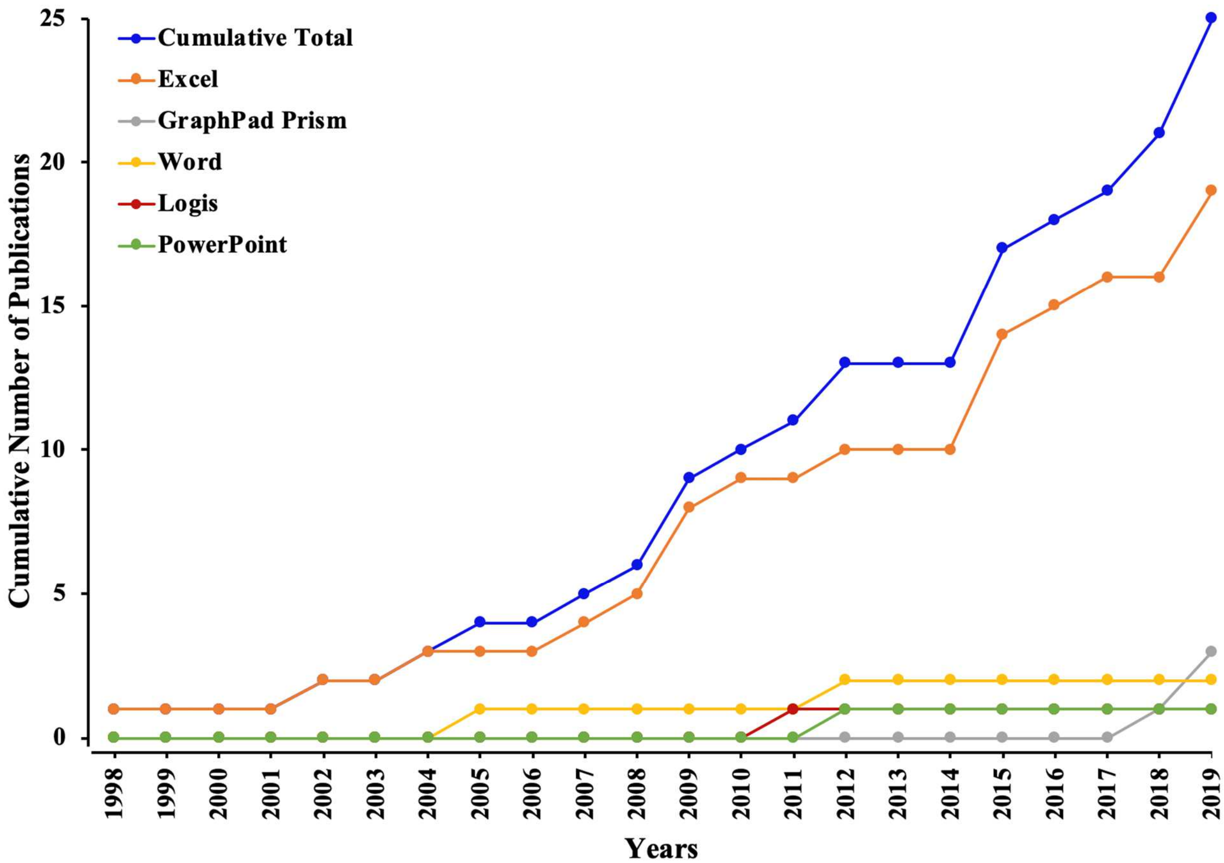

Figure 6. The cumulative number of publications specifying the use of different graphing programs to create teaching materials, both in technical publications and experimental publications, across consecutive years.

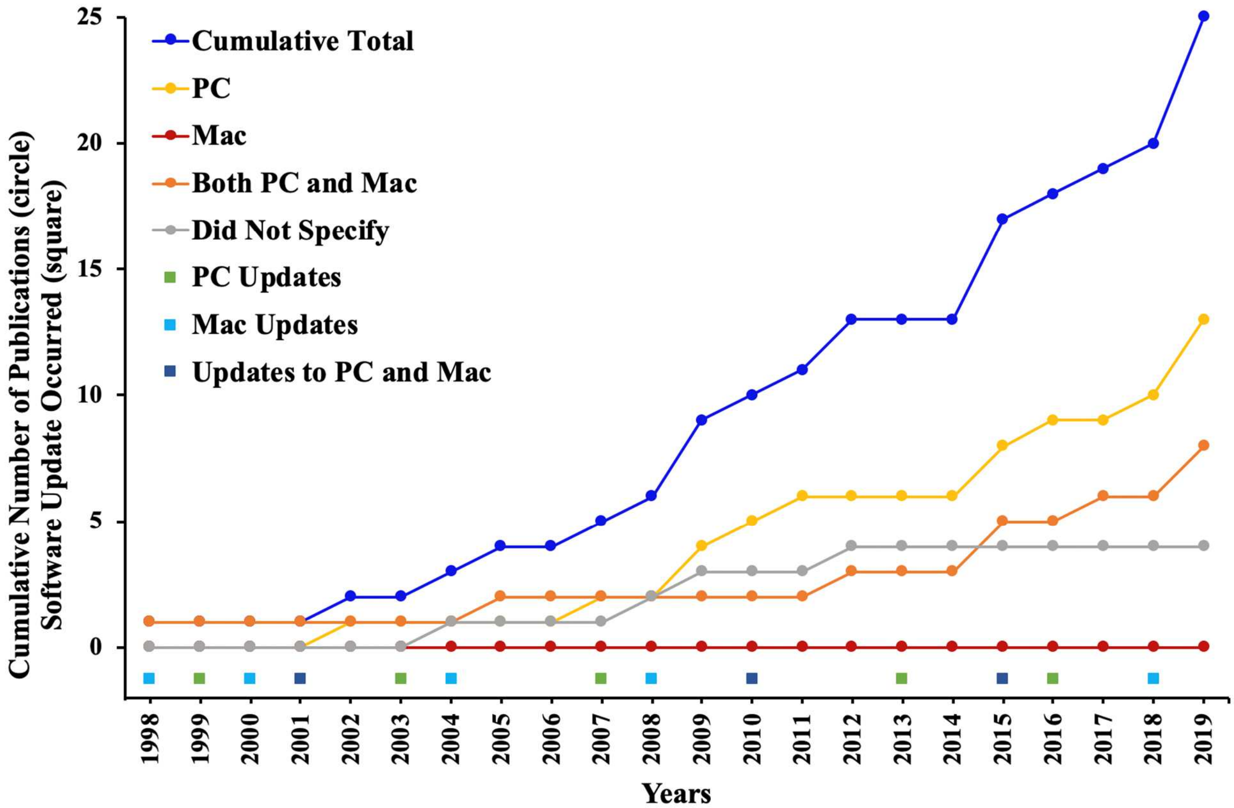

Figure 7. The cumulative number of publications specifying the use of different operating systems when creating teaching materials, for both technical publications and experimental publications, across consecutive years.

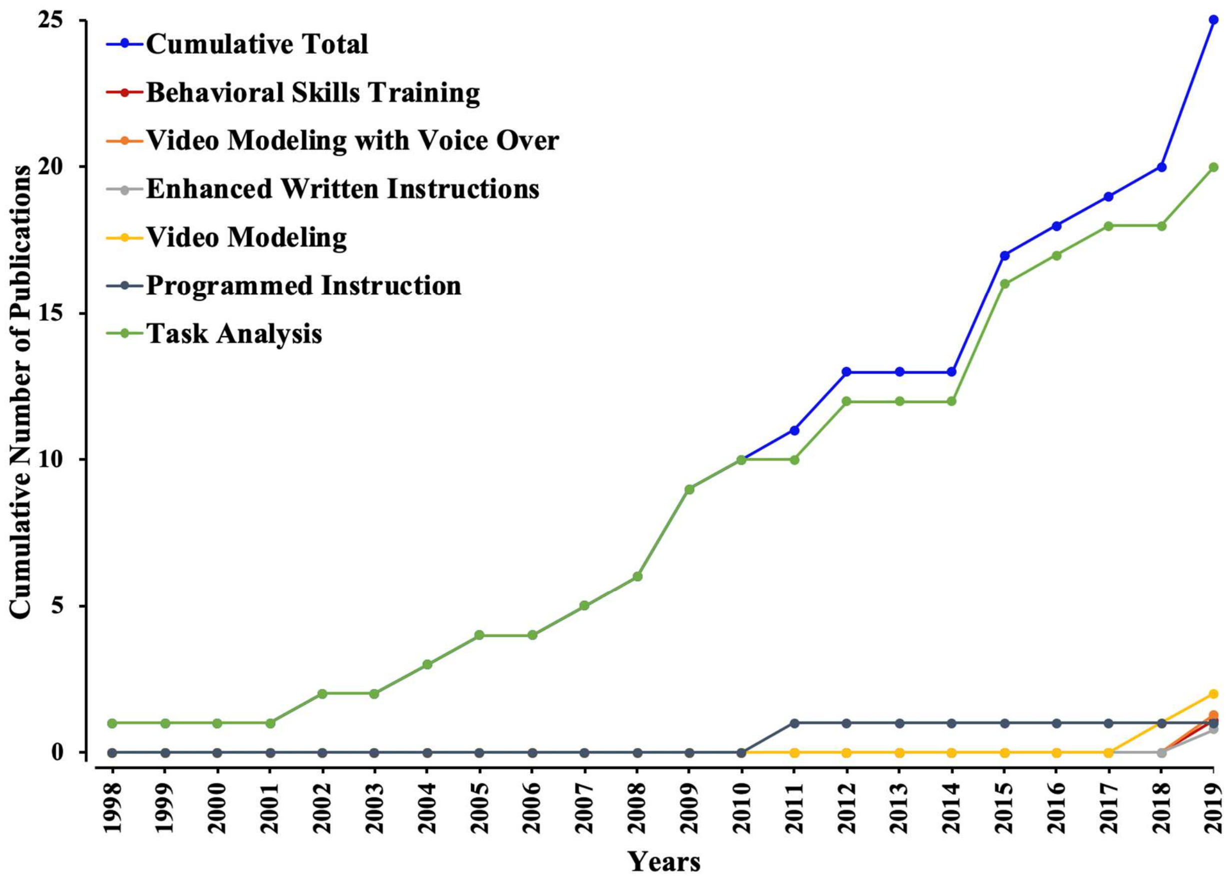

Figure 8. The cumulative number of publications with studies specifying the use of different interventions to teach graphing skills across consecutive years.

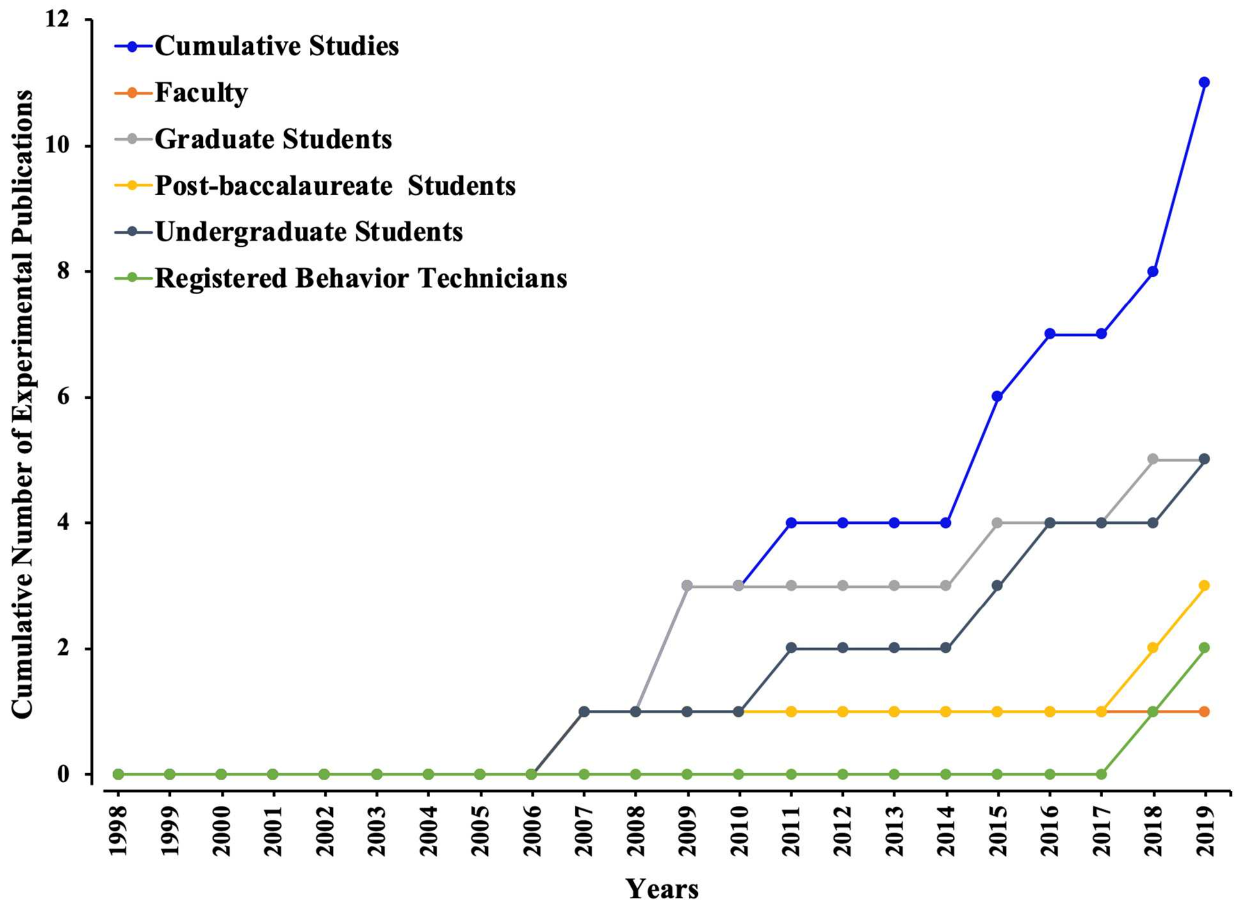

Figure 9. The cumulative number of publications with studies denoting specific participant demographics across consecutive years.

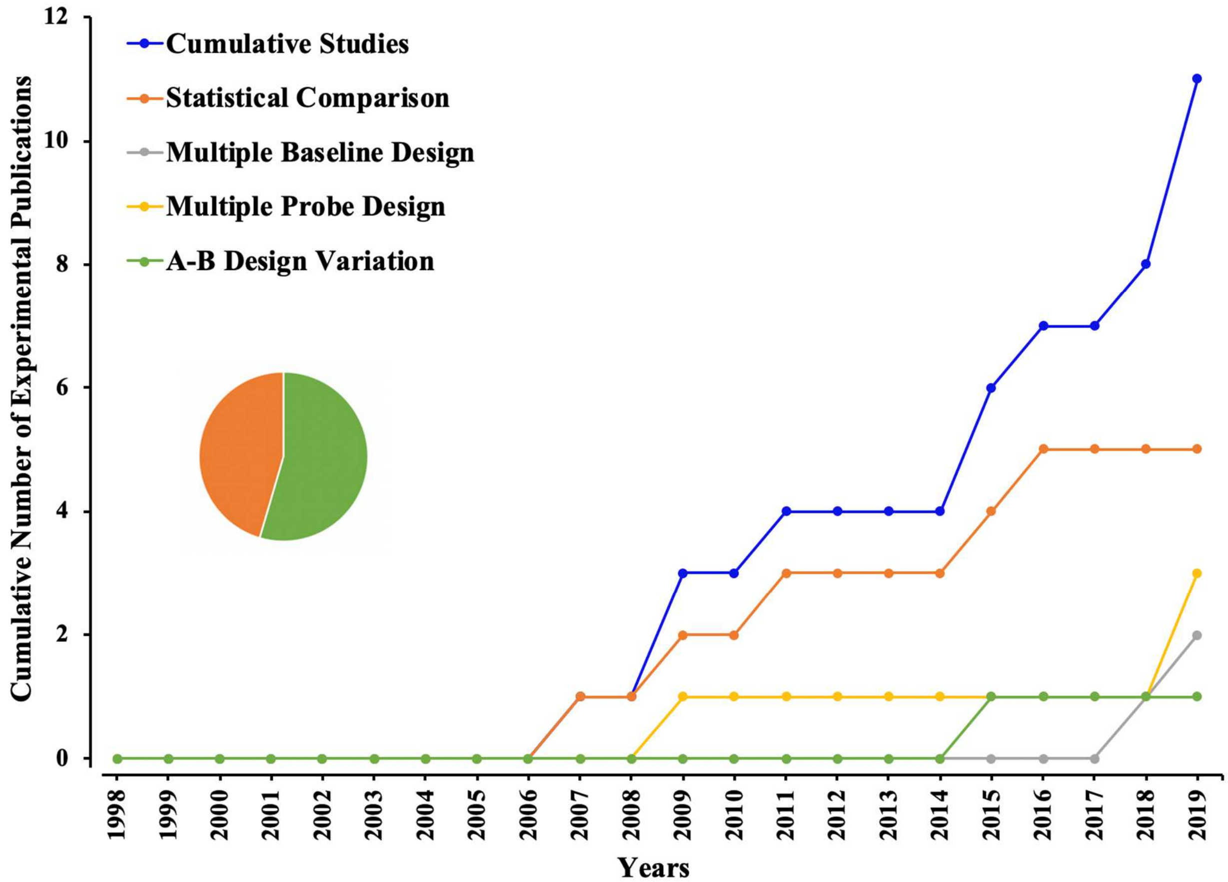

Figure 10. The cumulative number of publications with studies utilizing various experimental designs across consecutive years. The pie chart displays the distribution of the number of publications using a between-groups (orange area) versus within-subject (green area) design.

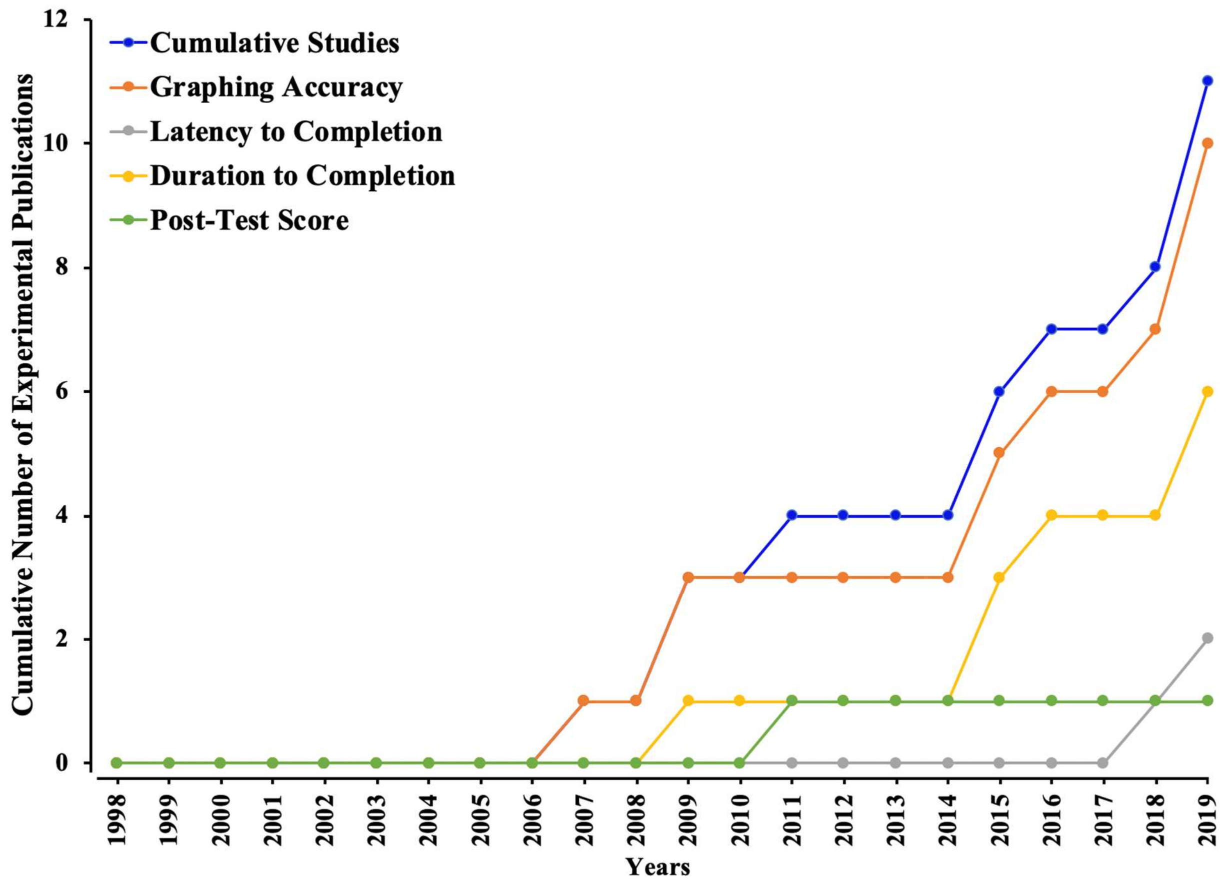

Figure 11. The cumulative number of experimental publications with studies specifying different dependent variables across consecutive years.

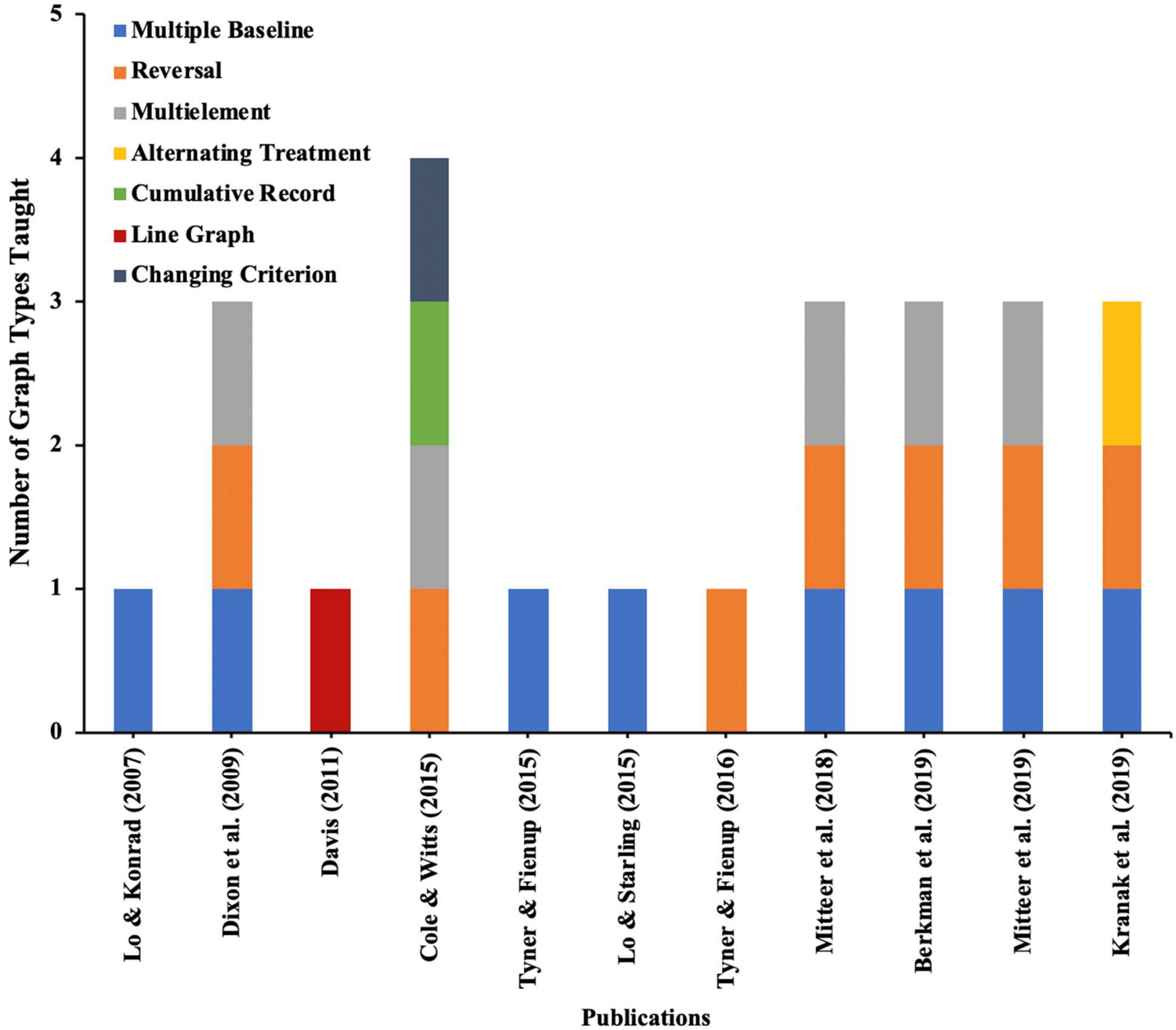

Figure 12. The types of graphs taught within publications.

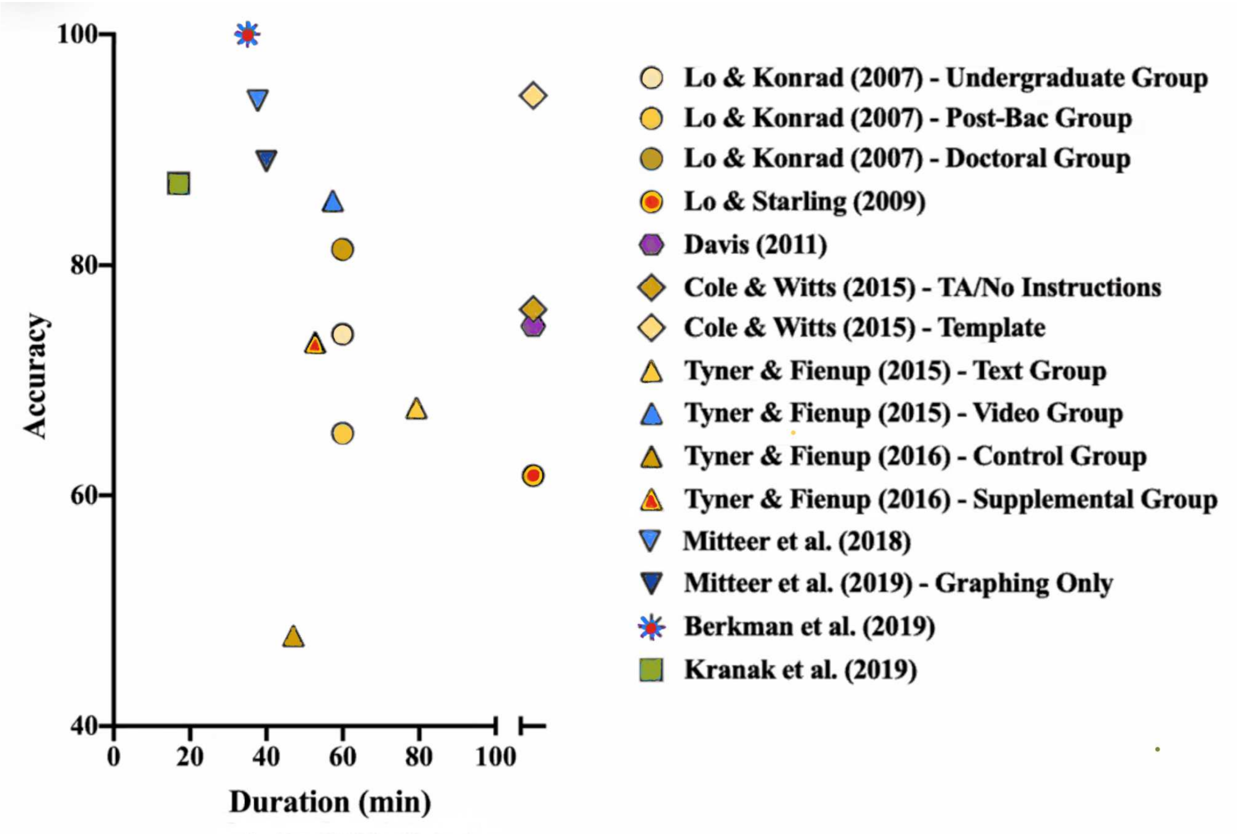

Figure 13. The overall efficiency of interventions across experimental publications. Yellow data points denote text-based instructions, red data points denote EWI/supplemented instructions, blue data points denote video modeling, green data points denote BST, and purple data points denote Logis.

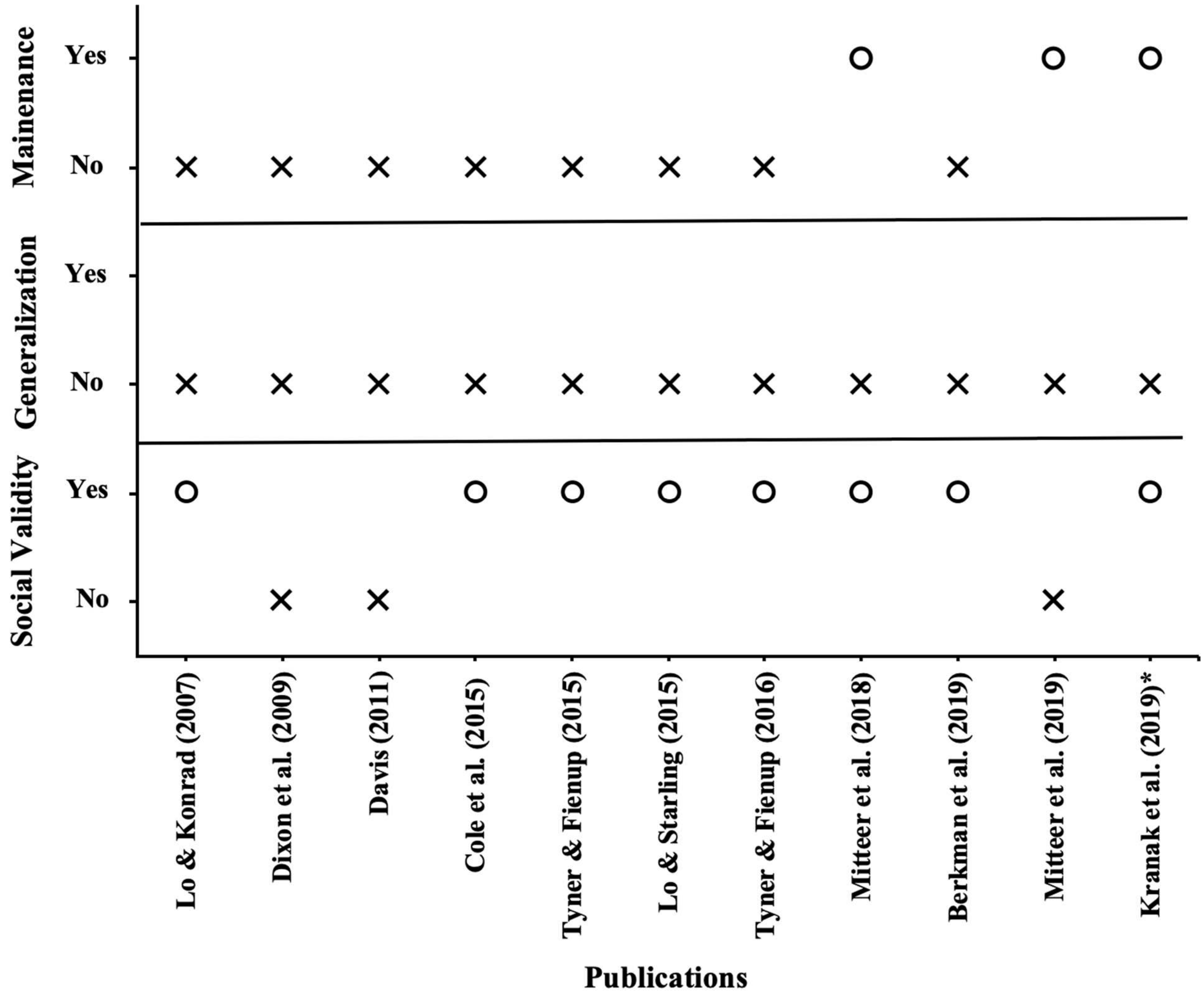

Figure 14. The inclusion or exclusion of maintenance, generalization, and social validity measures within studies.

Teaching graphing using enhanced written instructions: Does chunk size matter?

While it is evident that graphing skills can be taught using a variety of teaching methods (Berkman et al., 2019; Davis, 2011; Dixon et al., 2009; Kranak et al., 2019; Lo & Starling, 2009; Tyner & Fienup, 2015), how to teach graphing skills efficiently and in a manner participants prefer has yet to be determined. Research in the area of organizational behavior management suggests that increasing trainees' preference for job tasks might increase the trainees' work life satisfaction (Green et al., 2008; Reed et al., 2012). Furthermore, as graphing is a significant job responsibility of RBTs, efficient, self-directed training of the skill would not only be beneficial to supervisors, it could be timesaving and possibly cost effective (Berkman et al., 2019; Shapiro & Kazemi, 2017).

Shapiro and Kazemi (2017) defined self-directed training packages as antecedent strategies that do not require the presence of a trainer fluent with the target task. Ultimately, the absence of a trainer provides for more efficient training. Examples of self-instructed training methods include VM and text-based instructions (Shapiro & Kazemi, 2017). Some advantages of self-instructed training methods include multiple individuals can be trained at the same time (i.e., the trainer does not have to focus time on each individual), training curriculum is standardized (i.e., everyone gets the same training), and individuals can work through the training at their own pace (Shapiro & Kazemi, 2017).

Another type of self-instructed training method is Computer-Based Instruction (CBI), similar to programmed instruction (Davis, 2011; Shapiro & Kazemi, 2017). Benefits of CBI are similar to those of other self-instructed training methods (i.e., multiple individuals targeted at once, self-paced, saves instructor time), with the additional benefit that individuals can only move on to the next step of the training after they reach mastery criteria of the previous step

(Shapiro & Kazemi, 2017). One drawback to CBI is that because it requires effective programming, knowledge of how to program the training within the computer program itself is necessary (Shapiro & Kazemi, 2017).

As previously mentioned, text-based instructions, are another example of a self-instructed training method, to include TAs. While previous research deemed TAs effective at increasing graphing accuracy (Dixon et al., 2009; Lo & Starling, 2009; Tyner & Fienup, 2015), Tyner and Fienup (2016) sought to determine what aspects of a TA are responsible for that effectiveness, evaluating how to make the most effective TA to teach graphing. Specifically, the authors compared a control TA that stated necessary steps to a supplemented TA that also included important antecedent stimuli, performance criteria, and the consequences of accurate completion of the step. Participants, who were undergraduate students enrolled in a Psychology course, were first randomly assigned to an experimental group and were then asked to create an MBD graph using Microsoft Excel 2007 (i.e., one group received the control TA and one group received the supplemented TA; Tyner & Fienup, 2016). There were no statistically significant differences between the groups regarding courses taken or computer, graphing, and Excel capabilities/experience. Dependent variables analyzed by Tyner and Fienup included graphing accuracy (i.e., correctly formatted graphing elements) and duration (i.e., the amount of time it took from when the participant began the graph to notifying the experimenter they were done). Six out of the eight participants assigned to the supplemental TA group scored higher than the most accurate performer in the control TA, and participants receiving the supplemented TA completed a significantly higher percentage of graph elements accurately than participants utilizing the control TA (Tyner & Fienup, 2016). High variability in graphing duration was observed within and between groups, however Tyner and Fienup reported a statistically significant positive correlation between amount of time spent on the task and the percentage of correctly completed steps for the supplemental TA group. Of note, there was a similar correlation for the control TA group, however it was not statistically significant. Interestingly, although the supplemented TA consisted of more text, participants in that group did not take a significantly longer amount of time to complete their graphs (Tyner & Fienup, 2016). Tyner and Fienup (2016) suggested that the supplemented TA might have exerted greater instructional control and that the inclusion of performance criteria might have resulted in participants self-correcting errors.

Similar to supplemented TAs are EWI. According to Graff and Karsten (2012), EWI are materials that include “pictures and diagrams, step-by-step examples, and minimal technical jargon” (p. 81). Specifically, the authors analyzed the effects of EWI as a self-instructed training package (i.e., the package was antecedent only) for two methods of preference assessments. Overall, when inexperienced staff used basic written instructions, accurate implementation of preference assessments was low, however when supplied with EWI, the same staff accurately implemented preference assessments. The authors discussed that EWI could be used to teach a wide variety of behavior analytic procedures to inexperienced learners (i.e., EWI could be used as a tool to disseminate behavior analytic principles and technologies), which would make it a suitable method to teach graphing skills. However, it is important to mention the categorization of written teaching materials, as there is some distinction in the literature between the terms “task analysis” and “enhanced written instructions” (Berkman et al., 2019; Dixon et al., 2009). Examples of the different methods can look very different such as Dixon et al.’s self-proclaimed TA, which consisted solely of words and Berkman and colleagues’ EWI, which included figures.

However, they can also look very similar, such as Lo and Starling's (2009) TA, which included figures, compared again with Berkman et al.'s EWI.

While EWI are an effective training procedure (Graff & Karsten, 2012), the instructions can get quite lengthy when addressing complex behaviors. Therefore, it might be necessary to chunk (or combine) the steps into larger units such that there are fewer steps overall (Haring & Kennedy, 1988). Haring and Kennedy (1988) stated "chunking steps is a feasible [and pedagogically sound] alternative when the steps to be combined are topographically and functionally related" (p. 212). For example, if teaching toothbrushing, the steps "get toothpaste" and "take off toothpaste lid" could be combined (i.e., chunked) to state "get toothpaste and take off the lid" as both steps are part of the response of picking up the toothpaste.

According to Miller (1956), a chunk is a "familiar unit" with chunking consisting of combining multiple items to make a larger item (p. 93). Miller (1956) further explained that "bits" of information are the sub-items of which chunks are comprised (p. 93). To illustrate the use of chunking, Miller (1956) highlighted an analogy of an individual learning radio-telegraphic code; each specific noise emitted from the telegraph would be a separate chunk. Miller (1956) argued that one's memory span is a set number of chunks, therefore the number of bits of information that comprises a chunk can be increased to form larger chunks. Therefore, the noises coming from the telegraph would soon be organized into letters (i.e., larger chunks), then the letters would be organized into words (i.e., even larger chunks), and then the words are organized into phrases (also known as recoding; Miller, 1956). While Miller (1956) suggested that individuals can remember approximately seven chunks in short-term memory, others have suggested four to five chunks are more appropriate (however, it should be noted that these chunks likely consist of very few sub-items such as word pairings; Chen & Cowan, 2005;

Cowan, 2000). However, others argue that it might not only be the number of chunks, but the amount of material needed to recall within the chunks (Chen & Cowan, 2005).

Perhaps illustrating Graff and Karsten's (2012) earlier point that EWI could be used as a way to disseminate behavior analytic technologies, Berkman et al. (2019) sought to compare the effects of EWI (i.e., VMVO and EWI) on the creation of graphs within GraphPad Prism. As previously discussed, while both EWI and VMVO were considered effective, the authors observed slightly higher accuracy and decreased duration to completion in the VMVO conditions. Important, however, was that participants were more likely to choose EWI to complete graphs (Berkman et al., 2019). Furthermore, of all publications reviewed, Berkman and colleagues were the only authors who allowed participants to choose the training method.

Again, all training methods included publications discussed within the systematic review resulted in an increase in graphing accuracy, warranting the inclusion of learner preference when deciding which method to use. Preferred items are often reinforcing (Pace et al., 1985), thus it makes sense to align training methods with learner preference. To analyze choice, a concurrent-operants arrangement is often used; individuals are presented with two reinforcers and allocate responding accordingly, thus providing information on preference (i.e., individuals will choose the option with the higher reinforcer value; Fisher & Mazur, 1997). Furthermore, through differences in rate or proportion of choice allocation, a clear preference can be determined (Fisher & Mazur, 1997).

Therefore, the purpose of this study was to evaluate the effectiveness of two chunked presentations of EWI, while also analyzing participant preference for the chunked presentations. Specifically, the research questions asked were a) how does segmented as compared to a total task presentation of EWI affect graphing accuracy and duration, b) do participants prefer segmented or total task presentation of EWI, and c) does participant choice correspond to graphing accuracy and duration?

Method

Participants

Participants included four students enrolled in graduate programs (three master's and one doctoral student) and one undergraduate student at a midwestern university. While participants differed in age, academic history, behavior analytic history, and graphing capabilities, all participants either already maintained graphs as a responsibility of their current job position, had to create graphs for school projects, or would be responsible for creating and/or maintaining electronic graphs in their future employment or schooling. Another requirement for participation was a computer with Microsoft Excel and the video meeting application Zoom both installed, as well as internet access. Participants were assigned random numbers as pseudonyms using a random number generator website.

Participant 03 was a 54-year-old doctoral student enrolled in a program in international studies. The participant stated that his current position requires him to graph data, mainly using statistical software programs called R (https://www.r-project.org/) and Stata (https://www.stata.com/). Furthermore, the participant reported not using Microsoft Excel before participation in the study in any capacity for the purposes of graphing. Regarding specific types of instructions, Participant 03 stated he had been trained using both generic written instructions and EWI in the past, however neither had proven to be an effective training procedure. Responding to a pre-study social validity questionnaire, Participant 03 rated the ability for individuals to be able to graph data in order to efficiently make data-based decisions of high importance, as well as agreed that formal training in entering and graphing data would help him with his current and future responsibilities as a professional.

Participant 10 was a 50-year-old student enrolled in a graduate program in applied behavioral science. The participant stated that their current position required them to graph data, which was mainly completed with the Numbers program on Mac devices. However, the participant reported using Microsoft Excel of the purposes of graphing, to include creating graphs from input data. Regarding specific types of instructions, Participant 10 stated she had been trained using generic instructions, however she found them ineffective as a training procedure. Participant 10 reported she had never been trained using EWI. Participant 10 rated the importance to be able to graph data in order to efficiently make data-based decisions as moderately high, as well as agreed that formal training in entering and graphing data would help her with current and future responsibilities as a professional.

Participant 41 was a 21-year-old undergraduate student studying sports management. While the participant did not have any current graphing responsibilities for their job or school, nor had he ever used Microsoft Excel in any capacity for the purposes of graphing, he reported that a formal training in entering and graphing data would help with future job responsibilities within his field. Participant 41 rated the ability for individuals to be able to graph data in order to efficiently make data-based decisions of moderately high importance. Furthermore, Participant 41 had not, to his knowledge, been trained using generic or enhanced written instructions.

Participant 49 was a 35-year-old graduate student enrolled in a program in applied behavioral science. She reported her current position requires her to graph data, mainly via Catalyst. She also reported using Excel for the purposes of graphing, to include creating graphs from input data. Participant 49 stated she had received training via generic instructions in the past and that they were not effective as a training procedure. Participant 49 rated the ability for individuals to be able to graph data in order to efficiently make data-based decisions of high importance, as well as agreed that formal training in entering and graphing data would help with her current and future responsibilities as a professional. Participant 49 was one of two participants to receive extra credit for participation.

Participant 21 was a 24-year-old graduate student enrolled in an applied behavioral science program. She reported that her current position required her to graph data, mainly using Excel. Regarding training procedures, Participant 21 stated she had been trained using both generic and EWI but neither had been effective as a training procedure. Furthermore, she rated the ability for individuals to be able to graph data in order to efficiently make data-based decisions of high importance, as well as agreed that formal training in entering and graphing data would help with her current and future responsibilities as a professional. Participant 21 was one of two participants to earn extra credit for participating in the study.

Setting

All sessions were conducted remotely such that the researcher conducted sessions in a location separate from the participant. The first setting requirement was that both the researcher and participant work in a quiet room with little to no distractions. Some examples of workspaces included bedrooms, home offices, and dining rooms. A second setting requirement was reliable internet access such that the participant and researcher would be able to maintain participation in the Zoom meeting, the participant would be able to share their screen, the researcher could share the appropriate materials electronically, and the participant would be able to manipulate the shared materials.

Materials

Materials required of both the participant and researcher included a computer with internet access, as well as Zoom and Excel applications downloaded prior to the first session. Additionally, the program VLC Media Player was downloaded and used by the researcher to record some sessions, with other sessions recorded via Zoom. Prior to all sessions, the researcher compiled all necessary session materials into an electronic folder that was shared with the participant via the university's Microsoft OneDrive account. Documents in the folder consisted of a session start and stop prompt, which denoted the beginning and end of a session for the video recording and subsequent data collection (see Appendix A), a document outlining general directions of the study (i.e., the purpose, duration, and start/stop criteria for a session and an explanation of the use of video recording; see Appendix B), written instructions (depending on the condition; see a sample in Appendix C), and a hypothetical data set (i.e., data sets that were used to derive graphs). There were four different hypothetical data sets used, with variations including response measurement scaled to the *y*-axis and different titles for graphs, interventions, and *x*-axis breaks. Dates were always represented in the hypothetical data sets (i.e., the participants never scaled sessions to the *x*-axis). Hypothetical data sets were the same as used by Bernstein et al. (2020). Paper and writing utensils were also useful during sessions for both the researcher and participant; participants were prompted (not necessarily required) to write down certain components of the data set to include on their graph (e.g., baseline and treatment titles) and the researcher took direct observation notes of participant behavior during sessions.

Variables, Response Measurement, and Interobserver Agreement

The independent variable of the current study was the implementation of a chunked version of a previously piloted set of EWI (Appendix D; Bernstein et al., 2020). Screenshots of the EWI were taken on a computer and then uploaded to the website Qualtrics, an online survey platform (see Appendices E and F). The original EWI included 16 steps (as can be seen in Appendix D), each made up of a varying number of subitems. For the current study, we combined the original 16 steps to create a total of six chunks, thus creating large chunks consisting of multiple original steps (see Table 1 for a breakdown of chunks). To create the chunks, we combined steps that were similar to the graphing skills being taught. An entire chunk presented at a time (i.e., multiple original steps were on the screen at one time, typically two or three) was considered a total task (TT) presentation. This presentation was displayed on a yellow background (see Appendix E). Breaking up the tasks so that each of the original steps making up a chunk was presented one at a time with a green background was considered a segmented task (ST) presentation (see Appendix F). In summary, the original EWI were combined into six chunks, which were then chunked even further (i.e., TT or ST) in an attempt to analyze the effects of various chunk sizes of instructions on graphing.

The main dependent variables of the current study were overall graphing accuracy and duration to task completion (i.e., the duration from session start to session stop). Graphing accuracy was scored via visual inspection of “Live Excel” graphs; the researcher inspected various settings within the Excel graph to determine if the steps (86 to be exact; Table 1) were completed. For example, axes titles were instructed to be in Times New Roman, a font size of 12, and a text color of black, therefore to score those data, the researcher would click on each axis title, and observe the settings of each component in the corresponding formatting window within Excel. A “1” was scored if the setting was correct (i.e., the instruction was followed) and a “0” was scored if the setting was not correct (i.e., the instruction was not followed). Accuracy was measured as a percentage of opportunities, such that the number of correct steps were divided by the total number of steps required and then converted to a percentage. Mastery criteria were established at 96.51% overall accuracy and a session duration of under 45 minutes. Data scoring spreadsheets were provided by Bernstein et al. (2020).

Three trained observers scored graphs and recorded duration to graph completion in a manner identical to the lead researcher. IOA was assessed for around 33% of sessions across all conditions across all participants for both dependent variables. IOA for both the final overall performance accuracy and performance accuracy within chunks were scored, as participants saved a copy of their graph after each chunk. IOA for graphing accuracy (i.e., both the final permanent product and permanent products resulting from each chunk) was conducted using trial-by-trial IOA by dividing the number of agreements by the number of agreements plus disagreements. An agreement was scored if both observers scored an item as correct or incorrect on the scoring data sheet. Mean agreement for final graph accuracy was 95.55% (range, 93.02% - 100%). Mean agreements for Chunk 1, 2, and 3 were, with agreement for Chunk 4 at 97.78% (range, 88.89% - 100%), Chunk 5 at 94.29% (range, 89.28% - 100%), and Chunk 6 at 97.75% (range, 92.31% - 100%). Reed and Azulay's (2011) IOA calculator was used to determine mean agreements.

Duration to graph completion IOA was conducted for at least 33% of sessions across all conditions across all participants by dividing the shorter of the two recorded durations by the longer of the two recorded durations and then multiplying by 100%. Trained observers noted the start and stop times of each session. Mean agreement was 99.86% (range, 99.33% - 100%). Potentially, clear beginning and ends of sessions (denoted by the start and stop session prompt) led to high IOA. Duration to chunk completion was also scored for IOA, resulting in 100% agreement. Duration to chunk completion was mined from the Qualtrics website, thus resulting in high agreement.

Procedure

A nonconcurrent MBD across participants was used to analyze the effects of two different presentations of chunked EWI. Phases included baseline and EWI. One to four sessions were completed per day, one to five times per week. All sessions were prescheduled and lasted for as long as it took for the participant to complete their graph, with the exception of the first intervention session for Participant 49 as an Institutional Review Board modification removing a 45 minute termination criterion was awaiting approval therefore the session was ended accordingly.

Baseline

Prior to each baseline session, the researcher hosted and invited the participant to join a Zoom meeting. At the beginning of the first session, participants provided informed consent and then answered a pre-study social validity questionnaire (see Appendix G for an example). The researcher then shared their screen and discussed general directions and reviewed what the session would entail. At this point, and at the beginning of all subsequent sessions, the researcher shared a folder via Microsoft One Drive consisting of the necessary materials previously discussed. For baseline sessions, materials included a session start/stop prompt, a hypothetical data set, and written instructions (WI) in the form of a paragraph that provided context for the data set. Consistent with Mitteer et al. (2019), participants were not provided a model graph in either condition, as this helped ensure that certain accurate graph components were constructed using the EWI instead of the model graph (e.g., determining the *y*-axis range depended on following the EWI as opposed to simply referencing the model graph). When the participant had all of the necessary materials downloaded and their desktop set up the way they preferred such that they could easily manipulate all materials, the participant would display a session start prompt on their screen. The participant would minimize the prompt when they were ready to begin graph creation. When the participant was done creating their graph, they displayed the session start/stop prompt once again to signal the end of the session.

Enhanced Written Instructions (EWI)

EWI sessions were identical to baseline with the addition of the researcher sending participants a Qualtrics link for the EWI. Again, when the participant was ready to begin, they would display and then minimize the session start/stop prompt. Once the survey began, the participant was randomly presented with either a TT or segmented presentation of the first task (see Appendix E and F for examples). When finished with the chunk, participants were instructed to click a circle to move on to the next chunk, which would be the opposite chunk size presentation, as well as save their graph thus far such that we could score performance within the chunk (i.e., if TT was presented for Chunk 1, ST would be presented for Chunk 2 and vice versa). Before the third task was displayed, the participant was prompted to choose which presentation they wanted to use to complete the chunk, either TT, ST, or no preference. Because random assignment could not be programmed within each choice point, assignment of a chunk presentation following a choice of no preference, was programmed by the researcher while creating the survey. This was done using a randomization application called Roundom (http://apps.apple.com/us/app/roundom-decision-maker/id543582261) which is similar to a coin toss. ST were randomly assigned to no preference selections for both choice points. This process (randomized assignment of a presentation, followed by the opposite presentation, followed by a choice point) was replicated twice throughout the session in an attempt to compare the conditions within subjects (Berkman et al., 2019) as opposed to the between subjects designs often used in the graphing literature (e.g., Lo & Konrad [2007], Tyner & Fienup [2015], and Tyner & Fienup

[2016]). Of importance, the EWI were created using one of the hypothetical data sets such that all figures within the EWI corresponded to what the participant's graph should look like for that particular data set. This data set was always the first participants were exposed to such that it served as a tutorial. Following participation in the study, participants were asked to complete a post-study social validity questionnaire (PSQ; see Appendix H).

Treatment Integrity

Procedural fidelity (i.e., were the correct instructions provided) was assessed for 50% of sessions across all conditions across all participants. A trained observer analyzed session recordings to determine if the correct set of instructions were provided during sessions (i.e., WI were provided during baseline sessions and EWI were provided during intervention sessions). Procedural fidelity was scored as 100%.

Results

Figure 15 depicts the overall accuracy of final graphs across all participants. Depicted in the first tier of the graph in Figure 15, low and stable levels of accuracy were observed across baseline sessions for Participant 10, with the percentage of accurate graphing components completed remaining at or slightly below 29.07% (29.07%, 29.07%, and 27.91% respectively). Duration to graph completion ranged from 16 min to 68 min (68 min, 34 min, and 16 min respectively). Following implementation of EWI, an increase to 88.37% graphing accuracy was observed with another increase to 98.84% following the second intervention session, however durations to graph completion were above 45 min (i.e., did not meet mastery criterion). Specifically, duration to completion for the first intervention session was 70 min, and duration to completion for the second intervention session was 71 min. Of note, if it were not for one error of omission occurring within one of the first steps of the instructions, Participant 10 likely would have responded with over 97% accuracy. The next three intervention sessions maintained at high levels of accuracy (specifically 96.51%, 97.67%, and 98.84% respectively). Durations to graph completion also reached mastery criterion during these final three intervention sessions (42.43 min, 37.57 min, and 31.10 min respectively). Overall, Participant 10 completed eight sessions: three baseline sessions and four intervention sessions. Consistent errors emitted by Participant 10 included removing the chart border, using a line as the marker for the *x*-axis break, and placing the white rectangle in the wrong location to break the *x*- and *y*-axis (i.e., the floating zero).

Depicted in the second tier of the graph in Figure 15, during baseline, low, stable levels of accuracy were observed for Participant 21, with response accuracy remaining below 30% across all baseline sessions. Following implementation of EWI, performance of graphing components accurately completed immediately increased to 89.53%. Accurate responding remained at 89.53% following the second intervention session, with an increase to 98.84% following the third session. Accurate responding dropped to the lowest percentage observed throughout all intervention sessions (79.07%), with an increase back to 98.84% in the final intervention session. Overall mastery criteria were never met for Participant 21 due to withdrawal from the study (more specifically, the course in which Participant 21 was earning extra credit for participation in the study ended). However, while Participant 21 did not reach mastery criterion for graphing accuracy, she did meet mastery criterion for duration to completion for three consecutive sessions. In fact, duration to graph completion never exceeded mastery criterion for Participant 21 (43.93 min, 36.20 min, 24.08 min, 30.55 min, and 25.72 min respectively). Overall, Participant 21 completed nine sessions: four baseline sessions and five intervention sessions. Errors emitted by Participant 21 varied throughout intervention sessions, with no clear pattern. Errors included incorrect font color and size, and placement of the white rectangle in the wrong location to break the *x*- and *y*-axis (i.e., the floating zero).

Depicted in the third tier of the graph in Figure 15, low, stable levels of accuracy were observed throughout baseline for Participant 49, with the percentage of accurate graphing components completed remaining at or below 20%. Of note, during the first baseline session, Participant 49's graph was deleted during the session, most likely due to user error. Because there was no permanent product to score Live Excel data, the session was scored as an "N/A." There is the ability to score permanent product data from the recording of the session if necessary, however, this would require data collection from a video recording (i.e., a picture of a picture) and scoring all components would not be feasible as visual inspection of the graph alone would not provide the necessary information. Furthermore, due to a procedural error emitted by the lead researcher (i.e., issues with the video recording application, duration data were not available for the fourth baseline session. Following implementation of EWI, no increase in performance was observed in the first treatment session, with only an increase of 7% accuracy. However, it is important to note that due to a modification to study session parameters (i.e., changing the session length from 45 min to as long as was necessary to finish the graph), the first treatment session was terminated after 45 min. Therefore, the participant did not encounter the entire EWI and was not provided sufficient time to complete their graph in only the first intervention session. However, this modification would not have affected responding in the first four chunks, therefore it is quite interesting that an increase in accuracy was not observed following exposure to the EWI. In the second session, performance increased to 88.24%, with a continued increase in accuracy to 91.86% following the third session. Performance in the final three intervention sessions met mastery criterion, with accurate responding remaining at or slightly above 96.51% and duration to graph completion remaining below 45 min (42.38 min, 42.26 min, and 37.15 min, respectively). Participant 49 required three exposures to the EWI before reaching mastery criteria for both graphing accuracy and duration to completion, thus completing 11 sessions total (five baseline sessions and six intervention sessions). Errors emitted by Participant 49 varied but included inaccurate font sizes and failing to remove the chart border.

Depicted in the fourth tier of the graph in Figure 15, during baseline, low and stable levels of graphing accuracy for Participant 03 were observed, with the percentage of accurate graphing components completed remaining below 9.30% throughout baseline (8.14%, 9.30%, 9.30%, 9.30%, 6.98%, and 6.98% respectively). Graphing accuracy immediately increased to 97.67% following implementation of EWI and maintained at 97.67% throughout all intervention sessions. While graphing accuracy was at masterly level following the first intervention session, duration to graph completion was not. Specifically, duration to graph completion was almost 78 minutes for the first intervention session, however a decrease to mastery level was observed for the subsequent three sessions (i.e., mastery criteria was reached). Consistent errors emitted by Participant 03 were failure to correctly resize the graph and failure to break the *x*- and *y*-axis (i.e., the floating zero). Of note, as reported in the pre-study questionnaire, Participant 03 had no prior experience graphing in Excel.

Depicted in the final tier of the graph in Figure 15, low and stable levels of graphing accuracy were observed for Participant 41, with the percentage of accurate graphing components completed remaining below 11% throughout baseline (9.30%, 10.47%, 8.14%, 6.98%, 8.14%, 8.14%, and 10.47% respectively). Following implementation of EWI, an immediate increase to 100% graphing accuracy was observed, with high stable levels between 96.51% and 98.84% graphing accuracy for the remainder of intervention sessions (96.51%, 97.67%, 97.67%, and

98.84%). Participant 41 reached mastery criterion (45 min or under) for duration to graph completion after two exposures to the EWI, with mastery level durations maintaining at mastery criterion for three consecutive sessions. Overall, Participant 41 completed 12 sessions: seven baseline sessions and five intervention sessions. Consistent errors emitted by Participant 41 included selecting the wrong color for the *x*-axis, placing the white rectangle in the wrong location to break the *x*-axis and *y*-axis (i.e., the floating zero). Interestingly, levels of graphing accuracy emitted in baseline sessions were lower than three of the other participants (only higher than Participant 03), yet the highest percentage of graphing accuracy following the first implementation of EWI was observed. Furthermore, Participant 41 was the only participant to accurately complete all components of the graph within one session.

Figure 16 includes graphical display of graphing accuracy and duration to completion across chunks within intervention sessions. As presentation of EWI, and therefore presentation of chunks, was not available during baseline sessions, data for TT and ST presentation responding are not available. Furthermore, performance during differing chunk presentations within intervention sessions would not be comparable to performance during baseline sessions, as the conditions were too different. Therefore, analysis of performance within and across chunk sizes was only conducted for intervention sessions.

As depicted by the middle left graph in Figure 16, for Participant 10 Chunk 1 consistently resulted in 100% graphing accuracy across intervention sessions, regardless of chunk presentation (i.e., TT or ST). Duration of chunk completion for Chunk 1 (see Table 2) was similar during the first and second intervention session (17.29 min and 17.28 min respectively), with a decrease to 9.52 min during the third intervention session. The shortest duration to chunk completion for Chunk 1 occurred during the fourth intervention session (4.81 min). Duration to chunk completion for Chunk 1 was 6.23 min for the final intervention session. Chunk 2 resulted in 100% graphing accuracy as well, with the exception of the first intervention session, which resulted in 87.50% accuracy. Duration to completion for Chunk 2 (see Table 2) ranged from 8.82 min in the first intervention session to 3.02 min in the final intervention session. Chunk 3 was never completed with 100% graphing accuracy, due to an error in marker shape for the *x*-axis break (53.85% - 92.31%). Duration to chunk completion for Chunk 3 was around 12.24 min for the first and second intervention sessions, with the duration decreasing to 6.98 min during session three and decreasing even further to 3.92 min and 3.05 min for the final two intervention sessions. Chunk 4 resulted in either 88.89% or 100% graphing accuracy across intervention sessions, depending on whether Participant 10 deleted the chart border. Duration to chunk completion for Chunk 4 ranged from 2.62 min to 5.27 min, with the shortest duration occurring in the third intervention session and the longest duration occurring in the fourth intervention session. Chunk 5 resulted in 100% accuracy across all intervention sessions. Duration to chunk completion for Chunk 5 (which included the most graphing components/sub-items across all chunks; see Table 1) was 21.75 min and 20.83 min for the first two interventions sessions, with a substantial decrease duration 10.13 min, 11.17 min, and 11.74 min across the final three intervention sessions. Chunk 6 resulted in either 92.31% or 100% across sessions, depending on whether the *x*- and *y*-axis was broken appropriately to create a "floating zero." Duration to chunk completion for the final chunk ranged increased during the first three intervention sessions (6.15 min, 6.55 min, and 7.15 min respectively) with a decrease in duration for the final two intervention sessions (3.13 min and 3.12 min respectively).

Graphs in Figure 17 depict the average percentage accuracy for TT and ST presentation within sessions. Also included is the average percentage accuracy for all baseline sessions and an overall percentage accuracy for TT and ST presentation across all intervention sessions. As depicted in the middle left graph, for Participant 10, the average graphing accuracy for TT presentation of chunks remained high and stable across intervention sessions (93.75% - 100%) for an overall average of 97.64%. The average graphing accuracy for ST presentation of chunks was slightly lower across sessions (83.76% - 98.08%) with an overall graphing accuracy of 94.06%. Of note, 100% graphing accuracy of each chunk presentation within session was only observed across TT presentation (session two, four, and five). ST presentation of tasks never reached 100% across all ST presentation within a session.

As depicted in the middle left graph in Figure 16, Participant 21 completed five intervention sessions. Graphing accuracy was relatively variable across all chunks and all sessions, regardless of chunk presentation. For Chunk 1, graphing accuracy ranged from 71.43% - 100%. Duration to chunk completion decreased across sessions (see Table 2), with the first chunk of the first intervention session taking 7.53 min to complete and the first chunk of the last intervention session taking 3.69 min to complete. Chunk 2 resulted in 85.71% accuracy with an observed increase throughout sessions (87.5%, 100%, 87.5%, and 100% respectively). Duration to completion for Chunk 2 ranged from 4.27 min to 5.53 min with the longest duration occurring in the first intervention session. The greatest variability was observed in Chunk 3, with graphing accuracy ranging from 46.15% - 100%. Duration to chunk completion for Chunk 3 decreased across sessions, with a duration of 10.82 min in the first intervention session and a duration of 3.09 min in the final intervention session. Chunk 4 resulted in 88.89% graphing accuracy for the first two intervention sessions, with legend formatting errors responsible for the inaccuracy, and 100% graphing accuracy for the final three intervention sessions. Duration to chunk completion for Chunk 4 remained low and stable, ranging from 2.42 min to 3.50 min. Graphing accuracy for

Chunk 5 ranged from 85.71% to 100%, with 100% graphing accuracy occurring in the third and fifth intervention session. Duration to chunk completion for Chunk 5 was 11.54 min and 10.24 min for the first two interventions sessions, with a decrease in duration to 7.42 min, 8.39 min, and 6.80 min across the final three intervention sessions. Graphing accuracy for Chunk 6 was also quite variable, ranging from 61.54% to 100%, with 100% accuracy for Chunk 6 only occurring in the final intervention session. Duration to chunk completion for Chunk 6 was slightly variable across sessions, with the shortest duration occurring in the third intervention session (2.89 min) and the longest duration occurring in the fourth intervention session (5.58 min).

As depicted in the middle right graph of Figure 17, the average graphing accuracy for Participant 21 for TT presentation of chunks remained high with slight variability observed across intervention sessions (83.84% - 100%) for an overall average of 92.75%. The average graphing accuracy across sessions for ST presentation of tasks was slightly lower and more variable than TT presentation of chunks (73.80% - 100) with an overall graphing accuracy of 88.85%. Of note, 100% graphing accuracy of each chunk presentation within session was only observed once for each presentation across sessions (i.e., 100% graphing accuracy of ST task presentation only occurred in the third intervention session and 100% graphing accuracy of TT task presentation only occurred in the final intervention session).

As depicted in the bottom right graph of Figure 16, Participant 49 completed six intervention sessions. Chunk 1 graphing accuracy was 71.43% for the first intervention session and then increased to 100% for the remainder of sessions. Duration to chunk completion was slightly variable, with a duration of 10.59 min for the first intervention session, a decrease to around 7 min for the second and third intervention sessions, an increase to 8.24 min for the fourth intervention session, another decrease to 5.50 min for the fifth intervention session, and then a slight increase to 5.22 min for the final intervention session. Similar graphing accuracy response patterns were observed for Chunk 2, such that graphing accuracy increased to and maintained at 100% across sessions (75% - 100%). Duration to chunk completion was slightly variable throughout sessions with a duration to Chunk 2 completion around 7 min for the first three intervention sessions, a decrease to 5.83 min for the fourth intervention session, an increase to 8.15 min for the fifth intervention session, and then a decrease to 6.89 min. After an initial low graphing accuracy of 23.08% in the first intervention session, slight variability was observed across Chunk 3 graphing accuracy with responding increasing to 100% across the rest of the intervention sessions with the exception of the fifth intervention session, which was at 81.82%. Duration to chunk completion for Chunk 3 decreased throughout all interventions with a duration of 15.13 min in the first intervention session and a duration of 6.18 min in the final intervention session. Following an initially low percentage of accuracy in the first intervention session (33.33%), Chunk 4 graphing accuracy increased throughout intervention sessions, with some slight variability observed across the final four sessions (87.5%-100%). While slightly variable, duration to chunk completion for Chunk 4 was 5.14 min (the longest duration for Chunk 4) for the first intervention session and 2.72 min for the final intervention session (the shortest duration for Chunk 4). Due to changes in session parameters previously discussed, there is no graphing accuracy or duration to chunk completion for Chunk 5 and 6 for the first intervention session. Graphing accuracy for Chunk 5 increased throughout the subsequent five intervention sessions, with a graphing accuracy of 64.29% for the second invention session (again, this was the first full exposure to Chunk 5), with an observed increase to 100% by the fifth session. A decreasing trend in duration to chunk completion was observed across intervention sessions, with the first exposure to Chunk 5 resulting in a duration of 16.48 min and the final intervention session resulting in a duration to Chunk 5 completion of 10.58 min. Chunk 6 graphing accuracy was slightly variable, with an initial accuracy of 100% following the first exposure of Chunk 6, a decrease to 84.61% accuracy in the third intervention session, and an increase to 100%, 92.30%, and 100% for the final three intervention sessions. Duration to chunk completion remained stable after an initial decrease from 8.43 min to 4.48 min between the first and second exposure of Chunk 6.

As depicted in the bottom right graph of Figure 17, following an initial increase between the first two intervention sessions (47.20% - 92.86%), the average graphing accuracy for TT presentation of chunks for Participant 49 remained high and stable across the remainder of intervention sessions (92.86% - 100%) for an overall average of 87.77%. A similar pattern of responding was observed for ST presentation of chunks. Following an initial increase between the first two intervention sessions (57.29% - 100%), the average graphing accuracy for ST presentation of chunks remained high and relatively stable across the remainder of intervention sessions (93.37% - 100%), with an overall graphing accuracy of 88.23%. Of note, 100% graphing accuracy of each chunk presentation within session was only observed once for each presentation across sessions (TT presentation within the fifth intervention session and ST presentation within the final intervention session).

As depicted in the top graph of Figure 16, Participant 03 completed four intervention sessions, the least amount of required intervention sessions to reach mastery criteria. Chunk 1 graphing accuracy remained at 100% across all intervention sessions. While duration to Chunk 1 completion decreased during the second intervention session (see Table 2), there was a slight increase in duration across the final three sessions with durations at 13.03 min for the first intervention session, 5.56 min for the second, 6.42 min for the third, 7.25 min for the fourth. Chunk 2 graphing accuracy across sessions maintained at high levels, specifically at 100% except for the second intervention session which was at 93.75%. Duration to Chunk 2 completion decreased across all intervention sessions, with an initial duration of 19.5 min and a final duration of 7.41 min. Chunk 3 graphing accuracy remained high but slightly variable across intervention sessions (range, 84.62% - 100%). A decreasing trend was observed regarding duration to Chunk 3 completion, with an initial duration of 13.46 min and a final duration of 4.84 min. Chunk 4 graphing accuracy remained at 100% for all sessions. Following an initially higher duration to Chunk 4 completion in the first intervention session (8.19 min), the remainder of durations remained low and stable (range, 3.24 min - 5.11 min). Chunk 5, accuracy maintained at 96.43% across all intervention sessions, with a consistent error of resizing the graph emitted. Chunk 5 duration to completion decreased across intervention sessions, (range, 9.92 min – 15.82 min). Chunk 6 graphing accuracy reached 100% in the second intervention, but was at 92.33% for the remainder of sessions, in which the participant failed to place the shape in the correct location to break the *x*- and *y*-axis. Duration to Chunk 6 completion decreased across intervention sessions with a slight increase in the final intervention session (range, 3.7 min - 7.2 min).

For Participant 03, the average graphing accuracy for TT presentation of chunks remained high and stable across intervention sessions (93.34% - 100%) for an overall average of 96.67%, which can be seen in the top graph of Figure 17. A similar pattern of responding was observed for ST presentation of chunks, with high stable levels of average accuracy across intervention sessions (95.09%-100%) for an overall average of 98.33%.

Participant 41 completed five intervention sessions, as can be seen in the bottom left graph of Figure 16. Chunk 1 graphing accuracy remained at 100% across all intervention sessions. Duration to Chunk 1 completion decreased across sessions (Table 2), with durations at 14.03 min and 18.64 min for the first two session, to 9.91 min for the third session, 4.79 min for the fourth intervention sessions, and 3.85 min for the final intervention session. Chunk 2 graphing accuracy across Chunk 2 increased from 92.30% to 100% and then maintaining at 100% for the remainder of sessions. Duration to Chunk 2 completion decreased across all intervention sessions, with an initial duration of 10.76 min and a final duration of 5.26 min. Chunk 3 graphing accuracy remained high and relatively stable across intervention sessions (92.31% to 100%), with a consistent error of selecting the wrong color for the *x*-axis break marker. A decreasing trend was observed regarding duration to Chunk 3 completion, with an initial duration of 10.41 min and a final duration of 3.87 min. Chunk 4 graphing accuracy remained at 100% for the first four intervention sessions, with a decrease to 88.89% for the final intervention session. Following an initially higher duration to Chunk 4 completion in the first intervention session (12.04 min), the remainder of durations remained low and stable (ranging from 3.77 min - 5.65 min). Following 100% graphing accuracy for Chunk 5, accuracy maintained at 96.43% across the remainder of intervention sessions, with a consistent error of graph placement emitted. Chunk 6 graphing accuracy maintained at 100% except for a decrease to 92.31% for the final intervention session. Duration to Chunk 6 completion decreased across intervention sessions at relatively stable levels with a duration to Chunk 6 completion in the first session 12.29 min and a final duration to Chunk 6 completion of 4.76 min.

For Participant 41, the average graphing accuracy for TT presentation of chunks remained high and stable across intervention sessions (96.24% - 100%) for an overall average of

97.95%, which is depicted in the bottom left graph of Figure 17. A similar pattern of responding was observed for ST presentation of chunks, with high stable levels of average accuracy across intervention sessions (94.45%-100%) for an overall average of 98.12%. Of note, 100% graphing accuracy of each chunk presentation within session was observed only once for TT presentation across sessions (session one) and three times for ST presentation across sessions (sessions two, three and four).

Overall efficiency of chunk presentation is shown in Figure 18. Participant 10 displayed comparable percentages of graphing accuracy across chunk presentation, however, took longer to complete chunks presented as TT on average, suggesting ST was a more efficient presentation for Participant 10. Participant 21 displayed a higher average percentage of accuracy for ST presentation of steps than TT however also took longer on average to complete chunks presented as ST. Therefore, a trade-off would have to be determined when deciding the most efficient presentation for Participant 21 (i.e., is it better to be faster but less accurate or more accurate but take longer to complete). Average percentage of accuracy for Participant 49 was highest during ST presentation of chunks, with very little difference in duration to chunk completion between the two presentations, suggesting ST presentation would be considered efficient for Participant 49. Participant 03 displayed a higher average percentage of accuracy within ST presentation of chunks, while displaying a shorter average duration during TT presentation of chunks than ST presentation. Participant 41 displayed a higher average percentage accuracy during TT presentation of chunks, as well as completing chunks in a shorter duration than during ST presentation of chunks.

Preference for chunk presentation both within and across chunks, as well as overall preference, across all participants is depicted in Figure 19. Choice points were always provided directly prior to presentation of Chunk 3 and 6. Participant 10 contacted 10 choice points (i.e., two choice points during each of the five intervention sessions), of which they chose an ST presentation of chunks for both choice points during the first intervention session. For the remaining intervention sessions, Participant 10 chose no preference. Participant 21 contacted 10 choice points as well, choosing a TT presentation two times for Chunk 3 and three times for Chunk 6. ST presentation was chosen three times for Chunk 3 and two times for Chunk 6, for an even distribution of choice allocation across chunk presentations. Participant 49 contacted 11 choice points (due to the time constraint placed on the participant's first intervention session), choosing a TT presentation of chunks only once throughout all sessions. ST presentation was chosen five times for Chunk 3 and five times for Chunk 6. Participant 03 contacted eight choice points, choosing TT presentation, of which they solely chose a TT presentation of chunks. Participant 41 displayed similar a similar pattern of responding as Participant 03, however contacted 10 choice points.

Figure 20 depicts the number of times participants contacted each chunk presentation for chunks (i.e., how many time participants experienced TT and ST presentation of each chunk) with Figure 21 depicting the overall number of times participants contacted each chunk presentation. Overall, participants experienced a variety of chunk presentations with no observable pattern across participants.

Following participation in the study, participants were asked to complete a post-study social validity questionnaire (PSQ; see Appendix H). Three responses to the PSQ were submitted (Participant 03, Participant 10, and Participant 41 all submitted PSQs, none of whom received extra credit for participation). Participant 10 rated the effectiveness of WI (the instructions that were provided during baseline sessions) alone to complete the study's procedures as moderately high and somewhat agreed that WI is a good self-directed training procedure to be implemented when teaching graphing, however it should be noted that the participant reported later in the PSQ that she did not fully understand the distinction between WI and EWI. Regarding individual components of the EWI Participant 10, rated the effectiveness of limited technical jargon as high, pictures/diagrams as moderately high, and brief explanations as moderate. Participant 10 somewhat agreed that EWI are a good self-directed training procedure to be implemented when teaching graphing skills as well as somewhat agreed that EWI could be made better as a self-directed training procedure. Participant 10 somewhat agreed that the EWI was effective in teaching skills toward the creation of graphs, that the EWI were easy to follow, and that they observed their own behavior change. Specifically, the participant stated that graphs were produced faster, and they did not need the instructions for some parts in later interventions that they had needed for earlier sessions. Due to not understanding the difference between WI and EWI, the participant stated they did not prefer one or the other when completing graphs. Participant 10 reported that they had somewhat high confidence that they could adequately and independently complete similar graphing procedures without the use of the study materials and rated the likelihood that they would reference the materials again in the future as high. Participant 10 also rated that they were satisfied with the outcomes of the EWI, particularly because they could now understand more complex components of graph creation. Finally, the participant somewhat agreed that EWI would work to increase similar skills in the future or with other individuals, stating that they would have completely agreed if Mac instructions were included.

Participant 41 rated the effectiveness of WI alone to complete the study’s procedures as high and completely agreed that WI is a good self-directed training procedure to be implemented when teaching graphing, however it stands to reason that the participant did not fully understand the distinction between WI and EWI. Regarding individual components of the EWI Participant 41, rated the effectiveness of limited technical jargon as moderately high, pictures/diagrams as high, and brief explanations as high. Participant 41 agreed that EWI are a good self-directed training procedure to be implemented when teaching graphing skills as well as agreed that EWI could be made better as a self-directed training procedure. Participant 41 agreed that the EWI were effective in teaching skills toward the creation of graphs, that the EWI were easy to follow, and that they observed their own behavior change. Specifically, the participant stated it was easier to make the graphs during the final sessions and they were able to complete the graphs faster due to remembering previous steps. Furthermore, Participant 41 stated they preferred EWI over WI. Participant 41 reported that they had somewhat high confidence that they could adequately and independently complete similar graphing procedures without the use of the study materials and rated the likelihood that they would reference the materials again in the future as moderately high. Participant 41 also rated that they were satisfied with the outcomes of the EWI, particularly because were easy to follow. Finally, the participant somewhat agreed that EWI would work to increase similar skills in the future or with other individuals, stating the included pictures were particularly helpful.

Participant 03 rated the effectiveness of WI alone to complete the study's procedures as moderately high and completely agreed that WI is a good self-directed training procedure to be implemented when teaching graphing, however it stands to reason that, as with the other participants, Participant 03 did not fully understand the distinction between WI and EWI. Regarding individual components of the EWI, Participant 03, rated the effectiveness of limited technical jargon as high, pictures/diagrams as high, and brief explanations as high. Participant 03 agreed that EWI are a good self-directed training procedure to be implemented when teaching graphing skills as well as agreed that EWI could be made better as a self-directed training procedure. Participant 03 agreed that the EWI were effective in teaching skills toward the creation of graphs, moderately agreed that the EWI were easy to follow, and agreed that they observed their own behavior change. Specifically, the participant stated repetition made the subsequent sessions go quicker. Furthermore, Participant 03 stated they preferred EWI over WI. Participant 03 reported that they had high confidence that they could adequately and independently complete similar graphing procedures without the use of the study materials and rated the likelihood that they would reference the materials again in the future as high. Participant 03 also rated that they were satisfied with the outcomes of the EWI, particularly because they learned a new skill. Finally, the participant somewhat agreed that EWI would work to increase similar skills in the future or with other individuals, stating the included pictures were particularly helpful.

Discussion

Graphing and visual analysis of data are critical to the field of behavior analysis (Berkman et al., 2019; Kranak et al., 2019; Kubina et al., 2017; Tyner & Fienup, 2015). Graphing not only allows for visual analysis of data, it is an important job responsibility of behavioral professionals. While the significance of graphing is apparent, the most efficient method to teach the skill is not. In the present study, the effects of various chunk sizes of EWI on the graphing accuracy and duration were examined, specifically evaluating the extent to which a chunked and total task presentation of the EWI affected graphing accuracy and duration, whether participants displayed a preference for either presentation, and whether preference corresponded with graphing accuracy or duration. Participants learned to create SSD line graphs of clinical relevance (i.e., AB reversal graphs displaying baseline and intervention contingencies). The two chunked presentations (TT and ST) resulted in increases in graphing accuracy and decreases in graphing duration across intervention sessions among participants, with no discernable pattern regarding a more effective chunk across participants. All participants except one displayed either a clear preference for a specific chunk size or no preference for a chunk size (i.e., they were likely to make the same choice across successive choice points both within and across sessions), although which chunk size was preferred varied across participants. Overall, results indicated that both chunk presentations were effective at teaching graphing skills, therefore suggesting that preference of teaching material presentation could be implemented without decreasing effectiveness.

Strengths of this study included the use of a within-subjects design to expose participants to both presentations of chunk sizes within and across sessions. By coming into contact with both TT and ST presentations of tasks, an analysis of the effects of chunk size could be completed for each participant, as opposed to comparing groups of participants contacting various chunk sizes. Furthermore, we were able to discern participant preference for the different chunk size due to participants having to choose a chunked presentation following initial contact with both presentations. If participants had not been exposed to both chunk presentations, a clear preference could not be determined. Put another way, this addition of a concurrent-operant arrangement allowed for analysis of preference because the participant had to choose a chunk presentation at each choice point (participants could choose “no preference,” as did Participant 10, but that in and of itself is a choice; Fisher & Mazur, 1998). Another strength was the EWI itself, which included screenshots of icons, dropdown menus, tables discussing how to set various formatting requirements of the graph (e.g., where the *x*-axis crosses the *y*-axis, minimum and maximum bounds), and model graphs. Furthermore, the EWI were created using one of the hypothetical data sets such that all figures within the EWI corresponded to what the participant's graph should look like when graphing that particular data set (this was always the first data set participants were exposed to such that it served as a tutorial). Another strength was the addition of preference, as only one study within the graphing literature to date has examined preference for different methods of teaching graphing (Berkman et al., 2019).

Perhaps the biggest limitation of the present study was the fact the EWI were created using a PC and were intended to teach participants how to create a graph on a PC, however all participants used a Mac while participating in the study. Overall, the main differences between Excel for PC and Excel for Mac was display and retrieval of the "format selection" pane, which is used to format the graph (e.g., colors and size of axes and data path). The researchers had not originally planned to assess the generalization of teaching materials to other operating systems, however, the first two participants to respond to recruitment emails (which specifically stated a PC was necessary for participation), used Macs to create their baseline graphs. Subsequent participants had access to Macs, therefore it was decided that all participants would use a Mac to create graphs for the sake of consistency. Interestingly, a substantial increase in graphing accuracy and decrease in graphing duration was observed for all participants, arguably demonstrating some level of generalization of the EWI from Excel for PC to Excel for Mac. To further assess the generalization of these EWI, a between-subjects design could be employed, where one group of participants creates graphs on a PC using the EWI from the present study and another group creates graphs using a Mac. Alternatively, the current study could be replicated with the only change being the use of a PC instead of a Mac.

Another limitation of the study was inconsistent computer specifications. For example, there was no control for screen size of participants' computers, which could affect how the various applications were displayed on the screen. Additionally, there was no control for using a desktop versus laptop, a mouse versus no mouse, or more than one computer screen. Furthermore, we did not assess which version of Excel was installed on participants' computers. These limitations could be addressed by using consistent computers assigned to participants. However, once again, no effects of computer specifications on graphing performance were discerned across participants.

Multiple limitations of a technological nature surrounded the use of Qualtrics to display the EWI, of which we had no control. Perhaps the biggest limitation within Qualtrics is by programming the randomizing of conditions within the presentation of instructions (e.g., the first chunk was randomly presented as TT or ST), the ability to go back to previous chunks was unavailable. However, repeated exposure might lessen the need to refer to previous chunks in the first place. Additionally, as with all technology, one cannot control for all software glitches. While Qualtrics proved trustworthy, it was not without kinks. For example, during one session (i.e., session seven for Participant 49), the participant experienced the random inability to move on to the next chunk (i.e., when told to click the circle when they had completed the task, there was no circle). This glitch was only on the participant's end, as everything was displayed correctly on the researcher's computer. To solve this problem, the researcher shared her computer screen such that the participant could see the instructions and continue to manipulate the graph on their computer. Fortunately, this occurred during the final task presentation. Unexpected events such as those encountered in the present study could likely occur with any software program.

Another limitation of the current study is that two participants (i.e., Participants 21 and 49) received extra credit towards a summer course for their participation in the study, while the other three participants (i.e., Participants 03, 10, and 41 did not). Therefore, motivation likely varied across participants. Furthermore, regarding participants, we experienced a very limited participant pool. Participant recruitment emails were sent out at the beginning of the summer semester, therefore there was not much of an establishing operation for the offered extra credit. Additionally, two participants lived in the same house (i.e., Participants 03 and 41), so discussion about the study, while unlikely, could have occurred across the two participants. However, it could be argued that the same limitation could apply to any study using a pool of participants that come in contact with one another. For example, when using students from the same course or staff members in the same workplace as participants, there is always the chance of discussing aspects of participation in the study.

Yet another limitation of the current study is that the size of chunks (whether presented as TT or ST) were not weighted for size and content. Therefore, some chunks might have required more response effort both in terms of time required to complete the step and complexity of graphing components. An example of this is demonstrated by the fifth chunk of the EWI (titling the graph, phases, and axes, and resizing the graph), which included six pages of text in paper form and a total of 64 sub-items, compared to the fourth chunk (deleting chart junk and moving the graph to its own sheet) which included one and a half pages of text in paper form and a total of 26 sub-items. Furthermore, any conclusions about the effects of chunk size on graphing performance must be interpreted with caution as participants experienced both types of chunk presentations across sessions. So, not only did they have repeated exposure to the EWI in general chunk presentations were alternated.

The absence of a generalization probe, as well as a maintenance probe, could also be considered limitations of the current study. An example of assessing generalization of graphing skills would include requiring the participant to graph multiple topographies (i.e., data paths) on one graph, as data sets manipulated by participants in the current study only consisted of one topography of behavior to graph. An example of assessing maintenance would include reversing to baseline conditions in which WI were provided instead of the EWI. However, due to the self-directed nature of EWI, one could argue that maintaining responding following removal of EWI in an applied setting is irrelevant as one could simply reference the training materials when necessary (Berkman et al., 2019).

Another possible limitation includes how the dependent variable of graphing accuracy was measured. Accurate graph components were scored via Excel such that participant's graphs were opened on the scorer's desktop and manipulated within Excel to determine if components were completed. Because real-time data was not scored (i.e., recordings were not viewed to determine if each step was completed as specified by the EWI), one cannot completely determine if the EWI were responsible for the observed change in behavior. However, while real-time data would have added a higher level of experimental rigor, one could argue that in an applied setting (e.g., clinical setting), real-time data would not be necessary such that as long as an appropriate increase in behavior occurred, the intervention could be deemed effective.

This study extends Graff and Karsten (2012) which used EWI as a self-instructed training method to teach implementation of preference assessments by demonstrating effectiveness of the same teaching method while teaching graphing. This study also extends Berkman et al. (2019), which compared the effects of VMVO and EWI on graphing accuracy and duration to graph completions and evaluating the participant preference of training methods, by incorporating participant preference within all intervention sessions. Results of the present study were comparable to Berkman et al.'s such that graphing accuracy increased following implementation of EWI.

Another contribution of the present study is that it extends Tyner and Fienup's (2016) analysis of which aspects of a TA are responsible for its effectiveness. While Tyner and Fienup determined that a supplemented TA including important antecedent stimuli, performance criteria, and consequences of accurate completion of steps was a more effective training method than a TA that simply states target behaviors, the current study demonstrated that while the implementation of EWI resulted in an increase in graphing accuracy, chunk size did not have an effect on the accuracy (i.e., one chunk was not better than the other). Therefore, both studies analyzed various aspects of a TA that might attribute to its effectiveness.

A major contribution of this study is that while performance across chunk sizes did not vary much (i.e., performance was not consistently better when presented with one presentation over the other), there were differences across participants regarding preference for chunk size, with preference of one chunk size maintaining across sessions. A clear preference was displayed with one participant exclusively choosing an ST presentation at choice points, one participant with no preference for the vast majority of choice points, two participants choosing only a TT presentation at choice points, and one participant choosing a mixture of the two.

This aspect of undifferentiated results across chunk sizes, yet a clear preference for how the EWI were presented when given a choice, suggests that perhaps it is time to take a closer look at self-report of learner preferences. By focusing on what learners are doing (i.e., permanent products of graphs), we determined that the intervention was successful. Perhaps next steps include attending to what the participants are saying (i.e., what are they reporting as preferred).

This could also be done with training methods other than EWI, both within and across methods. For example, like Berkman et al. (2019) did with VMVO and EWI, preference across training methods should be accounted for. Regarding preference within training methods, as the current study did with EWI, future research should do the same with different training methods. Preference of VM vs. VMVO, preference for type of feedback given during BST, preference for different magnitudes of chunking (i.e., breaking down chunk size further) and preference for display of TAs (i.e., electronic or paper copies) are all avenues of research that could be beneficial, not only for teaching graphing, but across a wide variety of behaviors.

However, there are considerable implications for future research beyond preference. In a similar way that Berkman et al. (2019) compared EWI and VMVO, EWI should be compared with other training methods, such as BST. Furthermore, the effects of self-instructed training packages (e.g., VMVO and EWI) should be compared to packages including consequences during training (e.g., BST). Importantly, these training methods should be evaluated across graphing programs. For example, participants in Berkman et al.'s study only used GraphPad Prism to create their graphs, therefore, results might not generalize to other programs such as Excel. Either studies need to be replicated and utilize other graphing programs, or future research should incorporate multiple graphing programs within the study. Other simple procedural variations that could be assessed are performance when instructions are delivered electronically compared with performance when instructions are printed out (regardless of preference). Along a similar vein, if presented electronically, a further procedural variation could include comparing performance while using one screen to performance when instructions are displayed on a separate screen.

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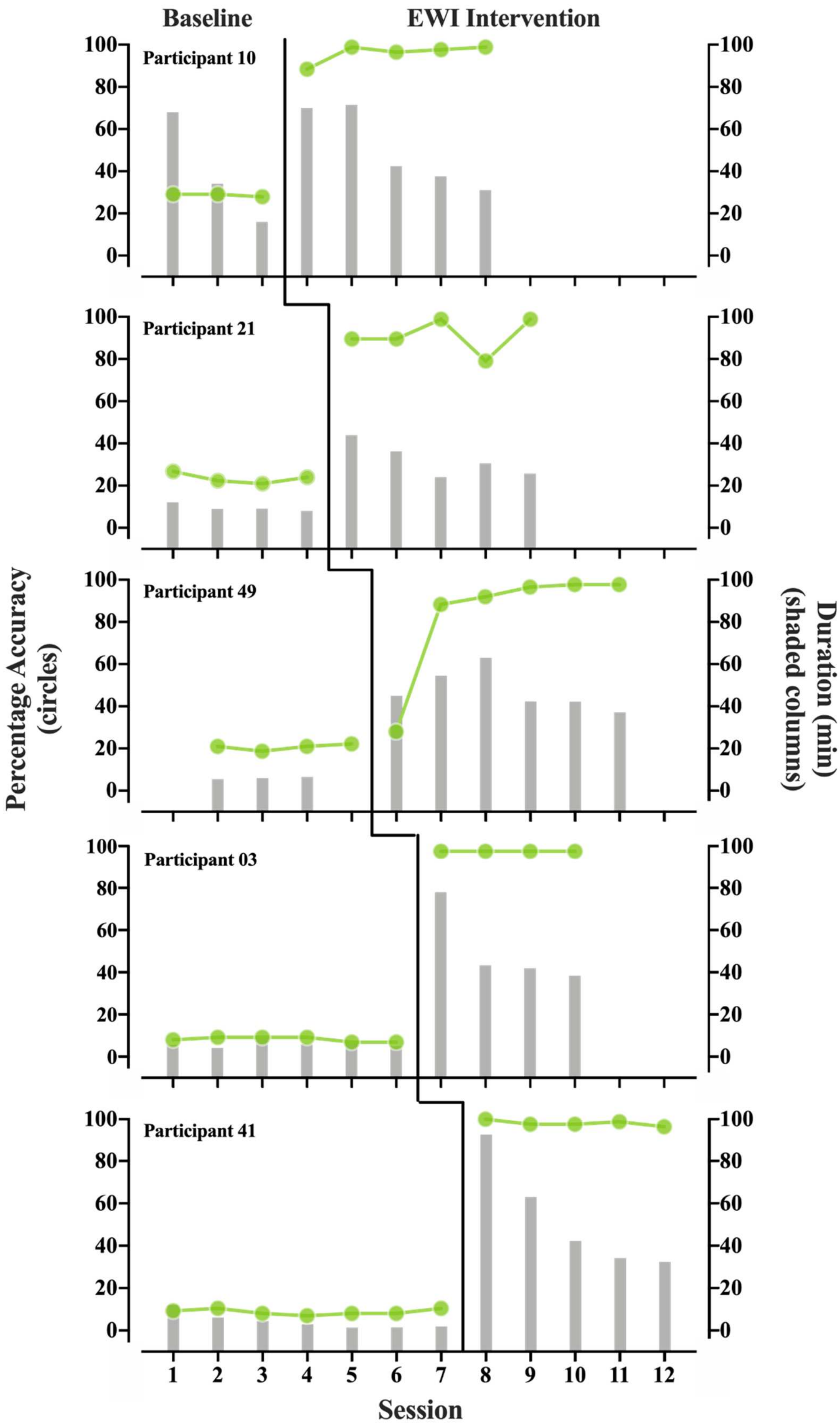

Baseline
EWI Intervention
Participant 10
Participant 21
Participant 49
Participant 03
Participant 41
Percentage Accuracy (circles)
Duration (min) (shaded columns)
0
20
40
60
80
100
1
2
3
4
5
6
7
8
9
10
11
12
Session

Figure 15. The overall results of the current study. The light green data path denotes the percentage accuracy for each participant across sessions, as well as the duration to graph completion (denoted by the gray bars).

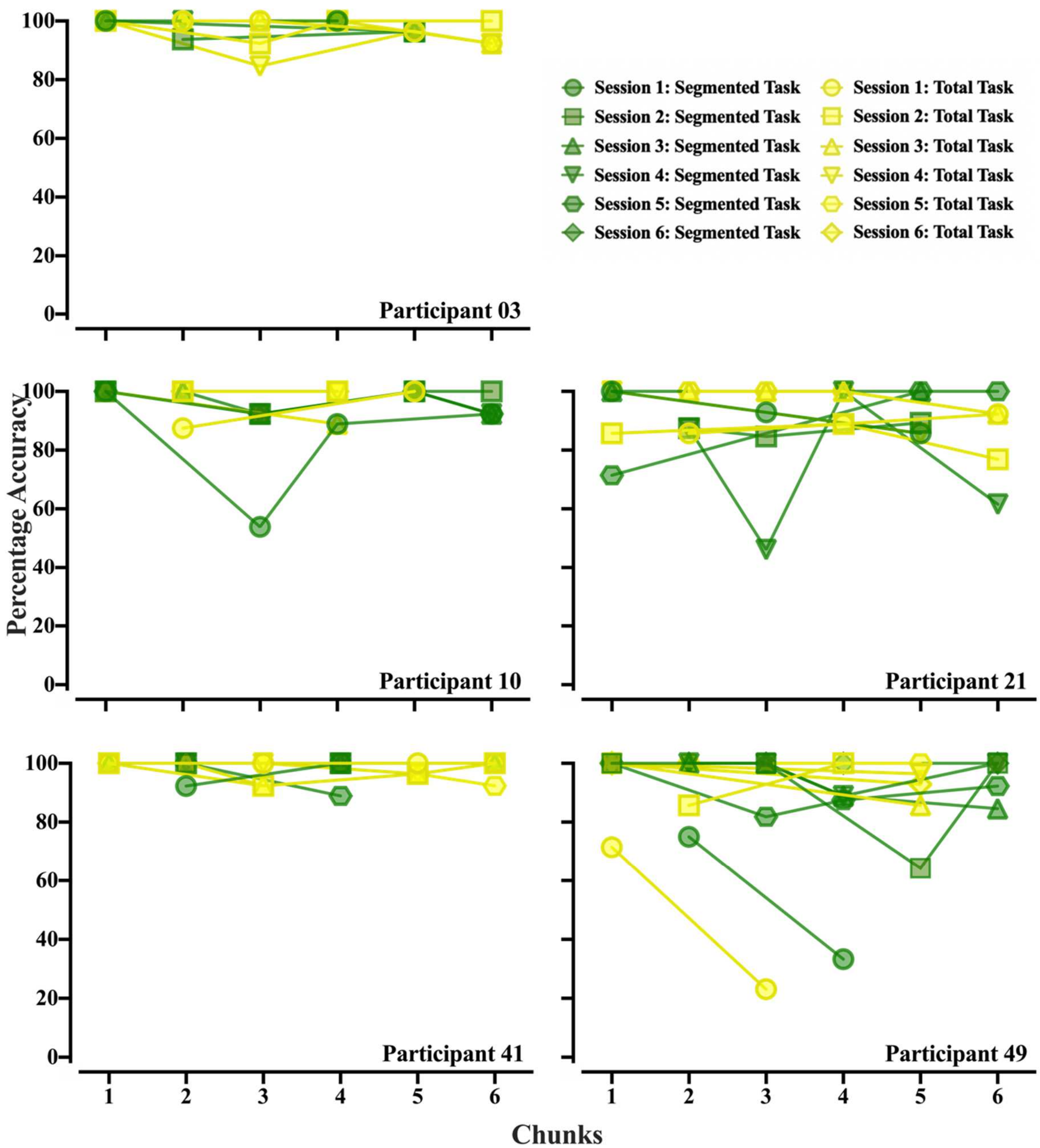


Figure 16. The overall percentage of graphing accuracy across chunks of the EWI for each participant.

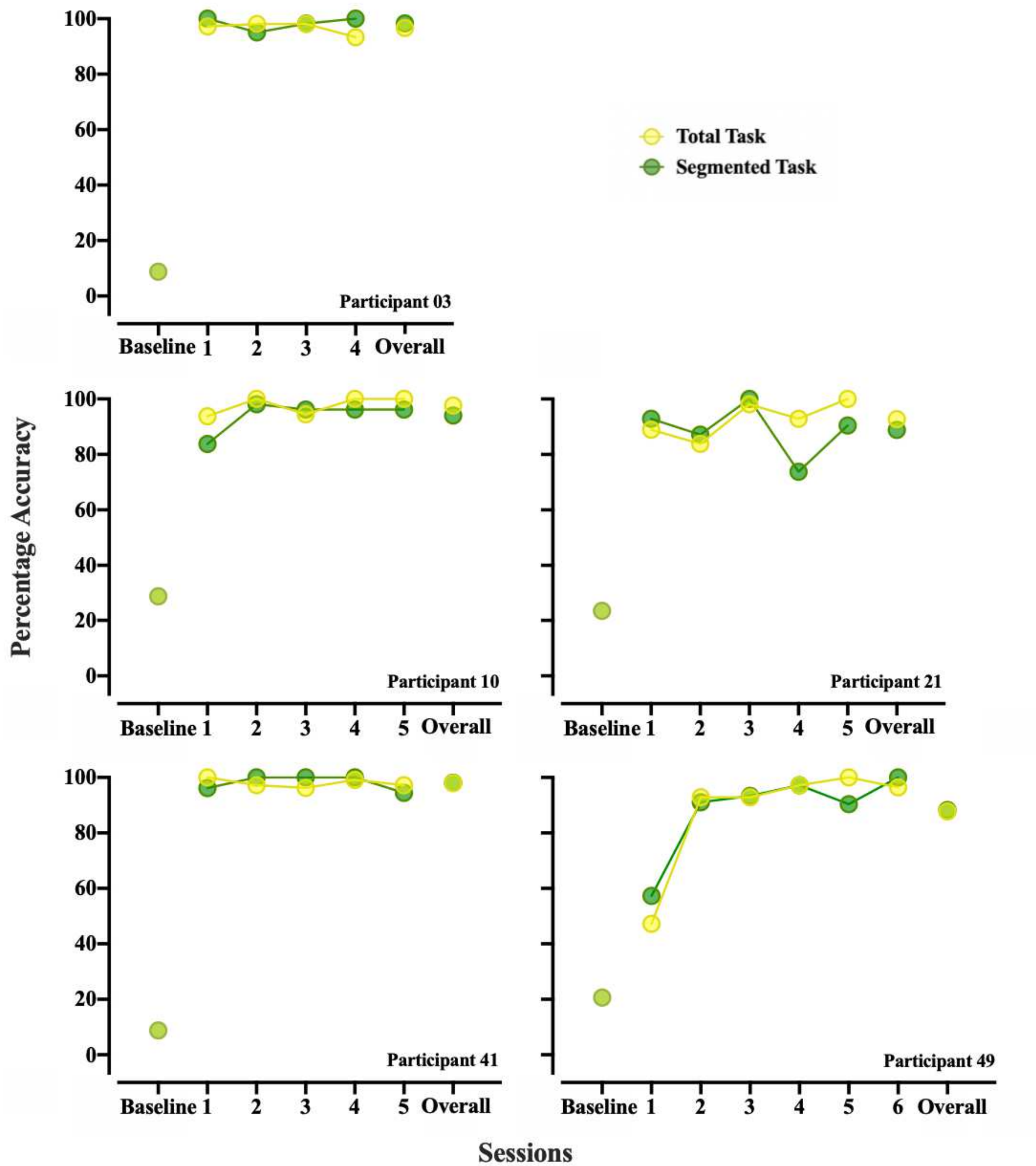


Figure 17. The average percentage accuracy for total task (yellow symbols) and segmented task (green symbols) presentations within sessions for each participant.

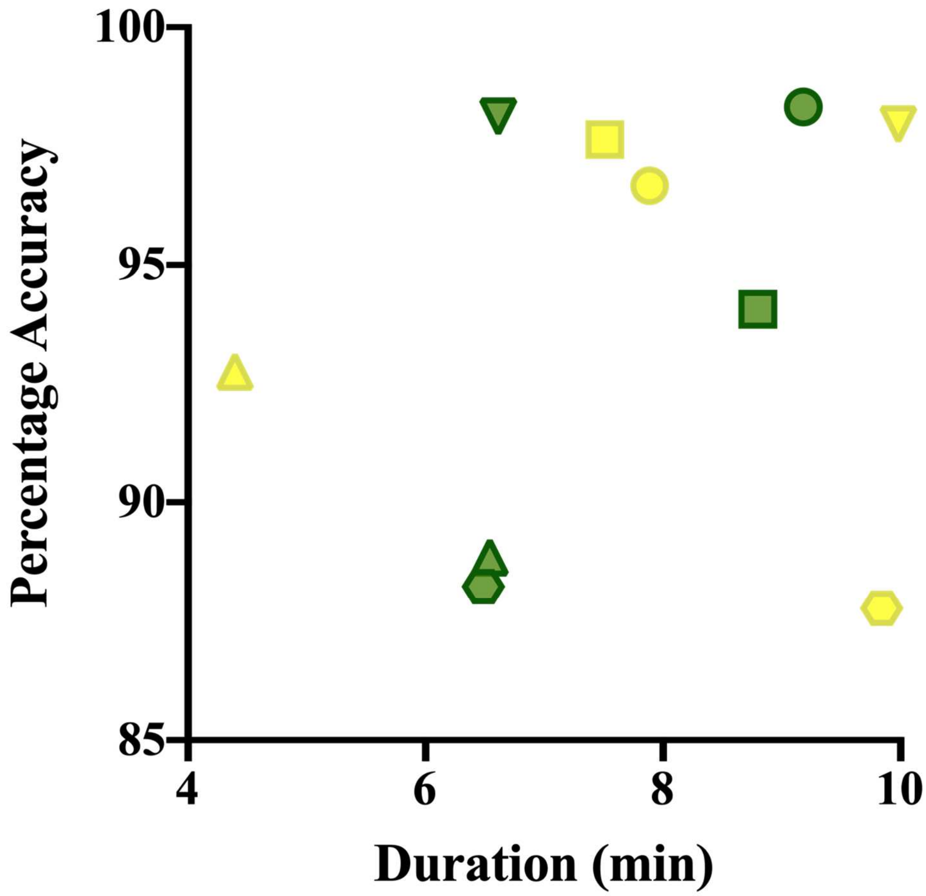


Figure 18. The overall efficiency for each participant during the two different chunk presentations. Yellow symbols represent total task (TT) presentation, green symbols represent segmented task (ST) presentation. Circle symbols represent Participant 03, square symbols represent Participant 10, triangle symbols represent Participant 21, inverted triangle symbols represent Participant 41, and hexagonal symbols represent Participant 49.

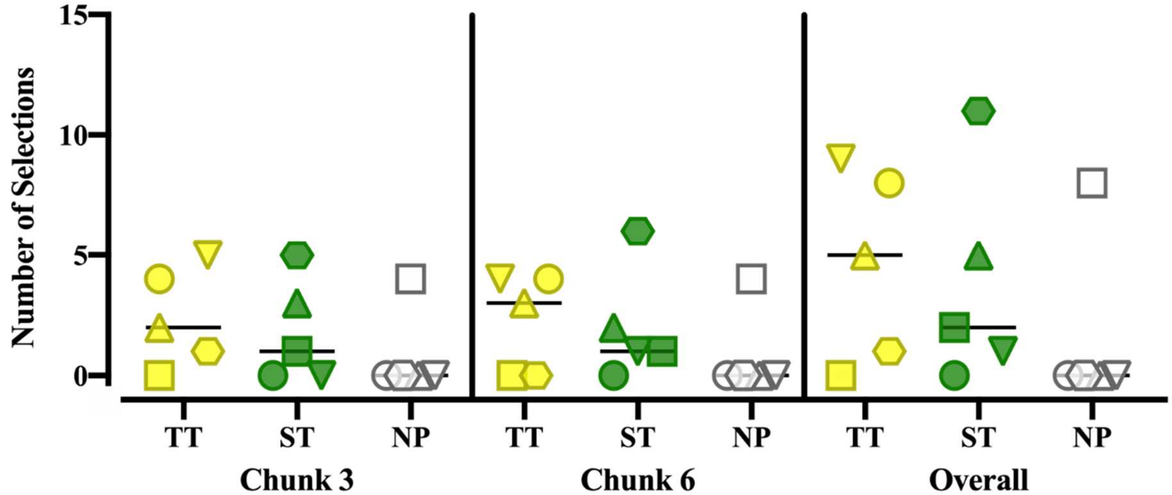


Figure 19. Yellow symbols represent total task (TT) presentation, green symbols represent segmented task (ST) presentation, and white symbols represent no preference. Circle symbols represent Participant 03, square symbols represent Participant 10, triangle symbols represent Participant 21, inverted triangle symbols represent Participant 41, and hexagonal symbols represent Participant 49.

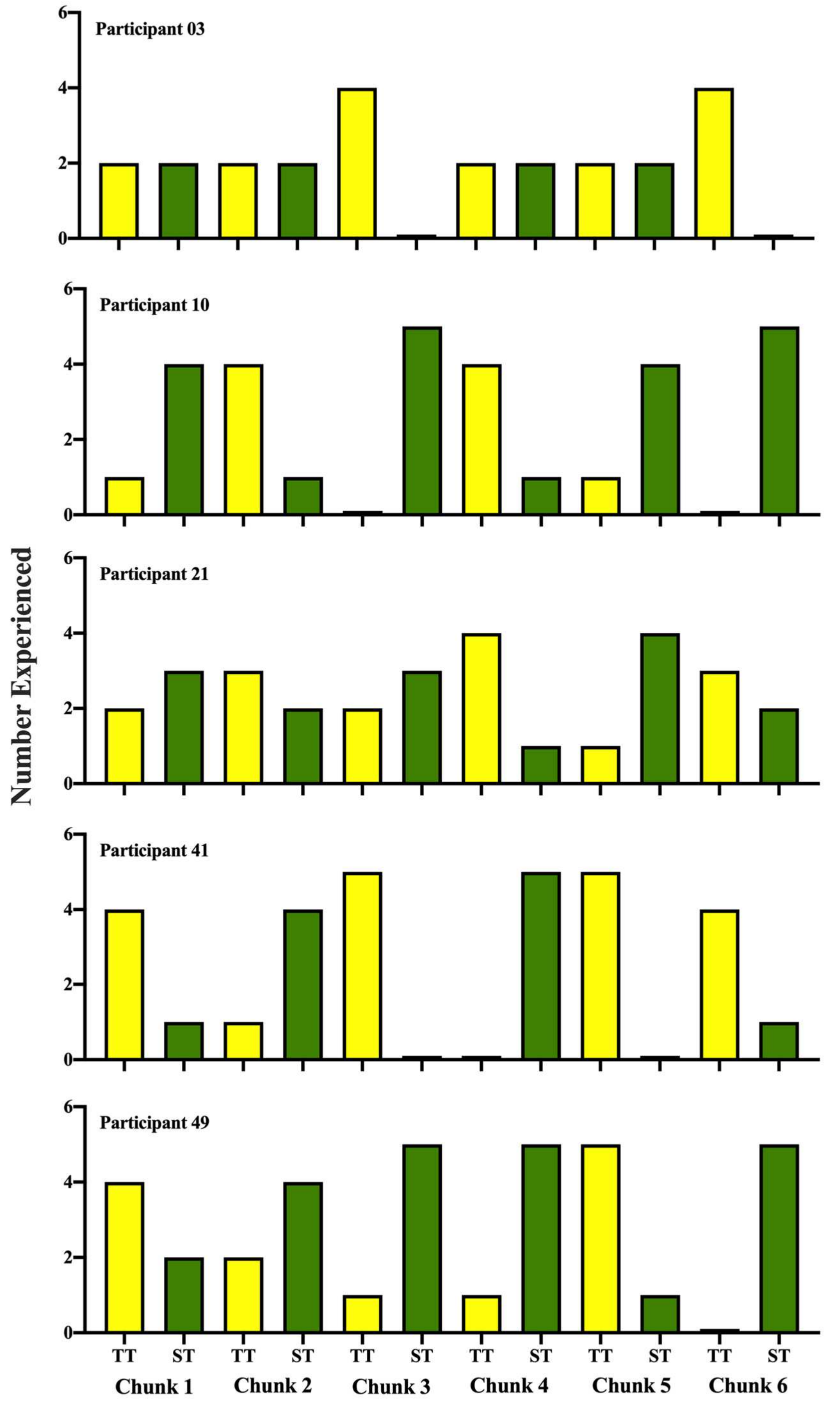


Figure 20. The number of times participants experienced each type of chunk presentation for each chunk.

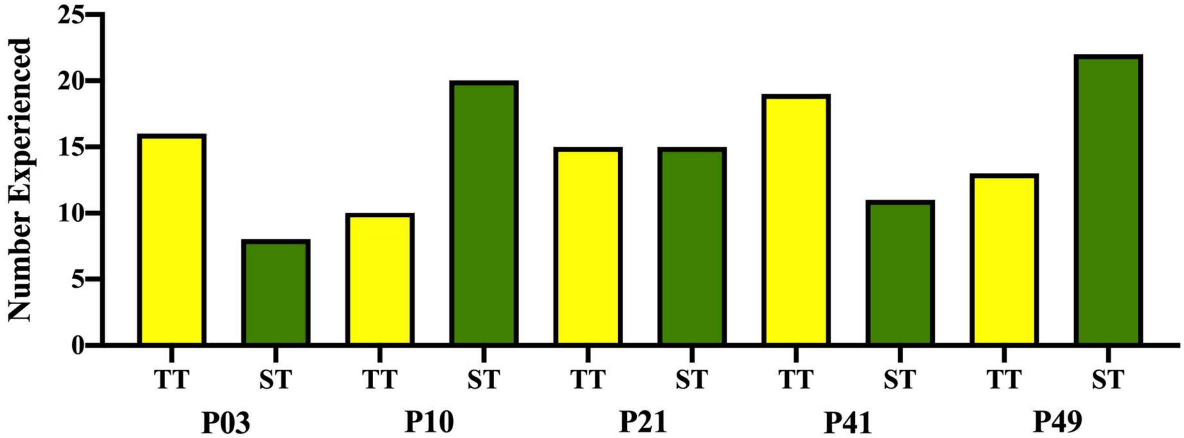


Figure 21. The overall number of times participants experienced each chunk presentation.

Table 1

Chunk Description

	Components Taught	Number of Sub-Items Included in EWI	Number of Sub-Items in Total Task	Number of Sub-Items in Segmented Task	Number of Graphing Elements Scored
Chunk 1	Select data for inclusion	38	36	10	7
	Select appropriate graph				
	Selecting graph area			5	
	Format *x*-axis			21	
Chunk 2	Format *y*-axis	40	40	27	16
	Format data path			13	
Chunk 3	Format phase change lines	43	43	28	13
	Format *x*-axis breaks			15	
Chunk 4	Delete chart junk	27	27	21	9
	Relocate graph			6	
Chunk 5	Titling phases and axes	65	61	45	28
	Resize graph			7	
	Titling graphs			9	
Chunk 6	Adding descriptive note	29	26	18	13
	Separate *x*- and *y*-axes			8	

Table 1. A description of chunks within the EWI. Components taught within each session are listed, as well as the number of steps included in the chunk and the number of steps that were scored within Excel.

Table 2

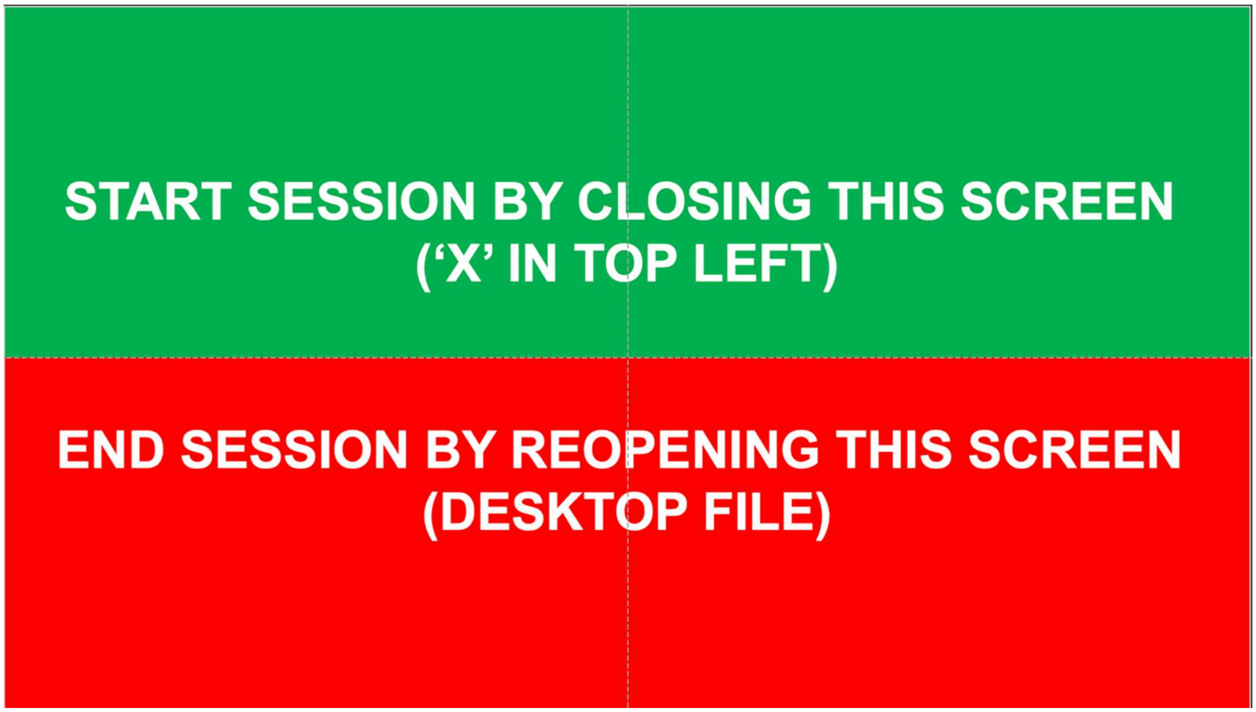
Duration of Chunk Completion in Minutes Across Sessions

		Chunk 1	Chunk 2	Chunk 3	Chunk 4	Chunk 5	Chunk 6
Participant 10	Session 1	17.29	8.82	12.24	3.74	21.75	6.15
	Session 2	17.28	10.54	12.24	3.96	20.83	6.55
	Session 3	9.52	8.33	6.98	2.62	10.13	7.15
	Session 4	4.81	6.37	3.92	5.27	11.17	3.13
	Session 5	6.23	3.02	3.05	3.16	11.74	3.12
Participant 21	Session 1	7.53	5.53	10.82	3.50	11.84	5.49
	Session 2	6.59	5.21	7.34	2.91	10.24	3.26
	Session 3	4.02	4.27	3.08	2.42	7.42	2.89
	Session 4	3.95	4.65	5.13	2.47	8.39	5.58
	Session 5	3.69	4.68	3.09	2.85	6.87	4.15
Participant 49	Session 1	10.59	7.21	15.13	5.14	2.41	--
	Session 2	11.04	7.01	7.50	4.17	16.48	8.43
	Session 3	5.58	7.21	12.14	3.40	16.35	4.48
	Session 4	8.24	5.83	5.56	3.85	13.91	4.50
	Session 5	5.5	8.15	6.14	2.75	12.05	5.28
	Session 6	6.29	6.89	6.18	2.72	10.58	5.22
Participant 03	Session 1	13.13	19.5	13.46	8.19	15.82	7.2
	Session 2	5.56	7.45	6.87	5.11	14.20	4.42
	Session 3	6.42	5.85	7.56	4.01	13.46	3.70
	Session 4	7.25	7.41	4.84	3.24	9.92	5.02

Participant 41	Session 1	14.03	10.76	10.41	12.04	32.23	12.29
	Session 2	18.64	6.85	7.04	4.47	19.83	4.69
	Session 3	9.91	6.41	5.06	3.71	13.54	3.63
	Session 4	4.79	5.89	4.45	5.65	11.05	3.25
	Session 5	3.85	5.26	3.87	3.77	10.96	4.76

Table 2. A display of duration to chunk completion data across participants, sessions, and chunks. Data are displayed in minutes.

Appendix A


START SESSION BY CLOSING THIS SCREEN
('X' IN TOP LEFT)
END SESSION BY REOPENING THIS SCREEN
(DESKTOP FILE)

Appendix B

General Directions

Overview
Graphs, when established correctly, are simple visual descriptors of responding across time and under certain conditions. There are many options to graph data (e.g., GraphPad Prism, SigmaPlot, Microsoft Excel), but Excel is the cheapest with the most information published on its use. Nonetheless, few of these are empirically validated and written as a training procedure. Even fewer publications focus on self-directed (i.e., self-teaching) training procedures. Therefore, the current investigation aims to evaluate the effects of enhanced written instruction (EWI) as a self-directed training procedure for graphing in Microsoft Excel.

Session Directions
We will give you pre-entered, hypothetical data in an Excel spreadsheet (i.e., Data-Entry Sheet). We will also give you a graph of these data. ***Your task is to re-create this hypothetical graph from the pre-entered data.*** Please do your best to complete the requirements in the allotted period. Do not worry if you do not know how to complete something! We are evaluating how well EWI serves as a self-directed training procedure – we are less worried about you as an individual and your current skill! ☺

<u>Starting & Stopping Sessions: Session Start & Stop Prompt</u>
The Session Start & Stop Prompt is a split screen with green and red sections. ***Minimizing or closing this screen officially starts the session.*** From there, will have the amount of time the proctor has noted to complete all graphing requirements. ***When you are complete with all graphing requirements, or cannot progress further, open this Session Start & Stop Prompter again.*** Please be careful! Intentionally or accidentally pulling up the Prompter will terminate your session!

<u>VLC Media Player</u>
We will also record your actions on your device using VLC Media Player (VLC). We will only record your screen, and this recording is only for the purpose of data collection. We will start and stop this recording – please <u>do not</u> do so on your own.

<u>Questions</u>
We will be able to see your movements and, again, will be recording the screen. However, unless initiated by you, we will not intervene until 45 min has expired or you reopen the Start & Stop Session Prompt effectively terminating your session, whichever occurs first. We may be able to answer *why* questions. However, remember, this is a self-directed training ☺!

Thank you!

Appendix C

Written Instructions

Problem Behavior
The effects of a token system were evaluated on problematic behavior (i.e., self-injurious behavior). The rate of self-injury was high during baseline; however, following the implementation of a token system, self-injury decreased to a zero-level.

Appendix D

Enhanced Written Instructions
Graphing *Dates* on X-Axis

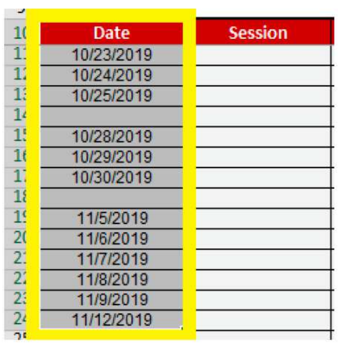
Directions

The following steps apply to all data sets within your Excel document unless otherwise noted. First, **please follow every step below, in order, as they relate to the data set you are graphing.** Second, **text boxes** throughout the instructions will help **clarify and give further direction** on a given step. Please read these! Third, the pictures may not exactly align with your hypothetical data set; however, your progress should look similar to that of the pictures throughout these instructions. Fourth, **note that you make different graphs depending on whether you are graphing *dates* or *sessions* along your x-axis** (note the title above and Step #2). Fifth, please go ahead and **fix any errors you see you have made**! Thank you for helping with this project! ☺

1. Select data for inclusion on your graph.

a. Click and hold on the red, data-header "Dates."

b. Drag down to the last date entered and release your click. These cells should now all be highlighted.



c. While holding down "Ctrl," on your keyboard, and click on the red, data-header topography abbreviation under "Topography 1."

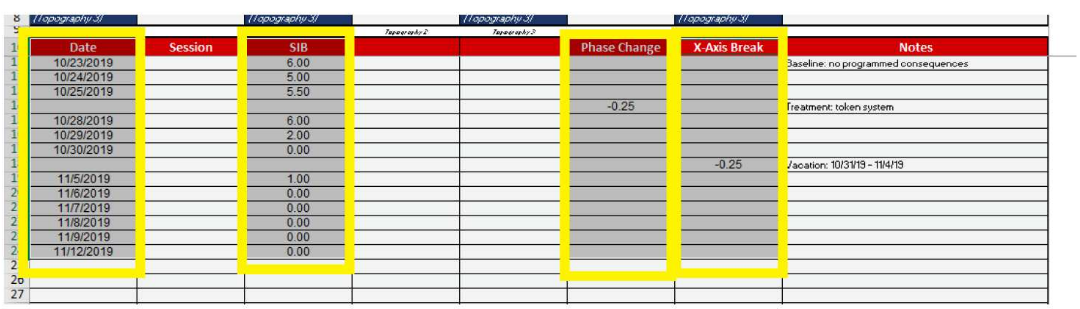
d. Drag down to the cell equal to that of the last date entered (i.e., you should be highlighting the same number of cells as you did before but within a different column). These cells should now all be highlighted, too.

e. While still holding down "Ctrl," repeat Steps #1c and #1d for:

i. "Phase Change," and

ii. "X-Axis Break."

f. Release "Ctrl."



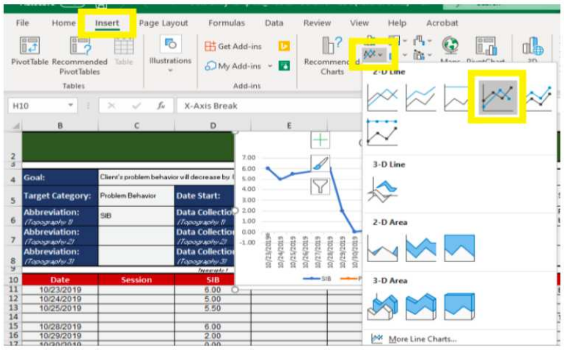
Date	Session	SIB			Phase Change	X-Axis Break	Notes
10/23/2019		6.00					Baseline: no programmed consequences
10/24/2019		5.00					
10/25/2019		5.50					
					-0.25		Treatment: token system
10/28/2019		6.00					
10/29/2019		2.00					
10/30/2019		0.00					
						-0.25	Vacation: 10/31/19 - 11/4/19
11/5/2019		1.00					
11/6/2019		0.00					
11/7/2019		0.00					
11/8/2019		0.00					
11/9/2019		0.00					
11/12/2019		0.00					

2. Select the appropriate graph for your data.

a. Click “Insert,” located at the top, left of your Excel document.

i. Above “Charts,” click “Insert Line of Area Chart” (this appears when you hover over the correct icon).

ii. Under “2-D Line,” click “Line with Markers” (this appears when you hover over the correct icon).



3. Select graph area to format.

a. Click on the graph.

b. Click “Format,” located at the top, center of your Excel document.

c. Above “Current Selection,”

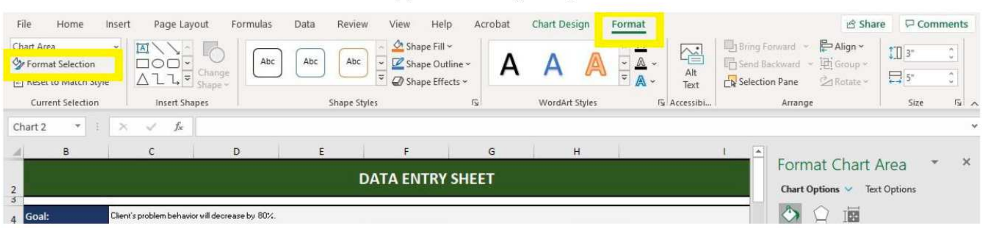
i. Click “Format Selection,” located to the top, left of your Excel document. A window (i.e., formatting window) should appear to the right of your Excel document.

ii. Above “Format Selection,” click the down arrow next to the textbox and select your current graph area in need of changing (see following steps for which area you need to select).

d. The Format Window should appear to the right of your screen.

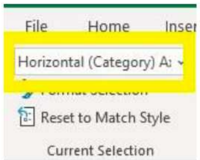
> **3. Selecting Graph Area & Format Window**
> Getting to and working in Format Window is going to be used throughout this training. However, you will need to select the respective graph area from the drop-down menu for your changes Format Window to be accurate.

> **3c. If Format Window Closes**
> If you close out of your Format Window, follow Step# 3ci to open it back up.

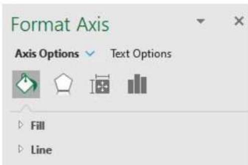


4. Format x-axis.

a. Repeat Step #3 (see p. 2) and click "Horizontal (Category) Axis."



b. Within Format Window, click "Axis Options," located just below "Format Axis" and to the left of "Text Options."

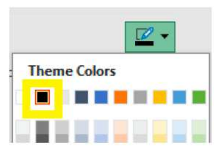


i. Click "Fill & Line" – the spilling paint icon.

1. Click "Line" so its sub-options are available.

a. Next to "Color," click the icon and click "Black, Text 1." This title should appear when hovering over the correct color, and this can be found in the first row of colors.

b. Set "Width" to "1 pt."



ii. Click "Axis Options" – the three-bar icon.

1. Click "Axis Options" so its sub-options are available.

a. Under "Axis Type," click "Text axis."

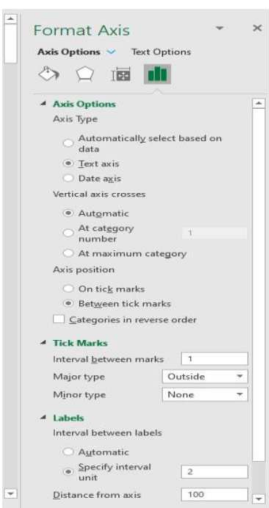
2. Click "Labels" so its sub-options are available.

a. Click "Specify interval unit."

i. Set "Specify interval unit" to best depict your data (see box #4bii below).

3. Click "Tick Marks" so its sub-options are available.

a. Set "Major type" to "Outside."



4bii. "Best Depict Your Data" for the X Axis

You want your reader to easily identify what date relates to which data point. What you don't want is your axis to be overcrowded too spread out. Follow this guideline for *best depicting your data:*

# of Dates Entered	"Specify interval unit"
1-10	1
11-20	2
21-30	5
31-50	10
51-100	10, 20, or 25
101+	20 or 25

iii. Click "Size & Properties" – the measuring square icon.

1. Click "Alignment" so its sub-options are available.

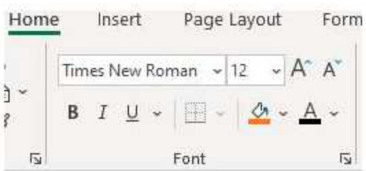
a. Next to "Text direction," click "Rotate all text 270°."

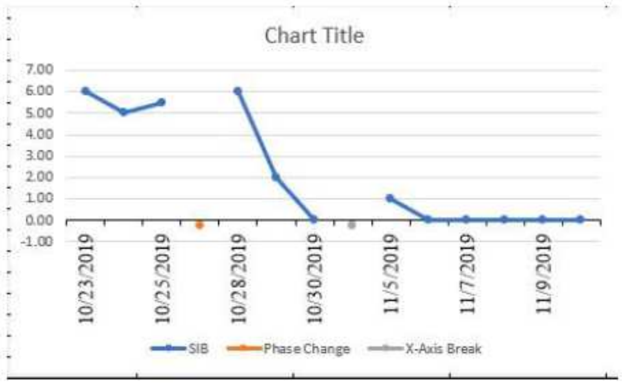
c. Click "Home," located at the top, left of your Excel document. Above "Font,"

i. Click the down arrow next to the font textbox and click "Times New Roman." You may have to scroll down within this drop-down menu.

ii. Click the down arrow next to the font size textbox and click "12."

iii. Click the down arrow next to underlined letter A and click "Black, Text 1."





5. Format y-axis.

a. Repeat Step #3 (see p. 2) and click "Vertical (Value) Axis."

b. Within Format Window, click "Axis Options," located just below "Format Axis" and to the left of "Text Options."

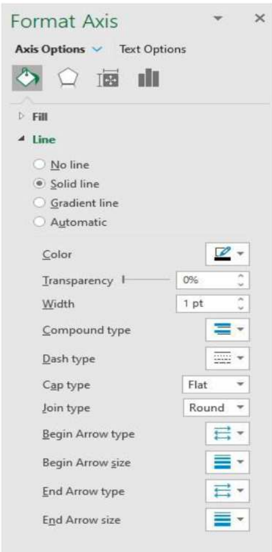
i. Click "Fill & Line" – the spilling paint icon.

1. Click "Line" so its sub-options are available.

a. Next to "Color," click the icon and click "Black, Text 1." This title should appear when hovering over the correct color, and this can be found in the first row of colors.

b. Set "Width" to "1 pt."

ii. Click "Axis Options" – the three-bar icon.



1. Click "Axis Options" so its sub-options are available.

a. Under "Bounds,"

i. Set "Maximum" to best depict your data (see Box #5bii on p. 6).

<u>5bii. How are my Data Analyzed?</u> Reference the Data Entry Sheet, and next to Data Analysis, to determine how your data are analyzed.

1. If your data are analyzed as cumulative or rate, set "Maximum" to best depict your data (see Box #5bii to right).
2. If your data are analyzed as percentage, set "Maximum" to "100."

ii. Set "Minimum" to best depict your data (see Box #5bii to right).

b. Under "Units," set "Major" to best depict your data (see Box #5bii to right).

c. Under "Horizontal axis crosses,"

i. Click "Axis value."

ii. Set "Axis value" to best depict your data (see Box #5bii to right).

2. Click "Tick Marks" so its sub-options are available.

a. Set "Major type" to "Outside."

3. Click "Number" so its sub-options are available.

a. If "Units, Major" was set to an interval other than a whole number (e.g., .25, 1.5), do not make any further changes.

b. If "Units, Major" was set to a whole number (e.g., 1, 2, 3), set "Decimal places:" to "0."

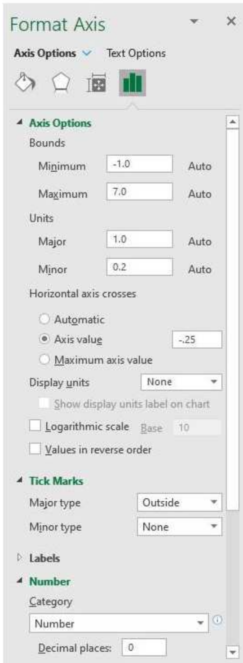
4. Click "Enter" on your keyboard.

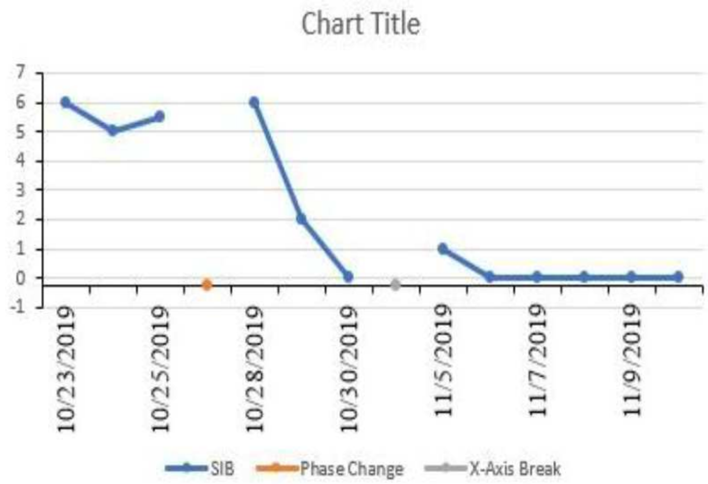
5bii. "Best Depict Your Data" for the Y Axis

You want your reader to easily identify the measurement of each data point. You don't want your axis to be overcrowded or too spread out. Follow this guideline for *best depicting your data:*

Greatest Data Point	"Units, Major" & "Bounds Minimum"	"Bounds, Maximum"	Axis Value
1-10	1 & -1	Next whole number greater than Greatest Data Point	-.25
11-20	2 & -2	Next even, whole number greater than Greatest Data Point (if Greatest Data Point is not already an even number)	-.25
21-30	5 & -5	Next multiple of 5 (if Greatest Data Point is not already a multiple of 5)	-.25
31-50	10 & -10	Next multiple of 10 (if Greatest Data Point is not already a multiple of 10)	-2.5
51-100	10, 20, or 25 & -10, -20, or -25	Next multiple of Unit decided (if Greatest Data Point is not already a multiple of decided Unit)	-2.5
100+	20 or 25 & -20 or -25	Next multiple of Unit decided (if Greatest Data Point is not already a multiple of decided Unit)	-2.5

The Axis Value should also match the number entered on your Data Entry Sheet under Phase Change and X-Axis Break.



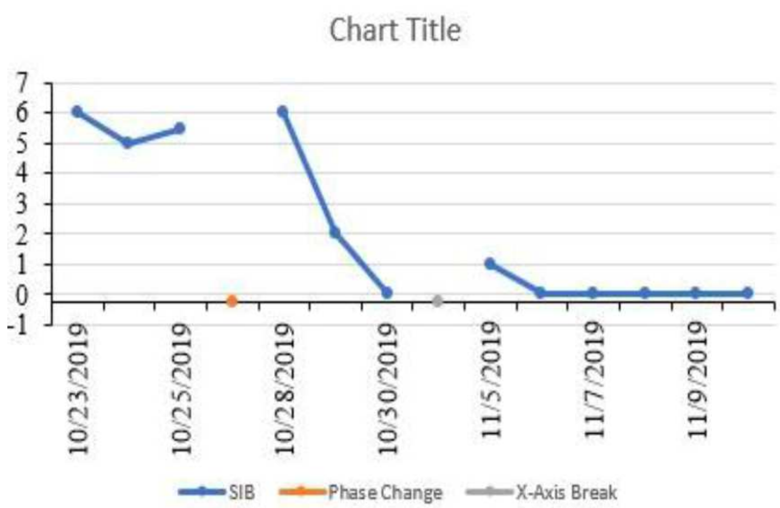


c. Click "Home," located at the top, left of your Excel document. Above "Font,"

i. Click the down arrow next to the font textbox and click "Times New Roman." You may have to scroll down within this drop-down menu.

ii. Click the down arrow next to the font size textbox and click "12."

iii. Click the down arrow next to underlined letter A and click "Black, Text 1."



6. Format data path.

a. Repeat Step #3 (see p. 2) and click the "Series" that corresponds with your target behavior (e.g., "Series 'Spoon'."

b. Within Format Window,

i. Click "Fill & Line" – the spilling paint icon.

1. Click "Line," located to the left of "Marker."

a. Click "Line" so its sub-options are available.

i. Next to "Color," click the icon and click "Black, Text 1." This title should appear when hovering over the correct color, and this can be found in the first row of colors.

ii. Set "Width" to "1 pt."

2. Click "Marker," located to the right of "Line."

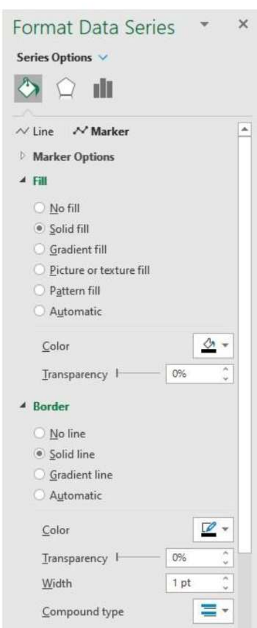
a. Click "Fill" so its sub-options are available.

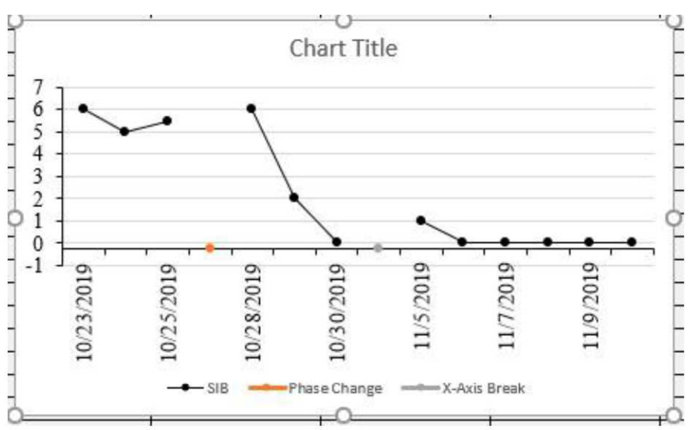
i. Next to "Color," click the icon and click "Black, Text 1." This title should appear when hovering over the correct color, and this can be found in the first row of colors.

b. Click "Border" so its sub-options are available.

i. Next to "Color," click the icon and click "Black, Text 1." This title should appear when hovering over the correct color, and this can be found in the first row of colors.

ii. Set "Width" to "1 pt."





7. Format phase change lines.

a. Repeat Step #3 (see p. 2) and click "Series 'Phase Change'."

b. Within Format Window,

   i. Click "Fill & Line" – the spilling paint icon.

      1. Click "Line," located to the left of "Marker."

         a. Click "Line" so its sub-options are available.

            i. Click "No line."

      2. Click "Marker," located to the right of "Line."

         a. Click "Marker Options" so its sub-options are available.

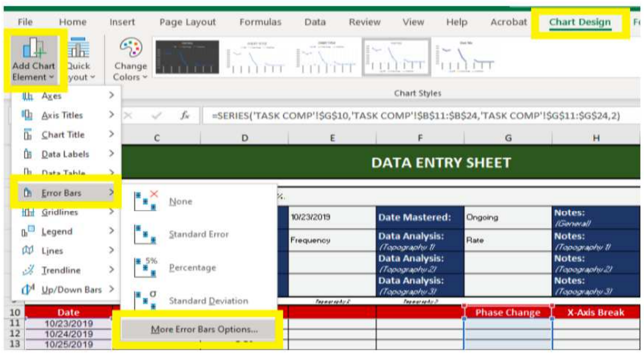
            i. Click "None."

c. Click "Chart Design" (or "Design"), located at the top, center of your Excel document.

   i. Above "Chart Layouts," click "Add Chart Element."

   ii. Click "Error Bars"

   iii. Click "More Error bars Options…." The formatting window should now read, "Format Error Bars."



d. Repeat Step #3 (see p. 2) and click "Series 'Phase Change' X Error Bars" (if necessary).

   i. Click "Backspace" on your keyboard.

e. Repeat Step #3 (see p. 2) and click "Series 'Phase Change' Y Error Bars."

f. Within Format Window,

   i. Click "Fill & Line" – the spilling paint icon.

      1. Click "Line" so its sub-options are available.

         a. Next to "Color," click the icon and click "Black, Text 1." This title should appear when hovering over the correct color, and this can be found in the first row of colors.

         b. Set "Width" to "1 pt."

   ii. Click "Axis Options" – the three-bar icon.

      1. Click "Vertical Error Bar" so its sub-options are available.

         a. Under "Direction," click "Plus."

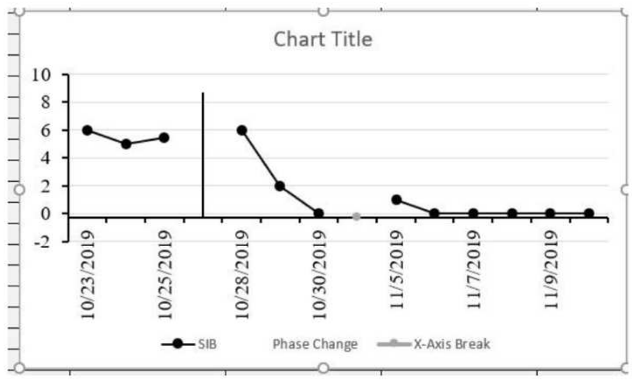
         b. Under "End Style," click "No Cap."

         c. Under "Error Amount," click "Fixed value."

> **<u>7fii. Absolute Values</u>**
> The phase change line needs to extend from your x-axis up to the top of your y-axis.
>
> Example:
> Y-axis Max= 7
> Y-axis Min= -1 (Abs. value: <u>1</u>)
> *Phase change: 7+1=<u>8</u>*

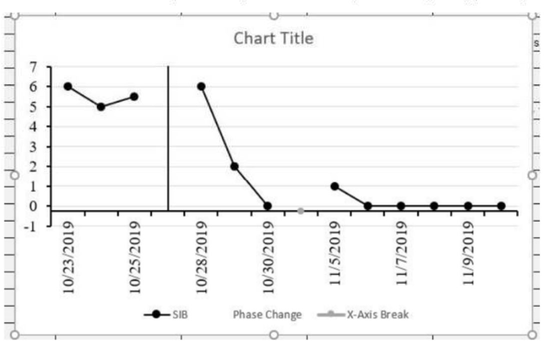
i. Set "Fixed value" to the maximum of your y-axis plus the absolute value of your minimum of your y-axis. To find the absolute value, simply change the negative to a positive (e.g., the absolute value of -1 is 1).

ii. Click "Enter" on your keyboard.



8. Reset your y-axis if this changed due to creating your phase change line (if necessary; otherwise, skip to Step #9.)

a. Repeat Step #5a and Step #5bii1 (see pp. 5-7).



9. Format x-axis breaks.

a. Repeat Step #3 (see p. 2) and click "Series 'X-Axis Break."

b. Within Format Window,

i. Click "Fill & Line" – the spilling paint icon.

1. Click "Line," located to the left of "Marker."

a. Click "Line" so its sub-options are available.

i. Click "No line."

2. Click "Marker," located to the right of "Line."

a. Click "Marker Options" so its sub-options appear.

i. Click "Built-in."

ii. Next to "Type," click the down arrow and click the long, horizontal line just above the circle.

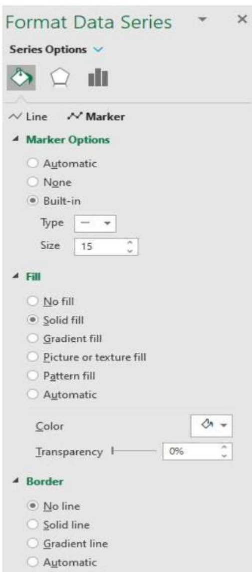
iii. Set the "Size" to "15."

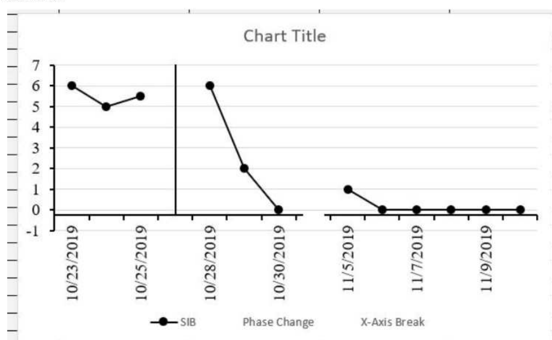
b. Click "Fill" so its sub-options appear.

i. Next to "Color," click the icon and click "White, Background 1." This title should appear when hovering over the correct color, and this can be found in the first row of colors.

c. Click "Border" so its sub-options appear.

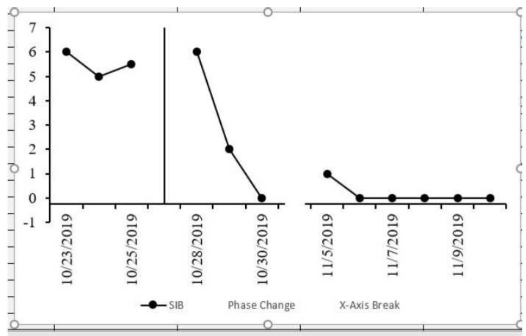
i. Click "No line."



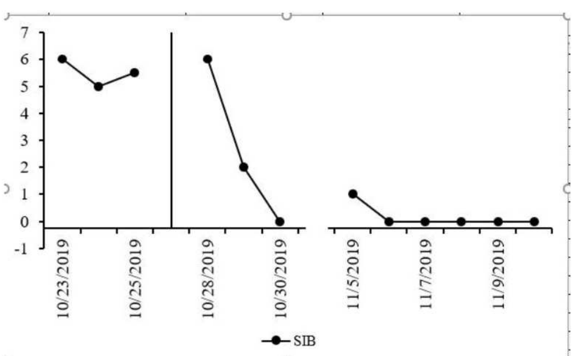


10. Delete chart junk.

a. Repeat Step #3 (see p. 2) and click "Chart Title."
   i. Click "Backspace" on your keyboard.
b. Repeat Step #10a (see above) for:
   i. "Horizontal (Value) Axis Major Gridlines;" and,
   ii. "Vertical (Value) Axis Major Gridlines.
c. Repeat Step #3 (see p. 2) and click "Chart Area."
   i. Within the formatting window, click "Chart Options," located just below "Format Chart Area" and to the left of "Text Options."
      1. Click "Fill & Line" – the spilling paint icon.
         a. Click "Border" so its sub-options are available.
            i. Click "No line."



d. Repeat Step #3 (see p. 2) and click "Legend."
   i. Within the physical legend on the graph, click specifically on "Phase Change."
      1. Click "Backspace" on your keyboard.
   ii. Repeat Step #10di (see above) but within the physical legend on the graph, click specifically on "X-Axis Break."
      1. Click "Backspace" on your keyboard.
   iii. Repeat Step #3 (see p. 2) and click "Legend."
   iv. Click "Home," located at the top, left of your Excel document.
      1. Above "Font,"
         a. Click the down arrow next to the font textbox and click "Times New Roman." You may have to scroll down within this drop-down menu.
         b. Click the down arrow next to the font size textbox and click "10."
         c. Click the down arrow next to underlined letter A and click "Black, Text 1."



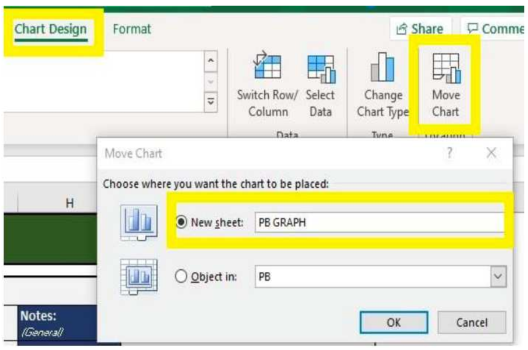
11. Relocate graph to its own, graph-specific tab.

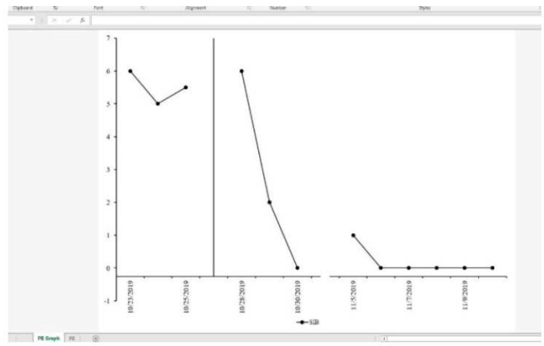
a. Click on the graph.

b. Click “Chart Design” (or “Design”), located at the top, center of your Excel document.

i. Above “Location,” click “Move Chart.”

1. Click “New sheet:”
2. Rename this new sheet the Target Category abbreviation (i.e., what is written on your tab; e.g., “Feeding”) followed by “Graph” (e.g., Feeding Graph).
3. Click “OK.” The graph should now appear in its own tab.



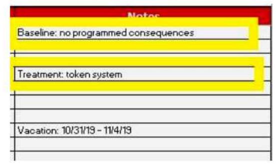


12. Titling phases and axes.

a. Click on tab at the bottom of your Excel document associated with the Data Entry Sheet and write down:

i. What your Target Category and Data Analysis are; and,

ii. What baseline and treatment consisted of (e.g., no programmed consequences, DRA, token system) – this information should appear next to "Baseline" and "Treatment" in the column under the red, data-header section "Notes."

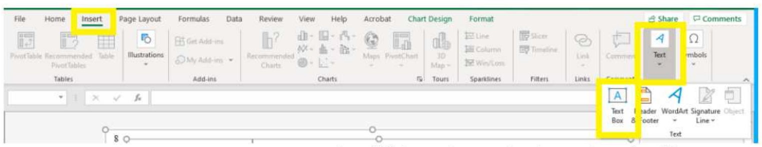


b. Click on tab at the bottom of your Excel document associated with the Graph.

i. Title the x-axis.

1. Click "Insert," located at the top, left of your Excel document.

a. Above "Text," click "Text Box." This may also appear as an italicized A within a box – click that icon and then click "Text Box."



b. Click on the graph. A text box should appear.

c. Type "Dates."

2. Click on the grey outline of the text box.

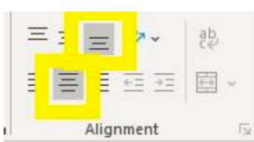
3. Click "Home," located at the top, left of your Excel document.

a. Above "Font,"

i. Click the down arrow next to the font textbox and click "Times New Roman." You may have to scroll down within this drop-down menu.

ii. Click the down arrow next to the font size textbox and click "14."

iii. Click the down arrow next to underlined letter A and click "Black, Text 1."



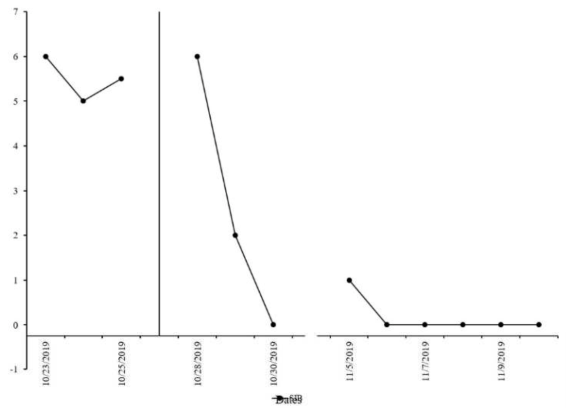
b. Above "Alignment,"

i. Click "Bottom Align" (this appears when you hover over the correct icon).

ii. Click "Center" (this appears when you hover over the correct icon).

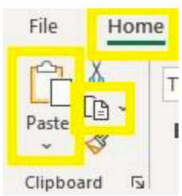
4. Resize the text box so there is relatively no unused space above or below the title.

5. Drag the text box so it is centered and flush with the bottom of the page.



ii. Title the y-axis.

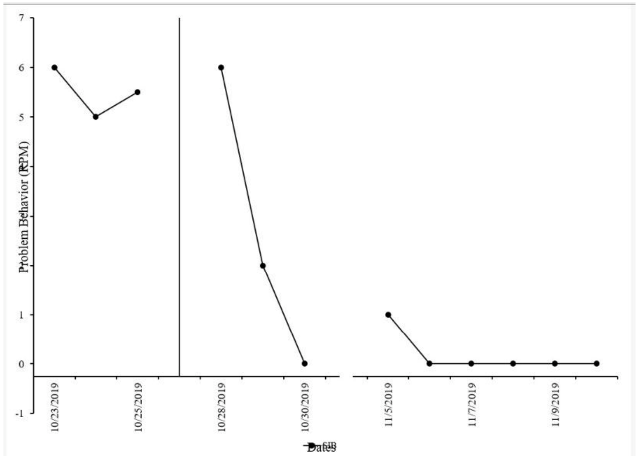
1. Click on the text box you created for the x-axis title.
2. Click again on the grey outline of the text box.
3. Click "Home," located at the top, left of your Excel document.
   a. Above "Clipboard,"
      i. Click "Copy" (this appears when you hover over the correct icon).
      ii. Click "Paste" (this appears when you hover over the correct icon).
      iii. A copy of the text box you created for the x-axis title should appear.
4. Highlight the text within the new text box and type Target Category (e.g., Feeding) – the first letter of each word being capitalized – followed by the method of data analysis in parentheses (e.g., [RPM]).
5. Rotate the text box until 270°, or until the text is vertical and facing the y-axis.
   a. Hold "Shift" on your keyboard and click and hold on the rotating arrow icon located just outside the text box (a rotating arrow should appear when you hover over the correct icon).
   b. Rotate until the text is vertical and facing the y-axis – let go of your click and "Shift."
6. Drag the text box so it is centered and flush to the far left of the page.



12bii1-3. Copy-and-Paste
You will be required to copy-and-paste a variety of text here on out. **Repeating these steps will be stated as "copy-and-paste."**

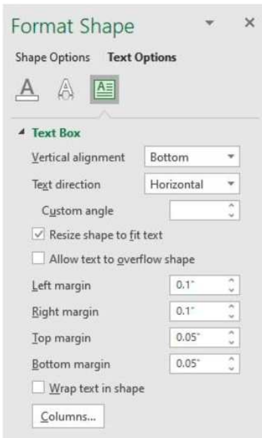
12bii. Titling Y-Axis
Data analyzed as a rate should be titled RPM or RPH, for example. Data analyzed as cumulative can just be titled "cumulative." Data analyzed as a percentage should be titled % Session or % Day, for example.

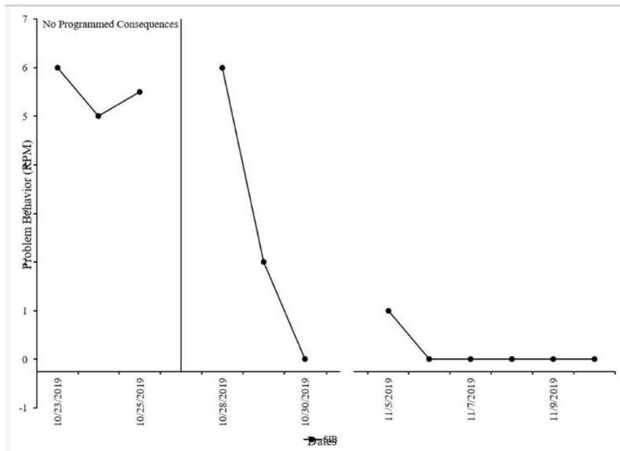
12bii. Rotating the Text Box
You may need to drag the text box so that it is in the middle of the screen in order to see the rotating arrow.



iii. Title the baseline condition.

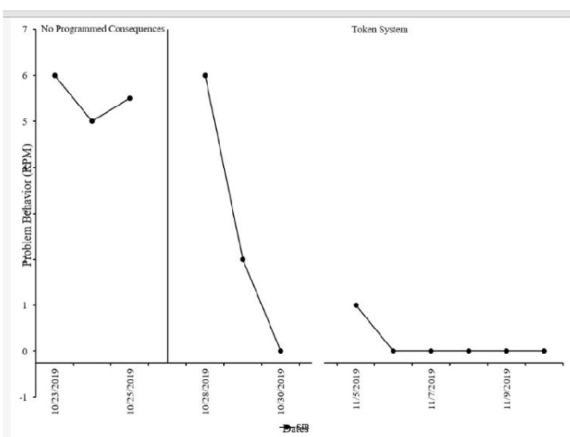
1. Copy-and-paste the text box you created for the x-axis title (see Box #12bii1-3 if needed, p. 15).
2. Highlight the text within the new text box and type what the baseline consisted of (e.g., no programmed consequences) with the first letter of each word being capitalized.
3. Click on the grey outline of the text box.
4. Click "Home," located at the top, left of your Excel document.
    a. Above "Font," click the down arrow next to the font size textbox and click "12."
5. Drag the text box so it is centered between the y-axis as the phase change line, and flush against the top of the page.
6. Within the formatting window, click "Text Options," located just below "Format Shape" and to the right of "Shape Options."
    a. Click "Textbox" – the A within a document icon.
        i. Click "Text Box" so its sub-options are available.
            1. Click the checkbox next to "Resize shape to fit text" so it is now checked.
            2. Unclick the checkbox next to "Allow text to overflow shape" so it is now not checked.





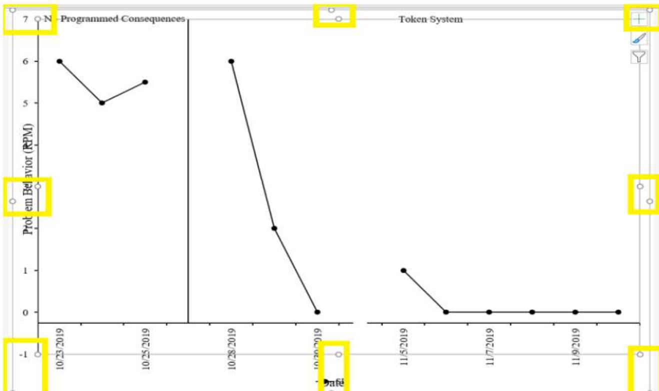
iv. Title the treatment condition.

1. Copy-and-paste the text box you created for the baseline condition (see Box #12bii1-3 if needed, p. 15).
2. Highlight the text within the new text box and type what the treatment consisted of (e.g., prompt fading, BST, token system) with the first letter of each word being capitalized.
3. Drag the text box so it is centered between the phase change line and the end of the graph and located at the top of your page.

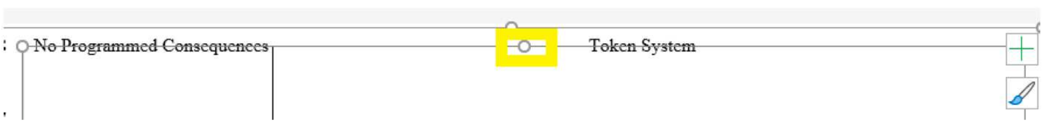


13. Resize graph and placement of legend.

a. Click within the graph such that the graph becomes outlined with white circles at all corners of the graph, as well as white circles in the middle of all four sides of the outline. The page itself will also be outlined with the same white circles.



i. Click and hold on the white circle located in the middle, top of the graph's outline, just above the middle of the graph. A black "+" should appear.



1. Drag the top of the graph until it is just below your phase change titles.

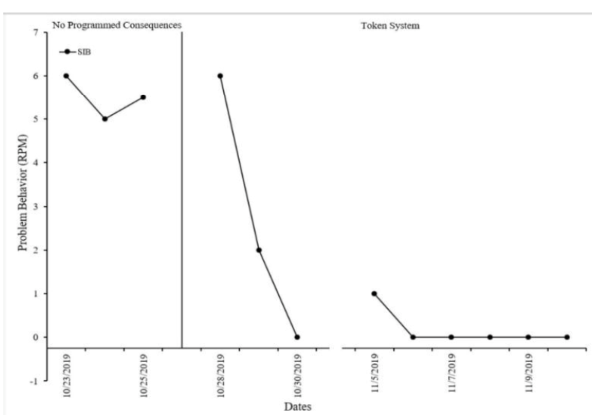
ii. Click and hold on the white circle located in the middle, left of the graph's outline, just to the right of the y-axis labels (i.e., the numbers) the middle of the y-axis. A black "+" should appear.

iii. Drag the left side of the graph until the y-axis labels (i.e., the numbers) are just to the right of your y-axis title.

b. Re-center the phase change titles as needed.

c. Click on the legend and drag it into the graph area so it can clearly be read and does not interfere with any data points, data paths, axes, etc.

13c. Legend Placement
Do not place your legend in the bottom right of your graph because your graph title will go here during the next step.



14. Titling graphs.

a. Click on tab at the bottom of your Excel document associated with the Data Entry Sheet and write down the details within (e.g., client name, location of sessions) – this information should appear in the "General Notes."

b. Click on tab at the bottom of your Excel document associated with the Graph.

   i. Copy-and-paste the text box you created for the baseline condition (see Box #12bii1-3 if needed).

   ii. Highlight the text within the new text box and type what your General Notes said to better describe the graph (e.g., Jackson, Lunch, Clinic) with the first letter of each word being capitalized.

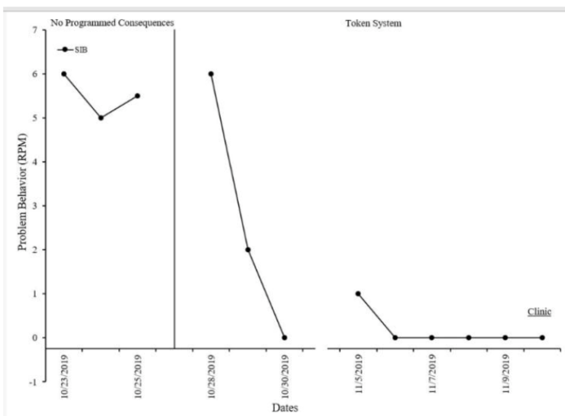
   iii. Click on the grey outline of the text box.

   iv. Click "Home," located at the top, left of your Excel document.

      1. Above "Font," click the underlined U icon to underline your graph's title.

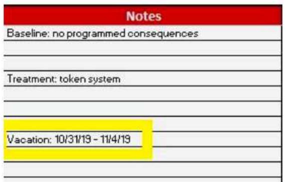
      2. Above "Alignment," click "Align Right" (this will appear when hovering over the correct icon).

   v. Drag the text box so it is to the far right of your graph and does not interfere with any data paths, either just above your x-axis or above your y-axis.



15. Adding descriptive notes and arrows.

a. Click on tab at the bottom of your Excel document associated with the Data Entry Sheet and write down why you broke the x-axis – this information should appear in the column under the red, data-header section "Notes."



Notes
Baseline: no programmed consequences
Treatment: token system
Vacation: 10/31/19 - 11/4/19

b. Click on tab at the bottom of your Excel document associated with the Graph.

c. Add descriptive text box to explain important information.

i. Copy-and-paste the text box you created for the baseline condition (see Box #12bii1-3 if needed).

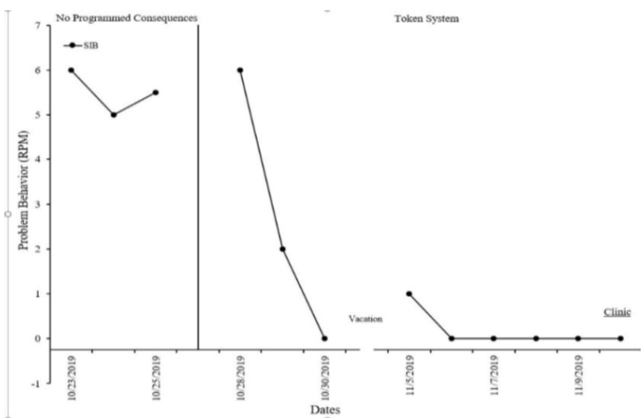
ii. Highlight the text within the new text box and type why you broke your x-axis (e.g., Break, Sick).

iii. Click on the grey outline of the text box.

iv. Click "Home," located at the top, left of your Excel document.

1. Above "Font," click the down arrow next to the font size textbox and click "10."

v. Drag the text box so it is slightly above x-axis break on your graph.

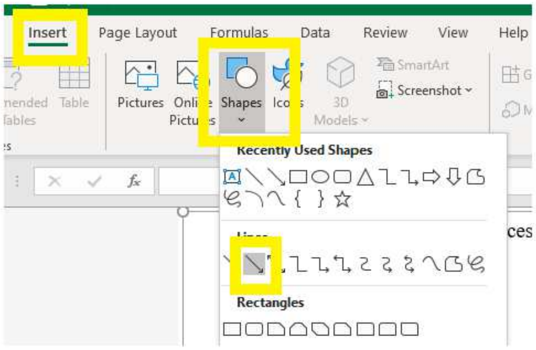


d. Add an arrow to help associate the descriptive text box to the location which you are describing.

i. Click "Insert," located at the top, left of your Excel document.

1. Above "Illustrations," click "Shapes." You may have to click "Illustrations" first.

a. Under "Lines," click "Line Arrow" (this will appear when hovering over the correct icon).



2. Click and hold just below your descriptive note and drag to where on the graph you want this note associated – let go of your click. The arrow should appear pointing to that location.

ii. Click "Shape Format," or "Format," located at the top, middle of your Excel document.

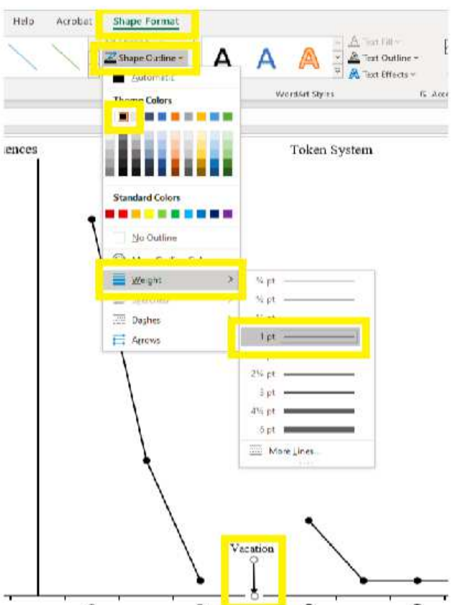
1. Above "Shape Styles," click "Shape Outline."

a. Below "Theme Colors," click "Black, Text 1" (this will appear when hovering over the correct icon).

2. Above "Shape Styles," click "Shape Outline" again.

a. Click "Weight."

i. Click "1 pt."



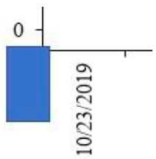
16. Separate X- and Y-Axes.

a. Click "Insert," located at the top, left of your Excel document.

   i. Above "Illustrations," click "Shapes." You may have to click on "Illustrations" first.

      1. Under "Rectangles," click "Rectangle" (this will appear when hovering over the correct icon).

   ii. Click and hold just under and to the left of the 0 on the y-axis and drag until your rectangle covers up until the first date the x-axis and the any numbers less than 0 appearing on your y-axis.



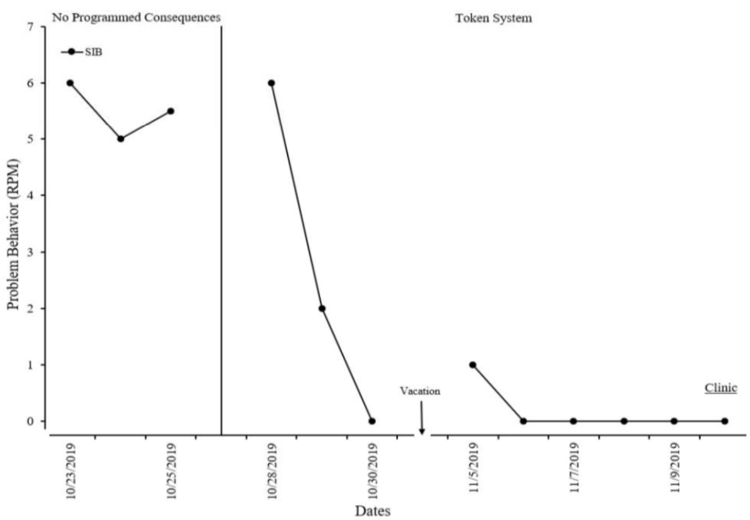
b. Click "Shape Format," located at the top, center of your Excel document.

   i. Above "Shape Styles," click "Shape Fill."

      1. Below "Theme Colors," click "White, Background 1" (this will appear when hovering over the correct icon).

   ii. Above "Shape Styles," click "Shape Outline."

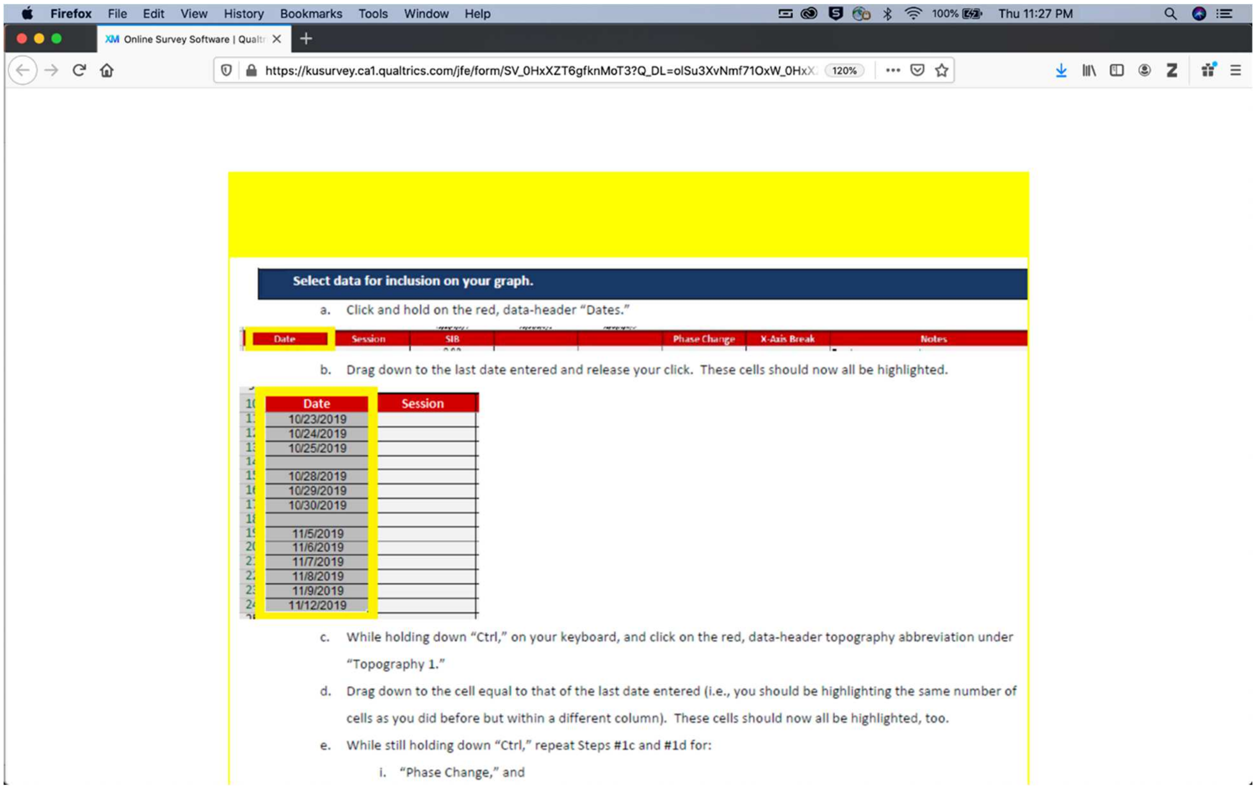
      1. Click "No Outline."



YOU ARE COMPLETE!

OPEN THE SESSION START & STOP PROMPT!
SAVE YOUR DOCUMENT!
Click "File," located in the top, left of your Excel document, then click "Save."

Appendix E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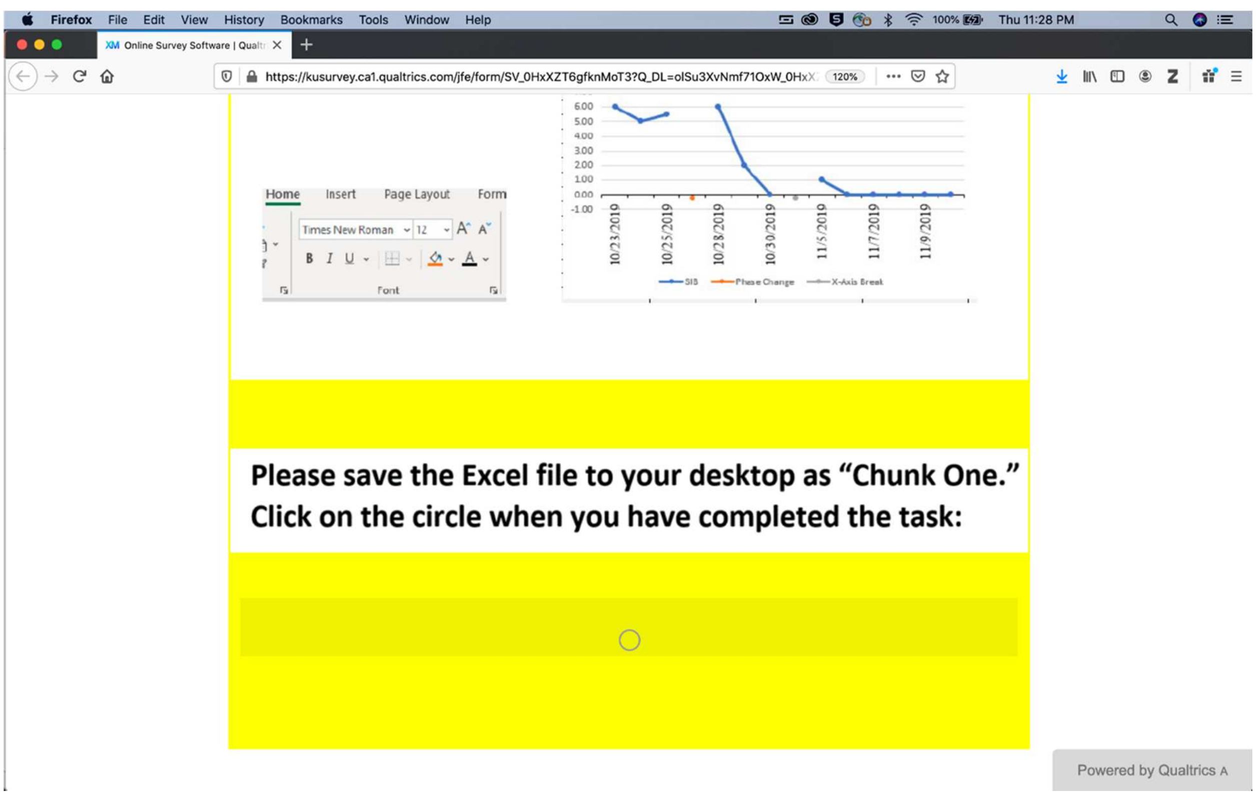
Thu 11:27 PM
Online Survey Software | Qualtr
https://kusurvey.ca1.qualtrics.com/jfe/form/SV_0HxXZT6gfknMoT3?Q_DL=olSu3XvNmf71OxW_0HxX
Select data for inclusion on your graph.
a. Click and hold on the red, data-header "Dates."
Date Session SIB Phase Change X-Axis Break Notes
b. Drag down to the last date entered and release your click. These cells should now all be highlighted.
Date Session
10/23/2019
10/24/2019
10/25/2019
10/28/2019
10/29/2019
10/30/2019
11/5/2019
11/6/2019
11/7/2019
11/8/2019
11/9/2019
11/12/2019
c. While holding down "Ctrl," on your keyboard, and click on the red, data-header topography abbreviation under "Topography 1."
d. Drag down to the cell equal to that of the last date entered (i.e., you should be highlighting the same number of cells as you did before but within a different column). These cells should now all be highlighted, too.
e. While still holding down "Ctrl," repeat Steps #1c and #1d for:
i. "Phase Change," and


Firefox File Edit View History Bookmarks Tools Window Help
Thu 11:28 PM
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https://kusurvey.ca1.qualtrics.com/jfe/form/SV_0HxXZT6gfknMoT3?Q_DL=olSu3XvNmf71OxW_0HxX
Home Insert Page Layout Form
Times New Roman 12
Font
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
10/23/2019
10/25/2019
10/28/2019
10/30/2019
11/5/2019
11/7/2019
11/9/2019
SIB Phase Change X-Axis Break
Please save the Excel file to your desktop as "Chunk One."
Click on the circle when you have completed the task:
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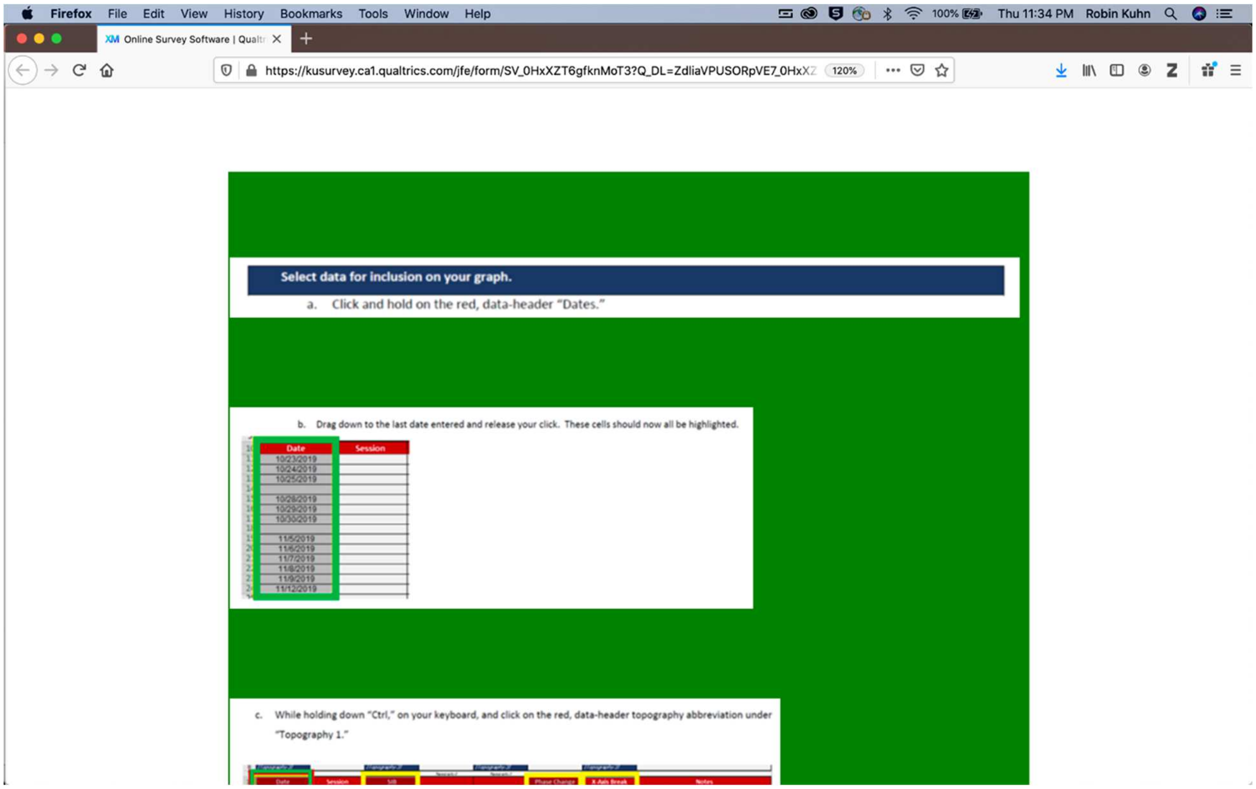
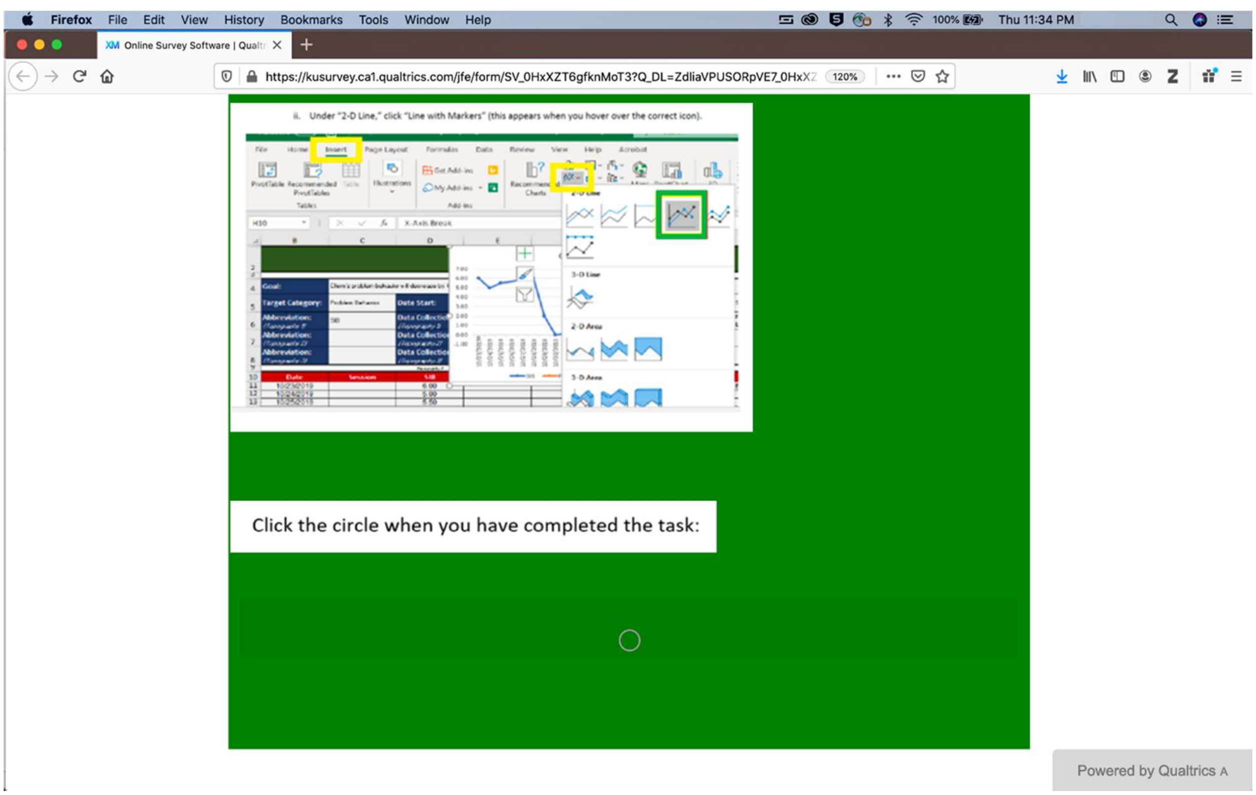
Appendix F


Firefox File Edit View History Bookmarks Tools Window Help
Thu 11:34 PM Robin Kuhn
Online Survey Software | Qualtr
https://kusurvey.ca1.qualtrics.com/jfe/form/SV_0HxXZT6gfknMoT3?Q_DL=ZdliaVPUSORpVE7_0HxXZ
Select data for inclusion on your graph.
a. Click and hold on the red, data-header "Dates."
b. Drag down to the last date entered and release your click. These cells should now all be highlighted.
c. While holding down "Ctrl," on your keyboard, and click on the red, data-header topography abbreviation under "Topography 1."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Thu 11:34 PM
Online Survey Software | Qualtr
https://kusurvey.ca1.qualtrics.com/jfe/form/SV_0HxXZT6gfknMoT3?Q_DL=ZdliaVPUSORpVE7_0HxXZ
ii. Under "2-D Line," click "Line with Markers" (this appears when you hover over the correct icon).
Click the circle when you have completed the task:
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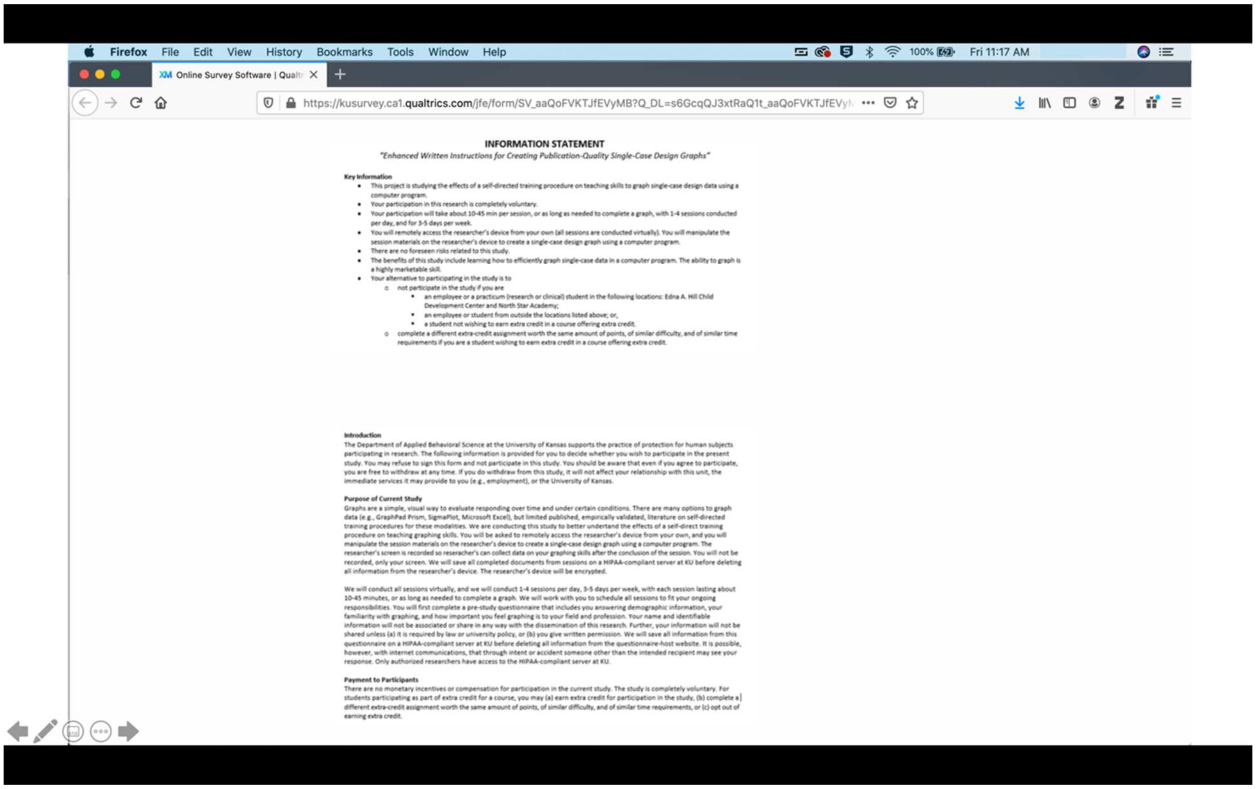
Appendix G



INFORMATION STATEMENT

"Enhanced Written Instructions for Creating Publication-Quality Single-Case Design Graphs"

Key Information

- This project is studying the effects of a self-directed training procedure on teaching skills to graph single-case design data using a computer program.
- Your participation in this research is completely voluntary.
- Your participation will take about 10-45 min per session, or as long as needed to complete a graph, with 1-4 sessions conducted per day, and for 3-5 days per week.
- You will remotely access the researcher's device from your own (all sessions are conducted virtually). You will manipulate the session materials on the researcher's device to create a single-case design graph using a computer program.
- There are no foreseen risks related to this study.
- The benefits of this study include learning how to efficiently graph single-case data in a computer program. The ability to graph is a highly marketable skill.
- Your alternative to participating in the study is to
  - not participate in the study if you are
    - an employee or a practicum (research or clinical) student in the following locations: Edna A. Hill Child Development Center and North Star Academy;
    - an employee or student from outside the locations listed above; or,
    - a student not wishing to earn extra credit in a course offering extra credit.
  - complete a different extra-credit assignment worth the same amount of points, of similar difficulty, and of similar time requirements if you are a student wishing to earn extra credit in a course offering extra credit.

Introduction

The Department of Applied Behavioral Science at the University of Kansas supports the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this unit, the immediate services it may provide to you (e.g., employment), or the University of Kansas.

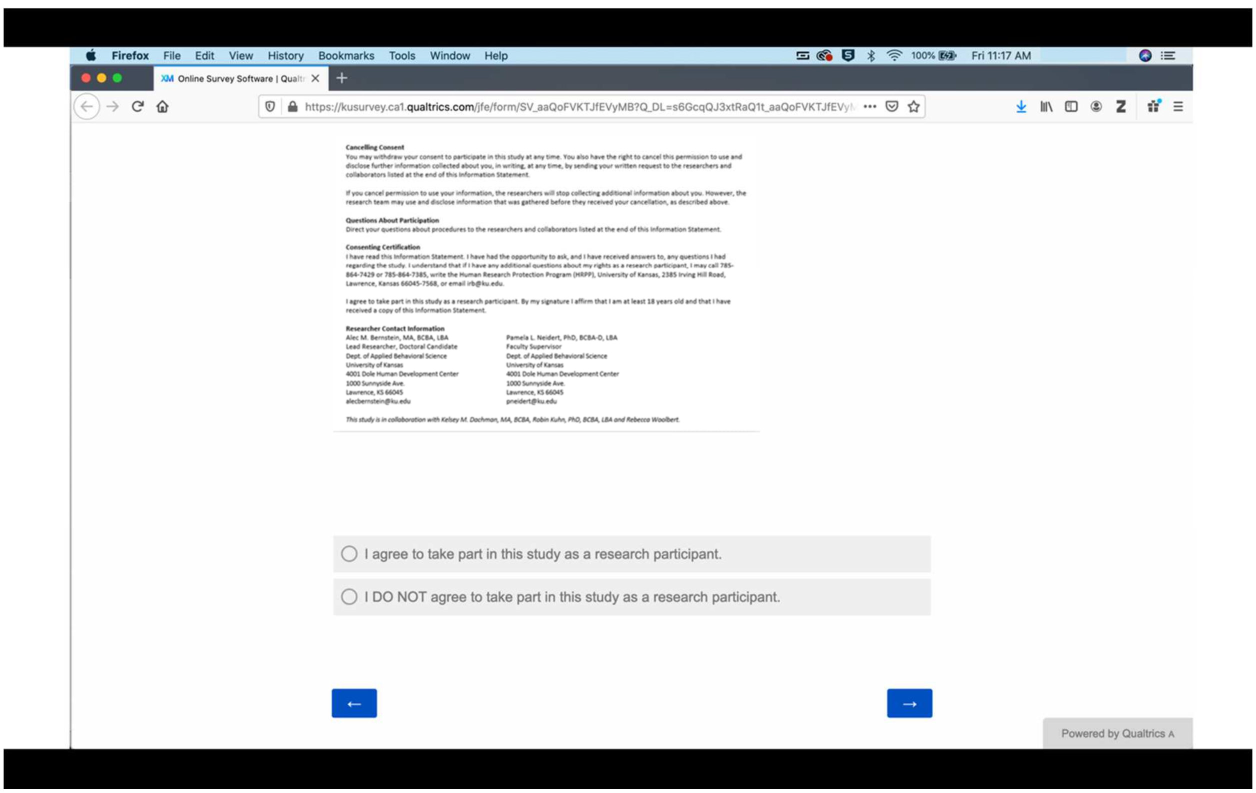
Purpose of Current Study

Graphs are a simple, visual way to evaluate responding over time and under certain conditions. There are many options to graph data (e.g., GraphPad Prism, SigmaPlot, Microsoft Excel), but limited published, empirically validated, literature on self-directed training procedures for these modalities. We are conducting this study to better undertand the effects of a self-direct training procedure on teaching graphing skills. You will be asked to remotely access the researcher's device from your own, and you will manipulate the session materials on the researcher's device to create a single-case design graph using a computer program. The researcher's screen is recorded so reseracher's can collect data on your graphing skills after the conclusion of the session. You will not be recorded, only your screen. We will save all completed documents from sessions on a HIPAA-compliant server at KU before deleting all information from the researcher's device. The researcher's device will be encrypted.

We will conduct all sessions virtually, and we will conduct 1-4 sessions per day, 3-5 days per week, with each session lasting about 10-45 minutes, or as long as needed to complete a graph. We will work with you to schedule all sessions to fit your ongoing responsibilities. You will first complete a pre-study questionnaire that includes you answering demographic information, your familiarity with graphing, and how important you feel graphing is to your field and profession. Your name and identifiable information will not be associated or share in any way with the dissemination of this research. Further, your information will not be shared unless (a) it is required by law or university policy, or (b) you give written permission. We will save all information from this questionnaire on a HIPAA-compliant server at KU before deleting all information from the questionnaire-host website. It is possible, however, with internet communications, that through intent or accident someone other than the intended recipient may see your response. Only authorized researchers have access to the HIPAA-compliant server at KU.

Payment to Participants

There are no monetary incentives or compensation for participation in the current study. The study is completely voluntary. For students participating as part of extra credit for a course, you may (a) earn extra credit for participation in the study, (b) complete a different extra-credit assignment worth the same amount of points, of similar difficulty, and of similar time requirements, or (c) opt out of earning extra credit.



Cancelling Consent

You may withdraw your consent to participate in this study at any time. You also have the right to cancel this permission to use and disclose further information collected about you, in writing, at any time, by sending your written request to the researchers and collaborators listed at the end of this Information Statement.

If you cancel permission to use your information, the researchers will stop collecting additional information about you. However, the research team may use and disclose information that was gathered before they received your cancellation, as described above.

Questions About Participation

Direct your questions about procedures to the researchers and collaborators listed at the end of this Information Statement.

Consenting Certification

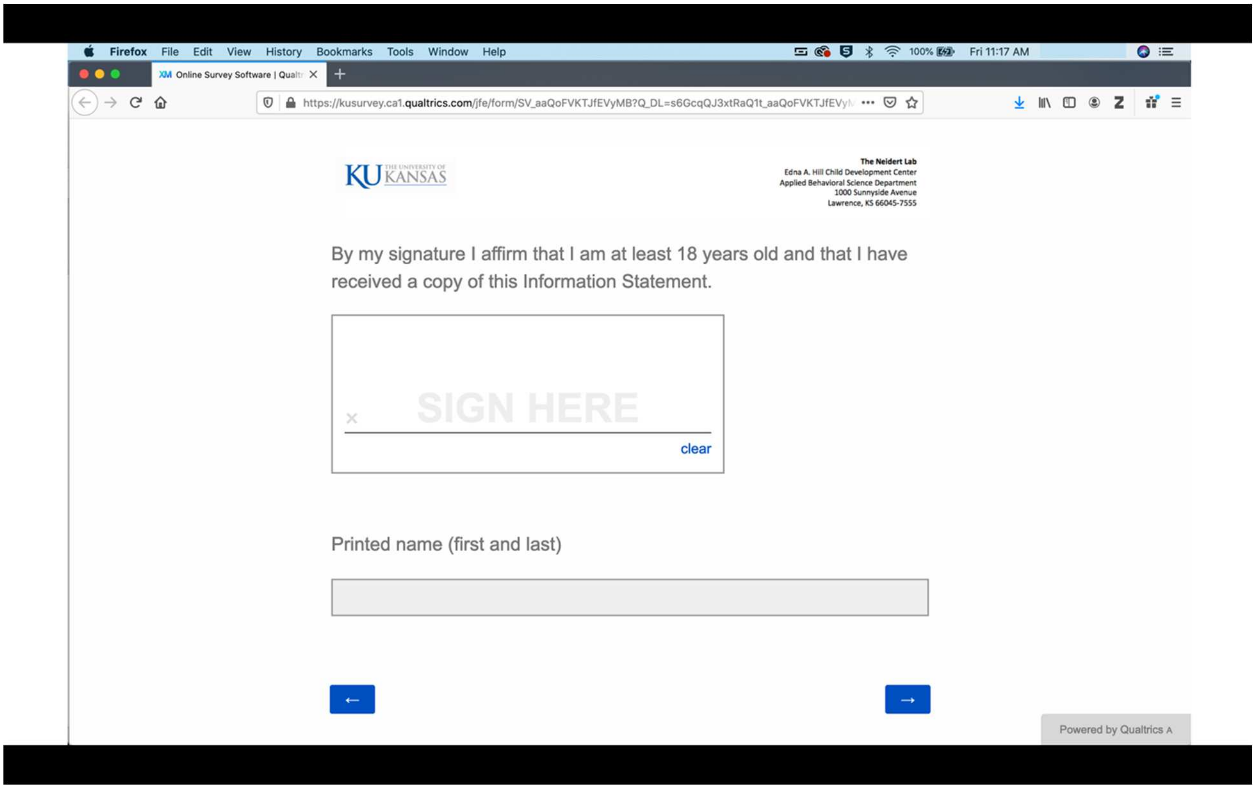
I have read this Information Statement. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional questions about my rights as a research participant, I may call 785-864-7429 or 785-864-7385, write the Human Research Protection Program (HRPP), University of Kansas, 2385 Irving Hill Road, Lawrence, Kansas 66045-7568, or email irb@ku.edu.

I agree to take part in this study as a research participant. By my signature I affirm that I am at least 18 years old and that I have received a copy of this Information Statement.

Researcher Contact Information

Alec M. Bernstein, MA, BCBA, LBA	Pamela L. Neidert, PhD, BCBA-D, LBA
Lead Researcher, Doctoral Candidate	Faculty Supervisor
Dept. of Applied Behavioral Science	Dept. of Applied Behavioral Science
University of Kansas	University of Kansas
4001 Dole Human Development Center	4001 Dole Human Development Center
1000 Sunnyside Ave.	1000 Sunnyside Ave.
Lawrence, KS 66045	Lawrence, KS 66045
alecbernstein@ku.edu	pneidert@ku.edu

This study is in collaboration with Kelsey M. Dochmon, MA, BCBA, Robin Kuhn, PhD, BCBA, LBA and Rebecca Woolbert.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https://kusurvey.ca1.qualtrics.com/jfe/form/SV_aaQoFVKTJfEVyMB?Q_DL=s6GcqQJ3xtRaQ1t_aaQoFVKTJfEVy
KU THE UNIVERSITY OF KANSAS
The Neidert Lab
Edna A. Hill Child Development Center
Applied Behavioral Science Department
1000 Sunnyside Avenue
Lawrence, KS 66045-7555
By my signature I affirm that I am at least 18 years old and that I have received a copy of this Information Statement.
SIGN HERE
clear
Printed name (first and last)
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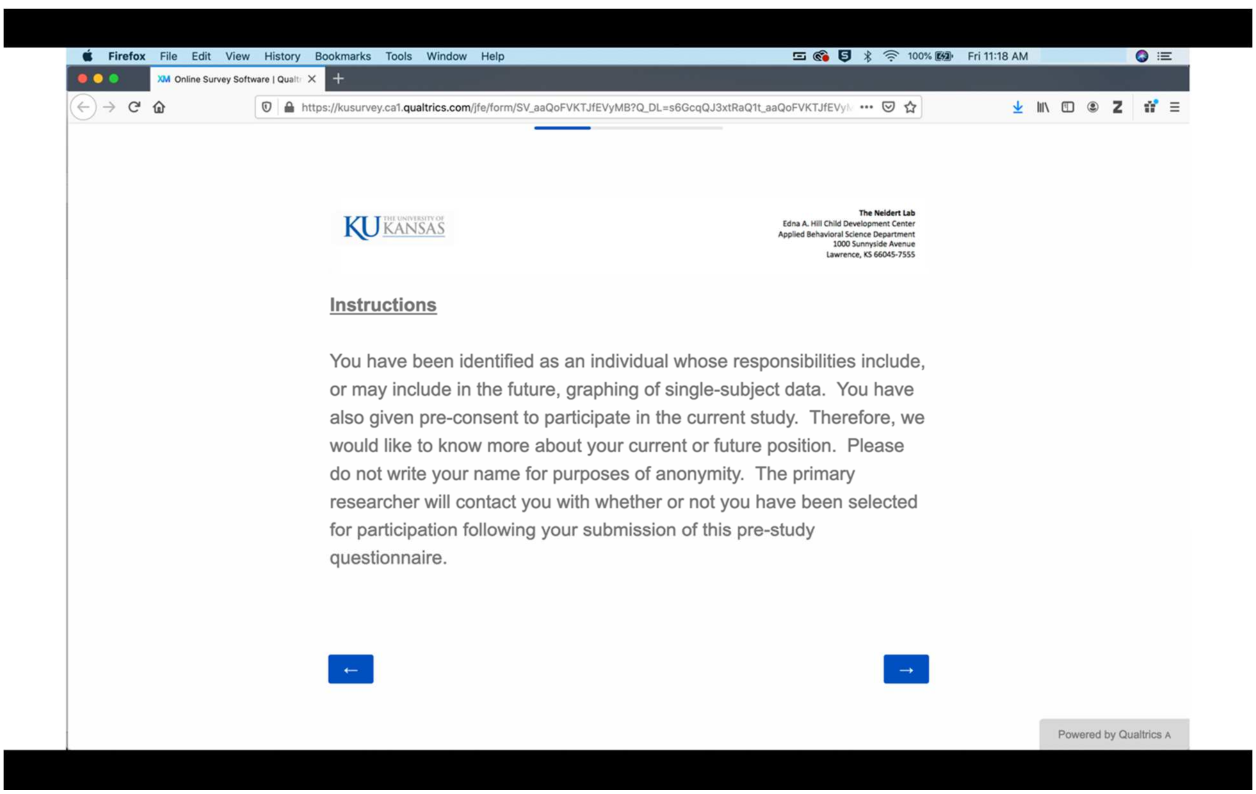
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Online Survey Software | Qualtrics
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KU THE UNIVERSITY OF KANSAS
The Neidert Lab
Edna A. Hill Child Development Center
Applied Behavioral Science Department
1000 Sunnyside Avenue
Lawrence, KS 66045-7555
Instructions
You have been identified as an individual whose responsibilities include, or may include in the future, graphing of single-subject data. You have also given pre-consent to participate in the current study. Therefore, we would like to know more about your current or future position. Please do not write your name for purposes of anonymity. The primary researcher will contact you with whether or not you have been selected for participation following your submission of this pre-study questionnaire.
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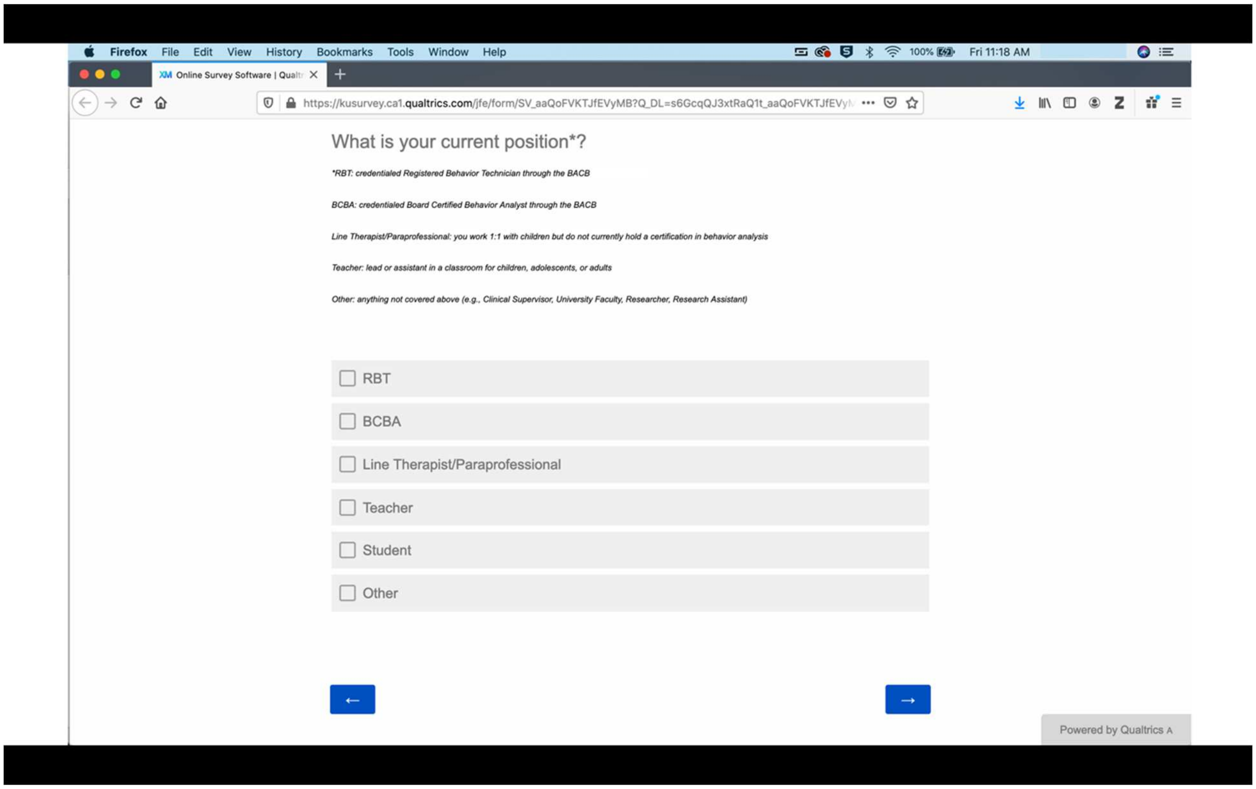

What is your current position*?

*RBT: credentialed Registered Behavior Technician through the BACB

BCBA: credentialed Board Certified Behavior Analyst through the BACB

Line Therapist/Paraprofessional: you work 1:1 with children but do not currently hold a certification in behavior analysis

Teacher: lead or assistant in a classroom for children, adolescents, or adults

Other: anything not covered above (e.g., Clinical Supervisor, University Faculty, Researcher, Research Assistant)

- ☐ RBT
- ☐ BCBA
- ☐ Line Therapist/Paraprofessional
- ☐ Teacher
- ☐ Student
- ☐ Other

← →

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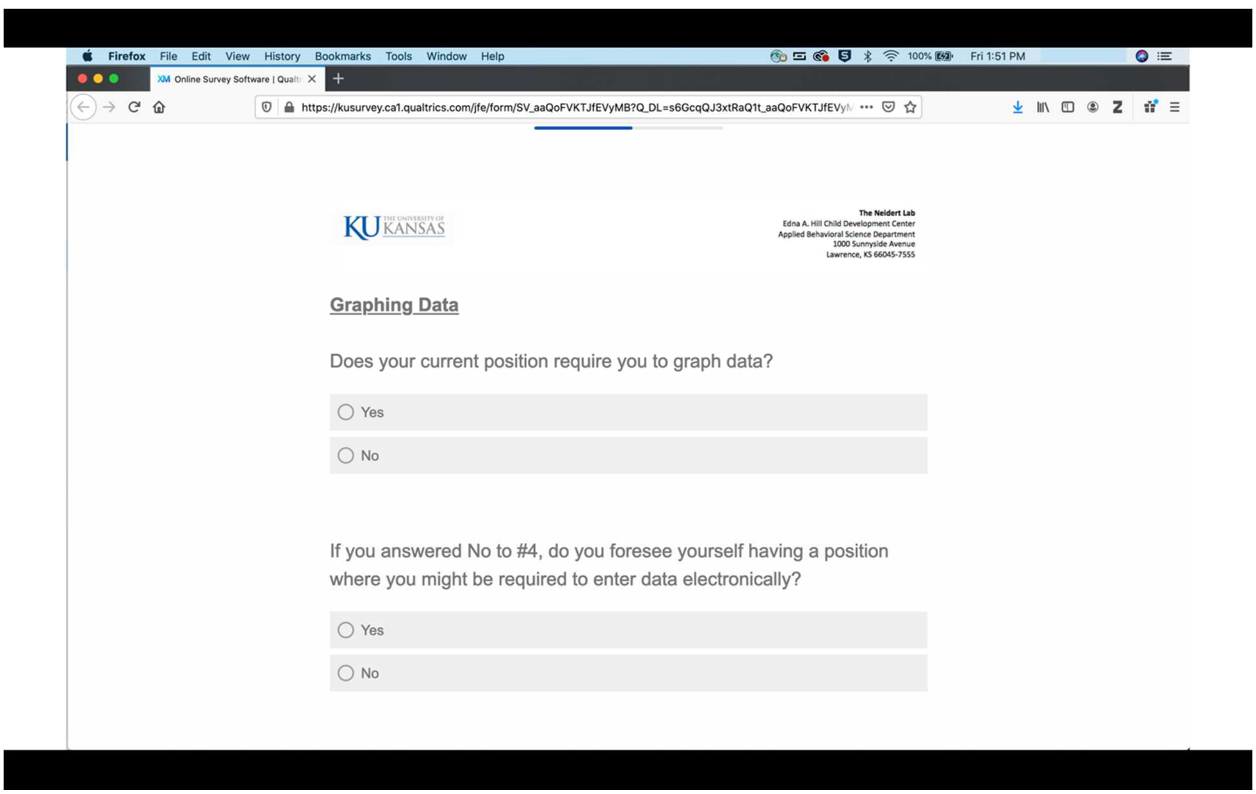

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Applied Behavioral Science Department
1000 Sunnyside Avenue
Lawrence, KS 66045-7555

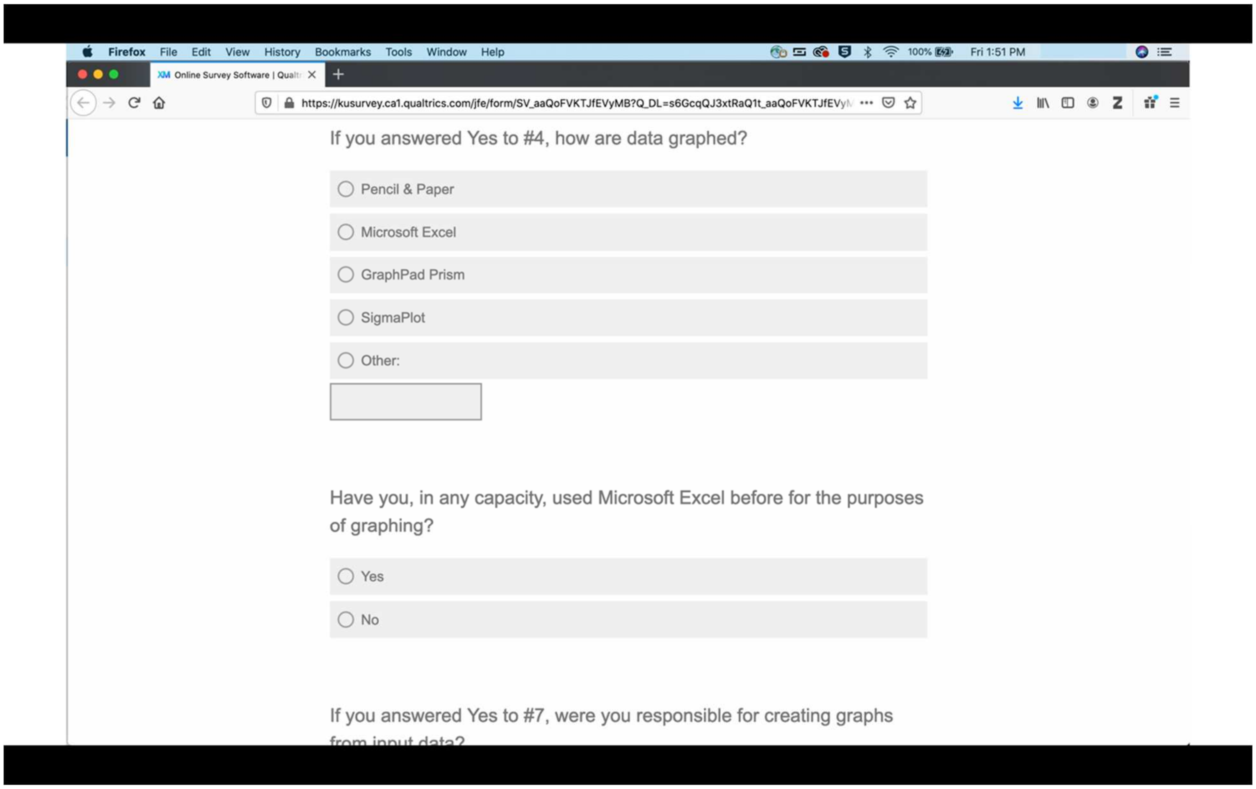
Graphing Data

Does your current position require you to graph data?

- ◯ Yes
- ◯ No

If you answered No to #4, do you foresee yourself having a position where you might be required to enter data electronically?

- ◯ Yes
- ◯ No



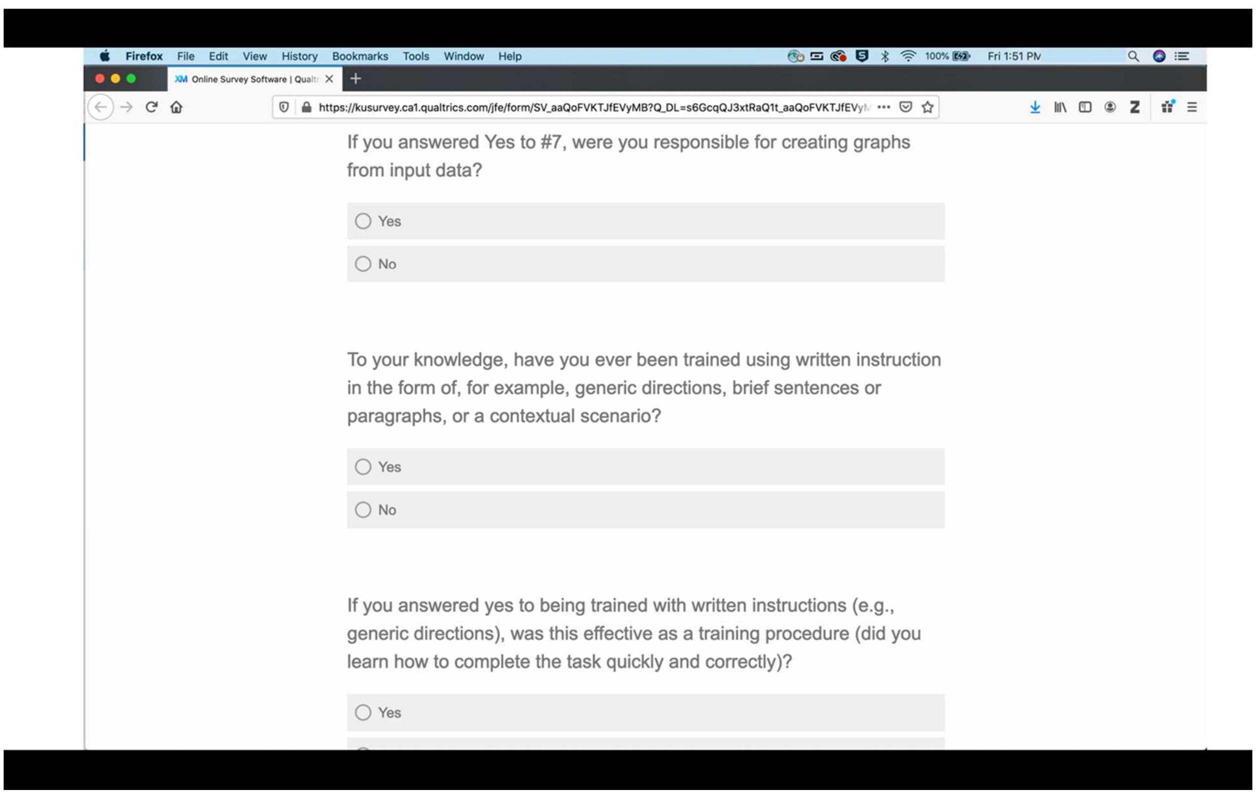
If you answered Yes to #4, how are data graphed?

- Pencil & Paper
- Microsoft Excel
- GraphPad Prism
- SigmaPlot
- Other:

Have you, in any capacity, used Microsoft Excel before for the purposes of graphing?

- Yes
- No

If you answered Yes to #7, were you responsible for creating graphs from input data?



If you answered Yes to #7, were you responsible for creating graphs from input data?

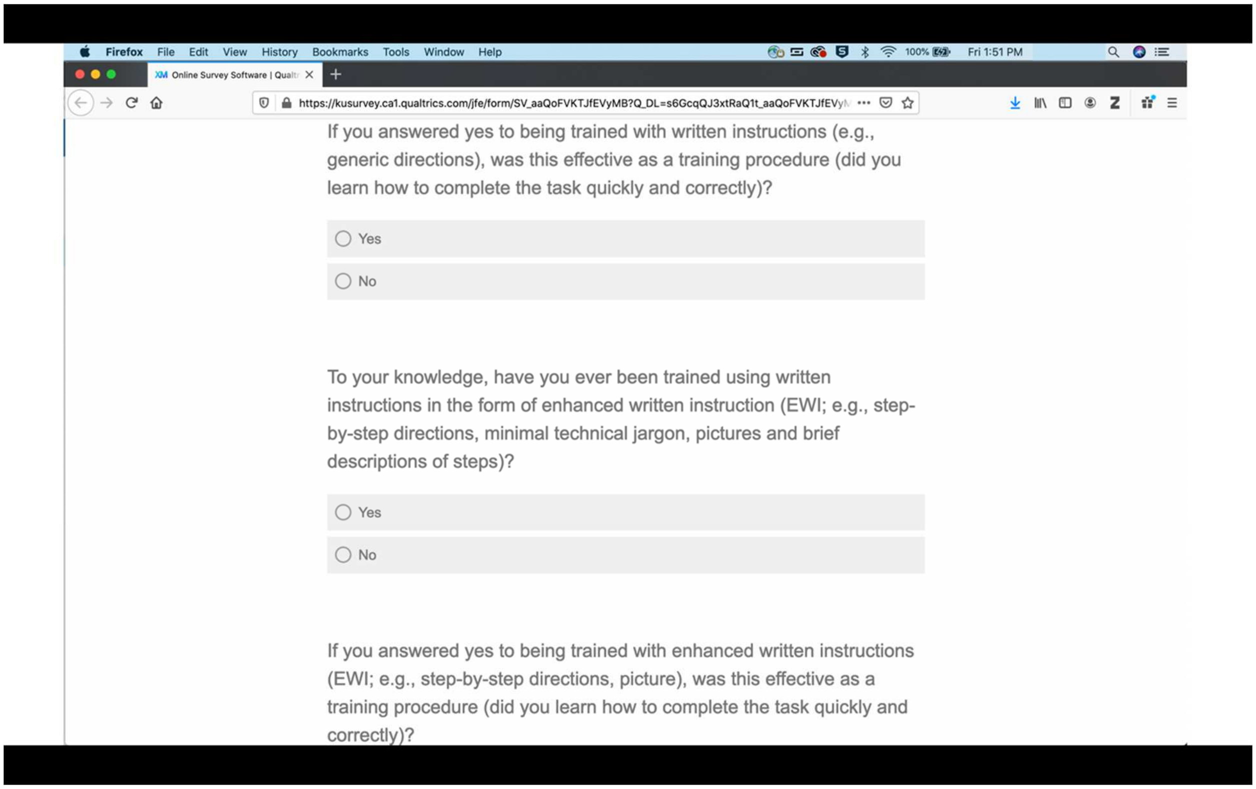
- Yes
- No

To your knowledge, have you ever been trained using written instruction in the form of, for example, generic directions, brief sentences or paragraphs, or a contextual scenario?

- Yes
- No

If you answered yes to being trained with written instructions (e.g., generic directions), was this effective as a training procedure (did you learn how to complete the task quickly and correctly)?

- Yes



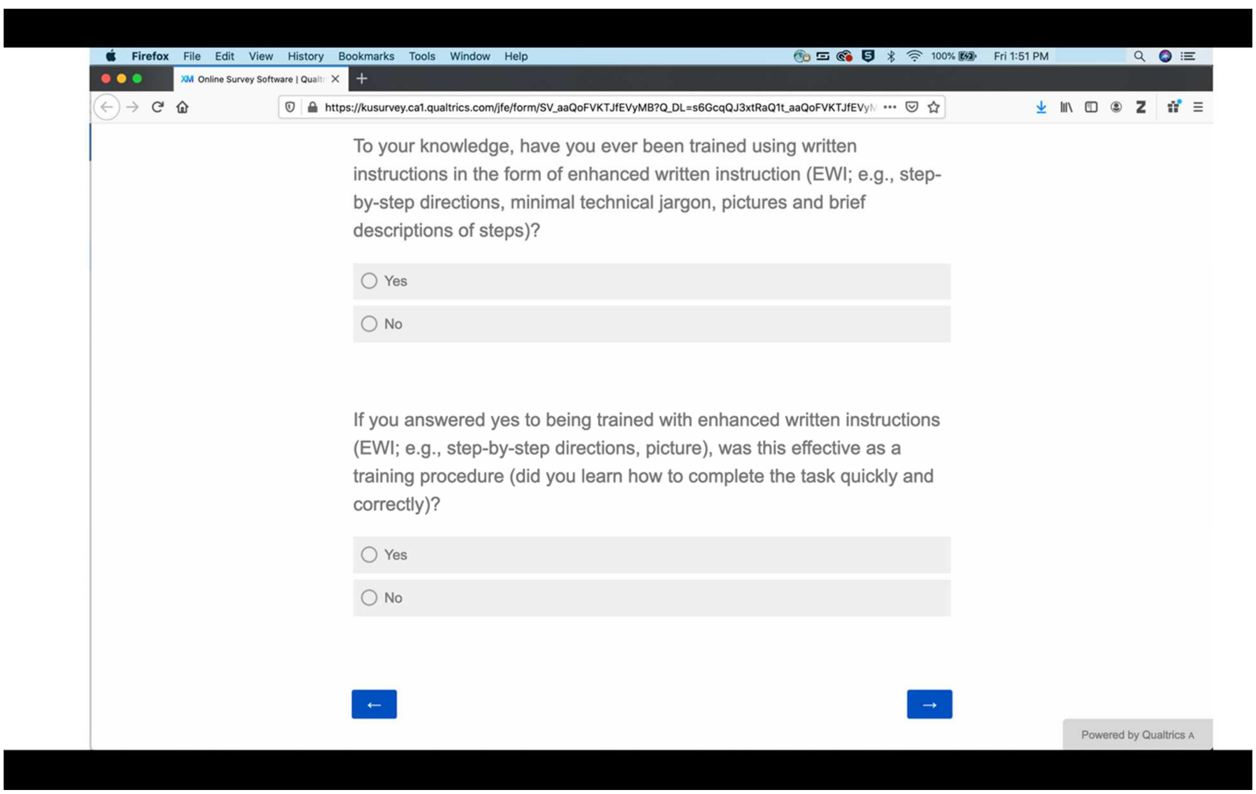
If you answered yes to being trained with written instructions (e.g., generic directions), was this effective as a training procedure (did you learn how to complete the task quickly and correctly)?

- Yes
- No

To your knowledge, have you ever been trained using written instructions in the form of enhanced written instruction (EWI; e.g., step-by-step directions, minimal technical jargon, pictures and brief descriptions of steps)?

- Yes
- No

If you answered yes to being trained with enhanced written instructions (EWI; e.g., step-by-step directions, picture), was this effective as a training procedure (did you learn how to complete the task quickly and correctly)?



To your knowledge, have you ever been trained using written instructions in the form of enhanced written instruction (EWI; e.g., step-by-step directions, minimal technical jargon, pictures and brief descriptions of steps)?

- Yes
- No

If you answered yes to being trained with enhanced written instructions (EWI; e.g., step-by-step directions, picture), was this effective as a training procedure (did you learn how to complete the task quickly and correctly)?

- Yes
- No

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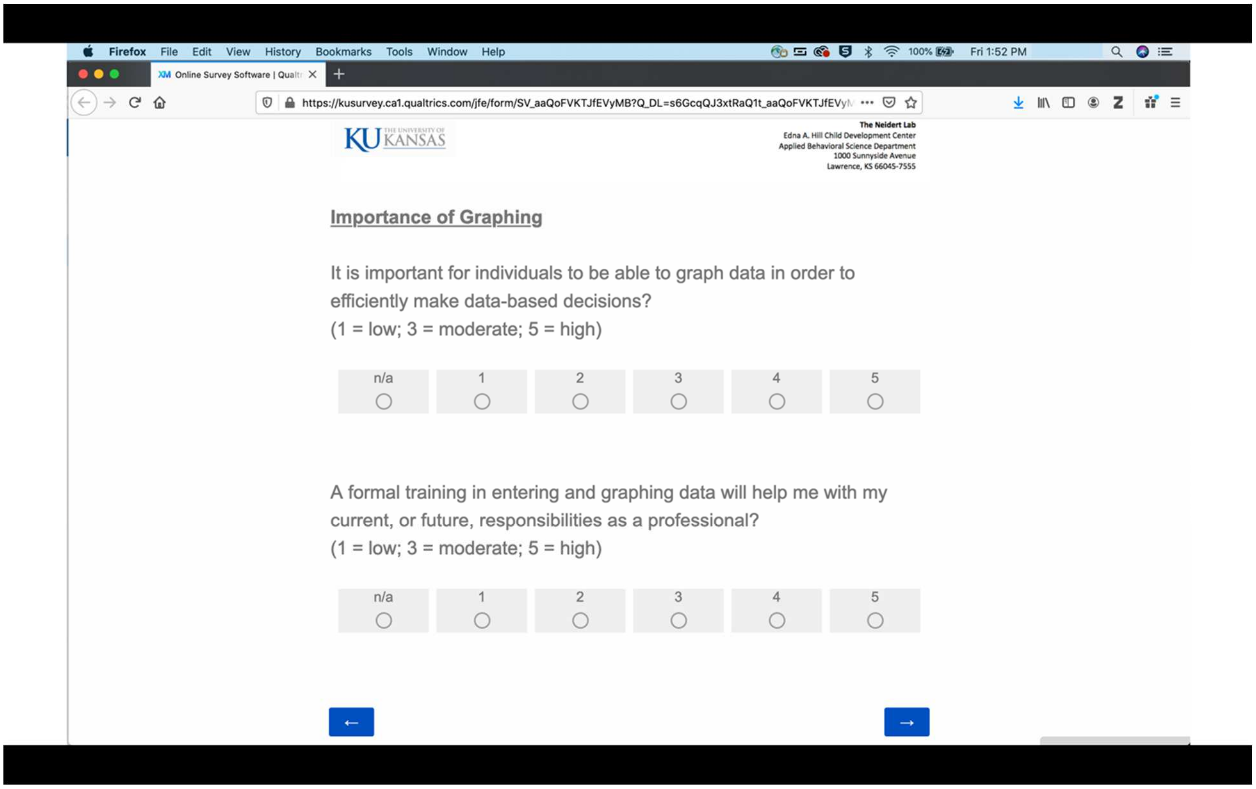
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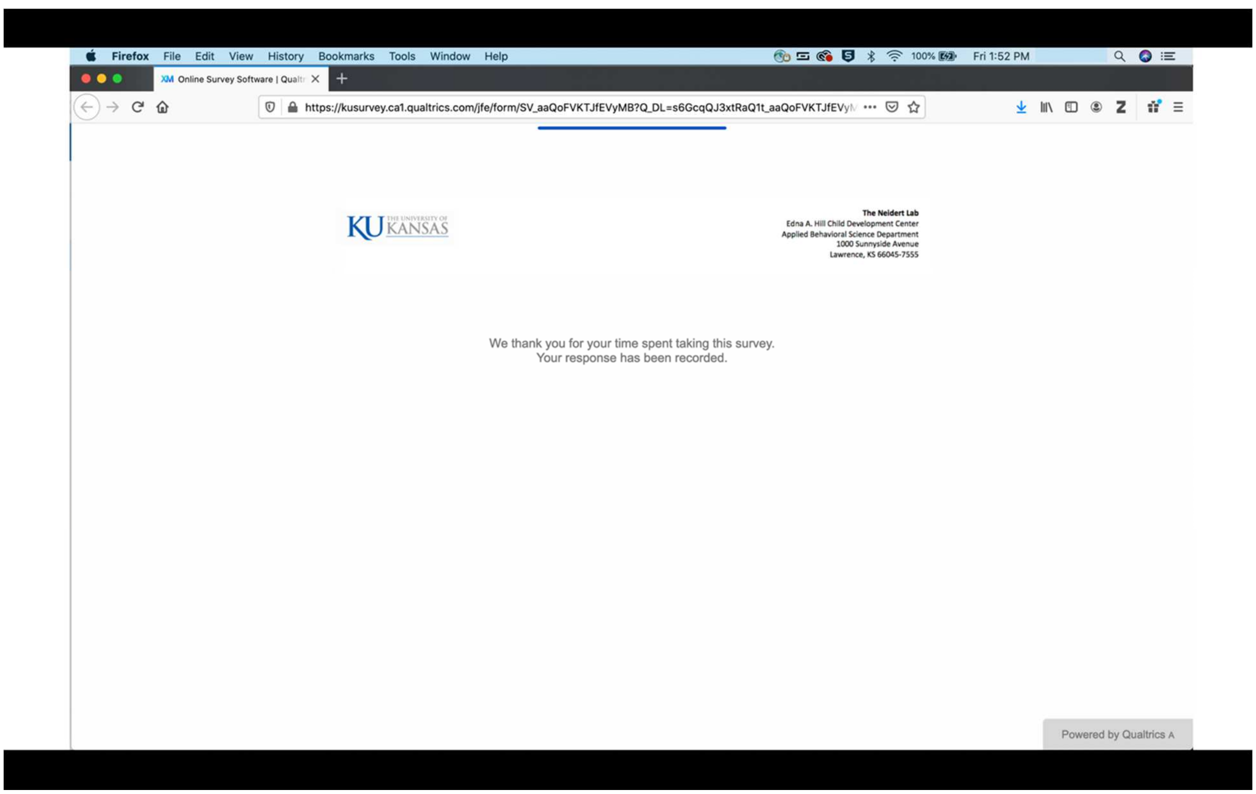
Applied Behavioral Science Department
1000 Sunnyside Avenue
Lawrence, KS 66045-7555
Importance of Graphing
It is important for individuals to be able to graph data in order to efficiently make data-based decisions?
(1 = low; 3 = moderate; 5 = high)
n/a 1 2 3 4 5
A formal training in entering and graphing data will help me with my current, or future, responsibilities as a professional?
(1 = low; 3 = moderate; 5 = high)
n/a 1 2 3 4 5
←
→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KU KANSAS
The Neidert Lab
Edna A. Hill Child Development Center
Applied Behavioral Science Department
1000 Sunnyside Avenue
Lawrence, KS 66045-7555
We thank you for your time spent taking this survey.
Your response has been recorded.
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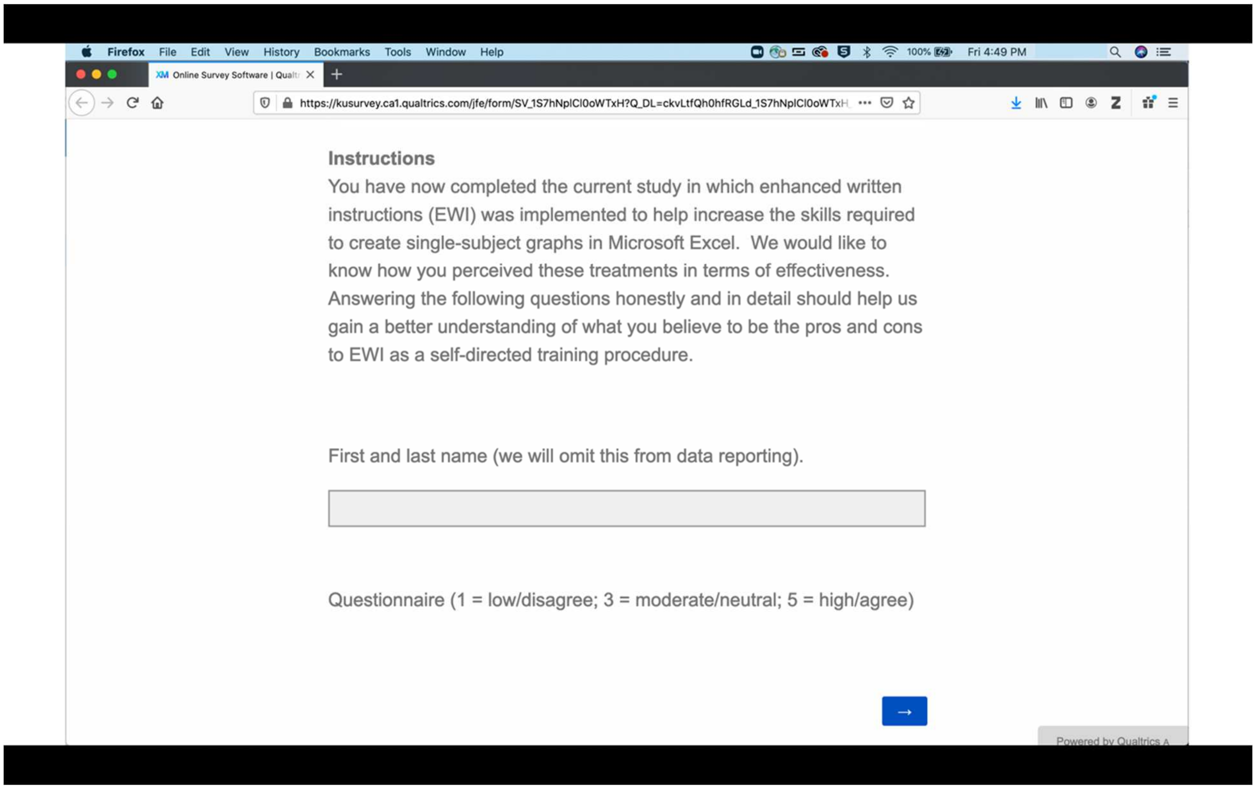
Appendix H

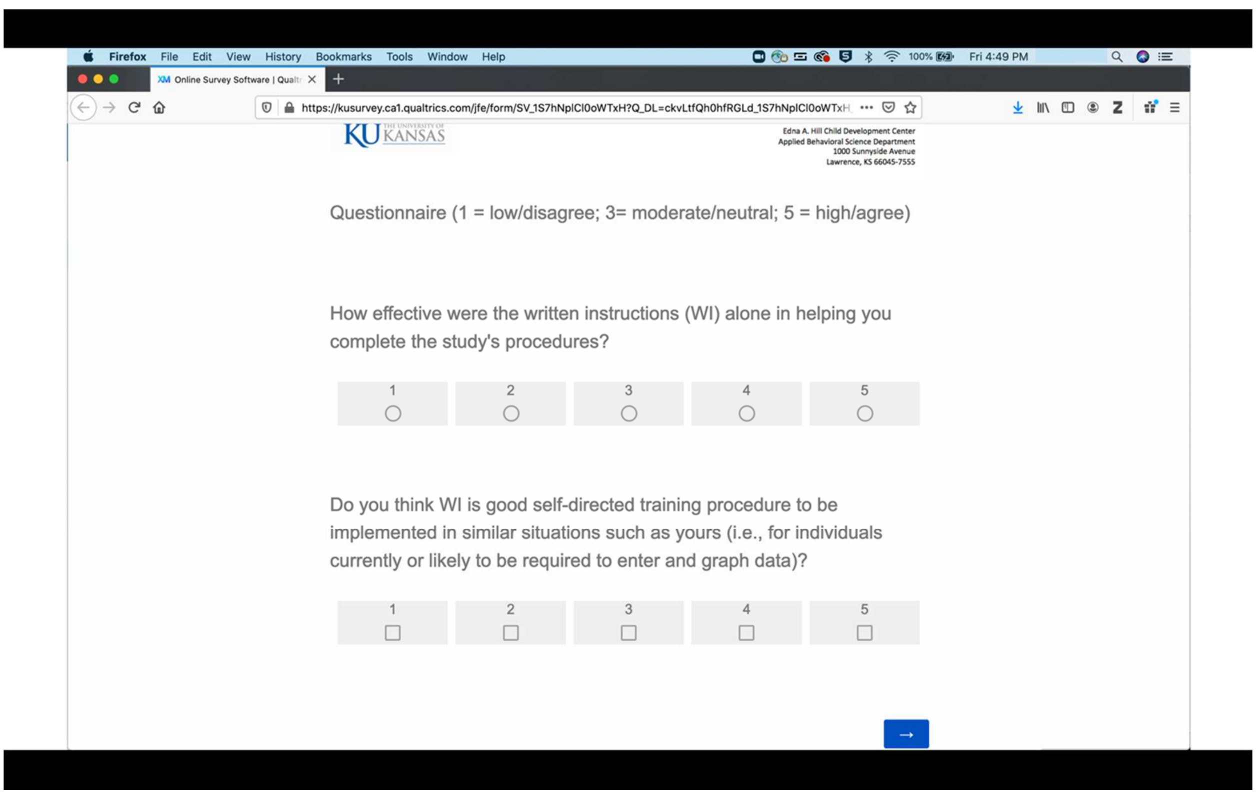


Instructions

You have now completed the current study in which enhanced written instructions (EWI) was implemented to help increase the skills required to create single-subject graphs in Microsoft Excel. We would like to know how you perceived these treatments in terms of effectiveness. Answering the following questions honestly and in detail should help us gain a better understanding of what you believe to be the pros and cons to EWI as a self-directed training procedure.

First and last name (we will omit this from data reporting).

Questionnaire (1 = low/disagree; 3 = moderate/neutral; 5 = high/agree)



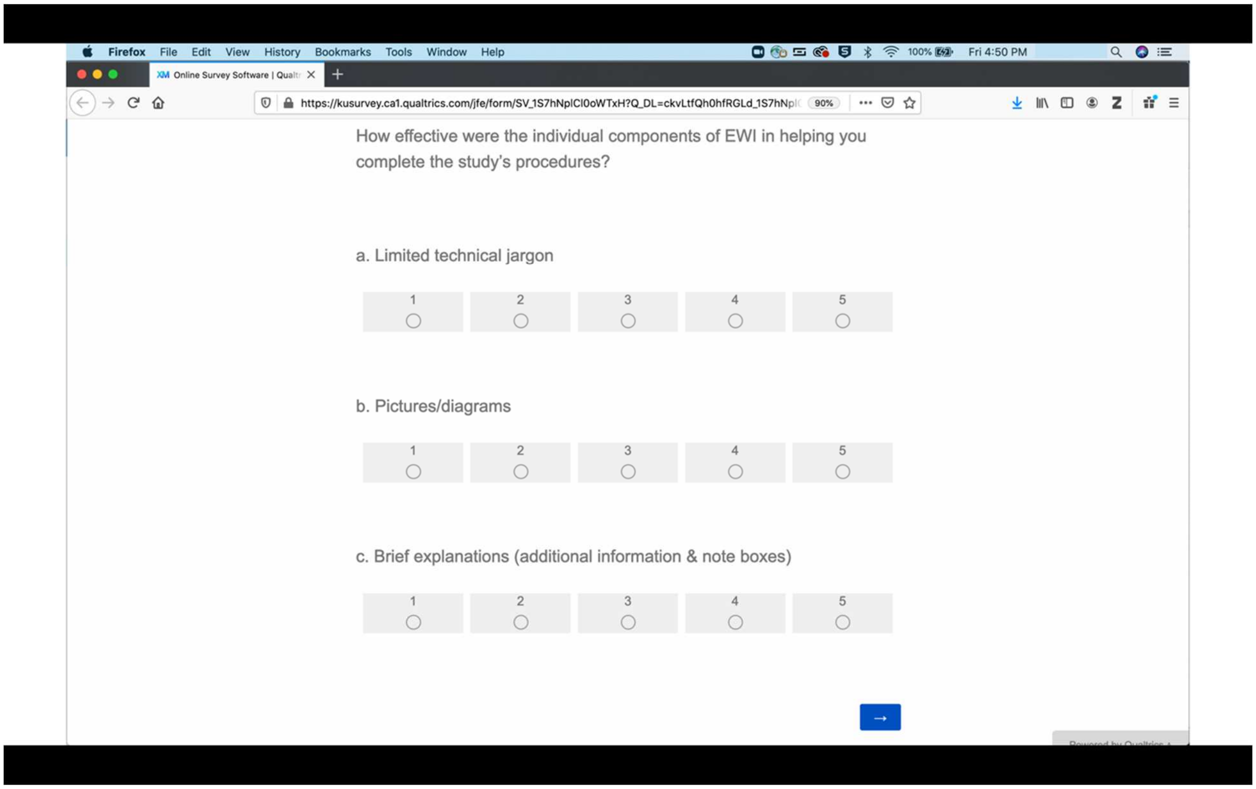
Questionnaire (1 = low/disagree; 3= moderate/neutral; 5 = high/agree)

How effective were the written instructions (WI) alone in helping you complete the study's procedures?

1 2 3 4 5

Do you think WI is good self-directed training procedure to be implemented in similar situations such as yours (i.e., for individuals currently or likely to be required to enter and graph data)?

1 2 3 4 5



How effective were the individual components of EWI in helping you complete the study's procedures?

a. Limited technical jargon

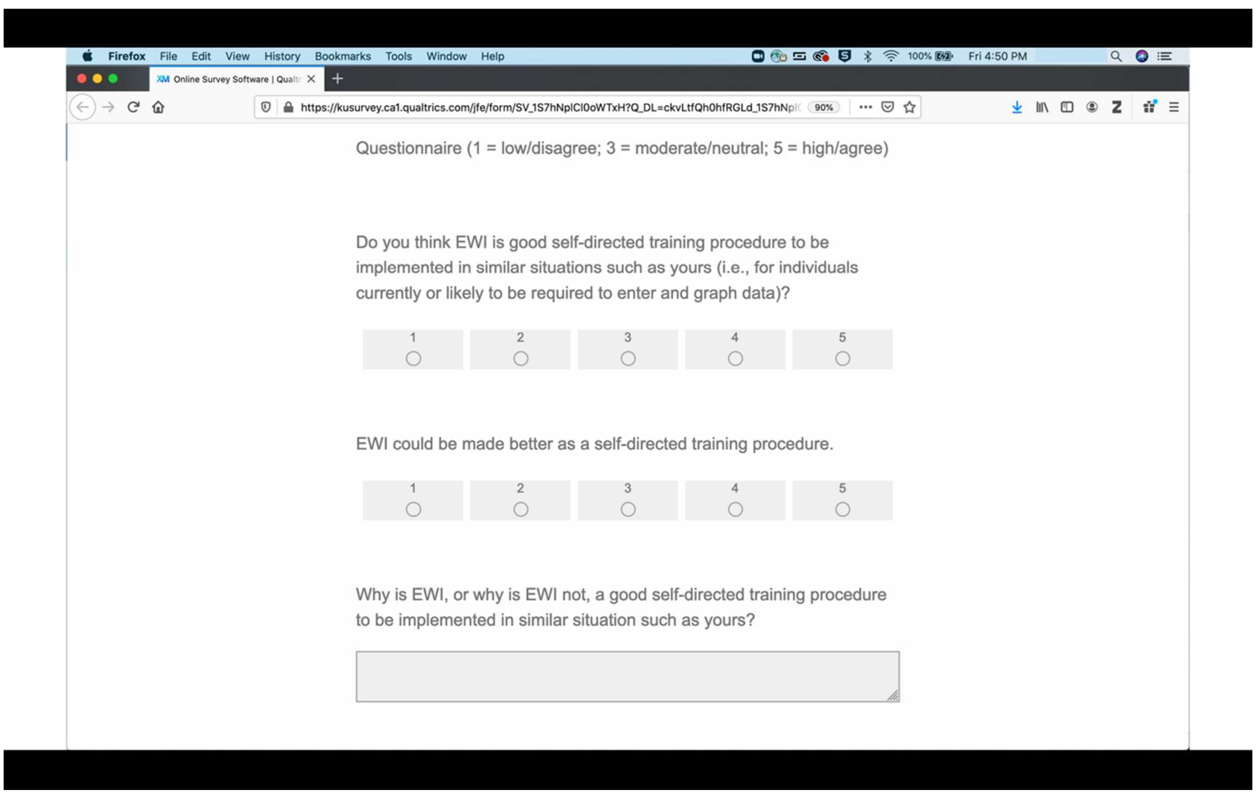
1 2 3 4 5

b. Pictures/diagrams

1 2 3 4 5

c. Brief explanations (additional information & note boxes)

1 2 3 4 5



Questionnaire (1 = low/disagree; 3 = moderate/neutral; 5 = high/agree)

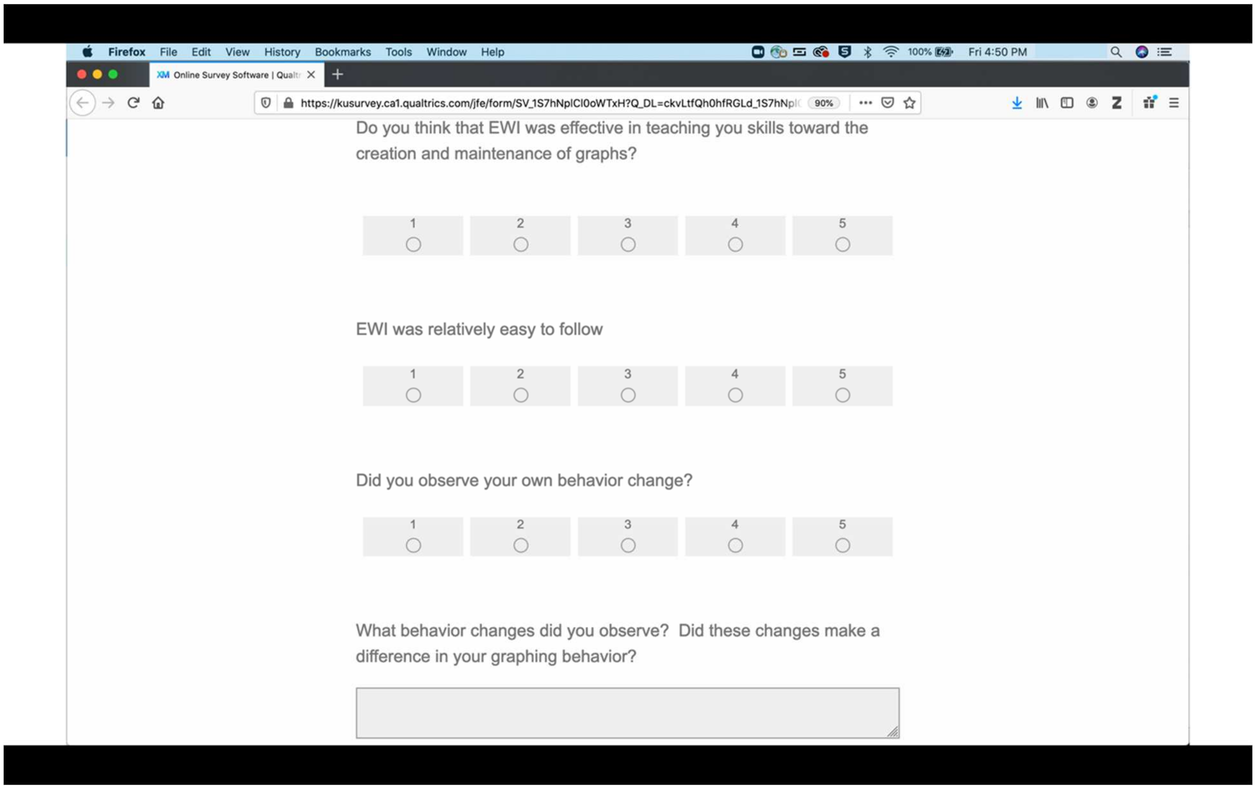
Do you think EWI is good self-directed training procedure to be implemented in similar situations such as yours (i.e., for individuals currently or likely to be required to enter and graph data)?

1 2 3 4 5

EWI could be made better as a self-directed training procedure.

1 2 3 4 5

Why is EWI, or why is EWI not, a good self-directed training procedure to be implemented in similar situation such as yours?



Do you think that EWI was effective in teaching you skills toward the creation and maintenance of graphs?

1 ○ 2 ○ 3 ○ 4 ○ 5 ○

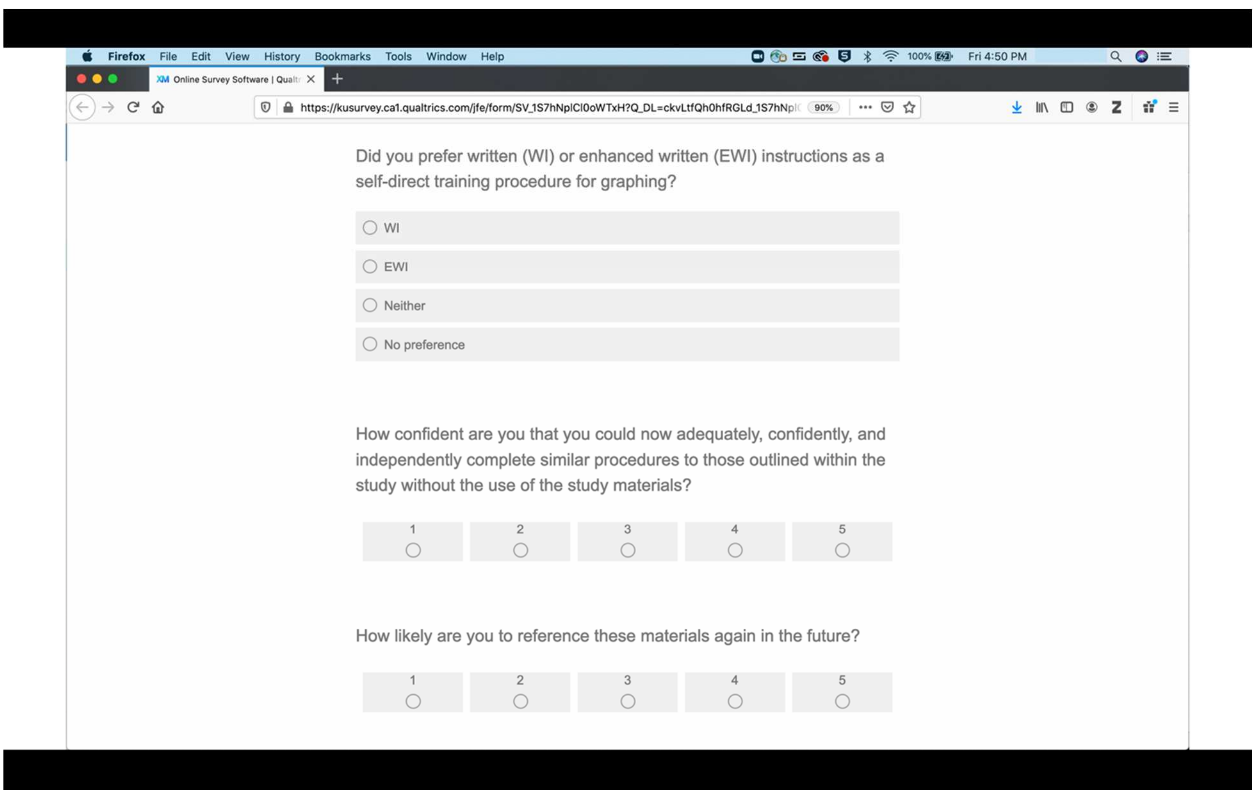
EWI was relatively easy to follow

1 ○ 2 ○ 3 ○ 4 ○ 5 ○

Did you observe your own behavior change?

1 ○ 2 ○ 3 ○ 4 ○ 5 ○

What behavior changes did you observe? Did these changes make a difference in your graphing behavior?



Did you prefer written (WI) or enhanced written (EWI) instructions as a self-direct training procedure for graphing?

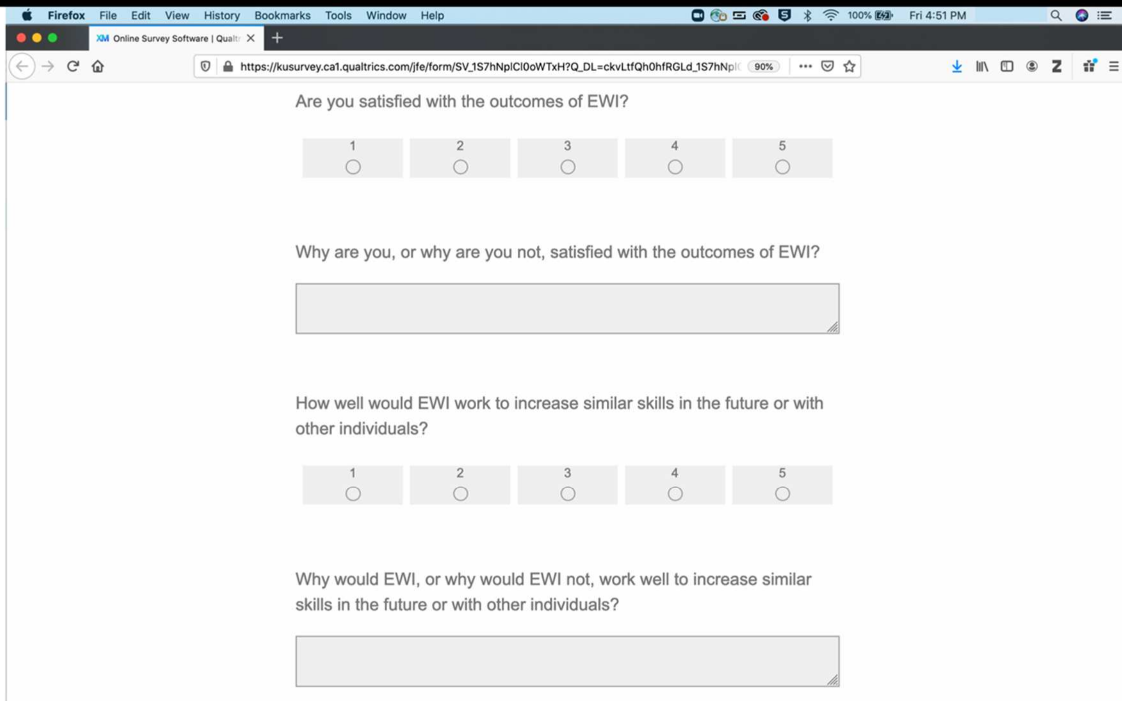
- ○ WI
- ○ EWI
- ○ Neither
- ○ No preference

How confident are you that you could now adequately, confidently, and independently complete similar procedures to those outlined within the study without the use of the study materials?

1 ○ 2 ○ 3 ○ 4 ○ 5 ○

How likely are you to reference these materials again in the future?

1 ○ 2 ○ 3 ○ 4 ○ 5 ○



Are you satisfied with the outcomes of EWI?

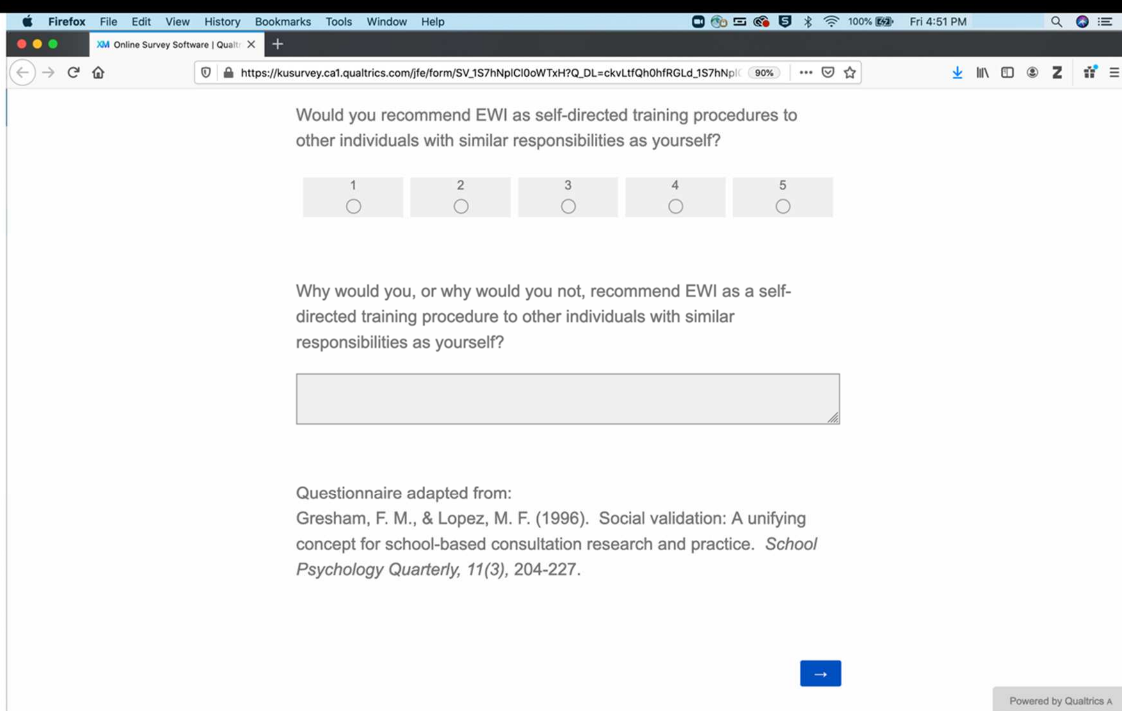
1	2	3	4	5
○	○	○	○	○

Why are you, or why are you not, satisfied with the outcomes of EWI?

How well would EWI work to increase similar skills in the future or with other individuals?

1	2	3	4	5
○	○	○	○	○

Why would EWI, or why would EWI not, work well to increase similar skills in the future or with other individuals?



Would you recommend EWI as self-directed training procedures to other individuals with similar responsibilities as yourself?

1	2	3	4	5
○	○	○	○	○

Why would you, or why would you not, recommend EWI as a self-directed training procedure to other individuals with similar responsibilities as yourself?

Questionnaire adapted from:
Gresham, F. M., & Lopez, M. F. (1996). Social validation: A unifying concept for school-based consultation research and practice. *School Psychology Quarterly, 11(3)*, 204-227.

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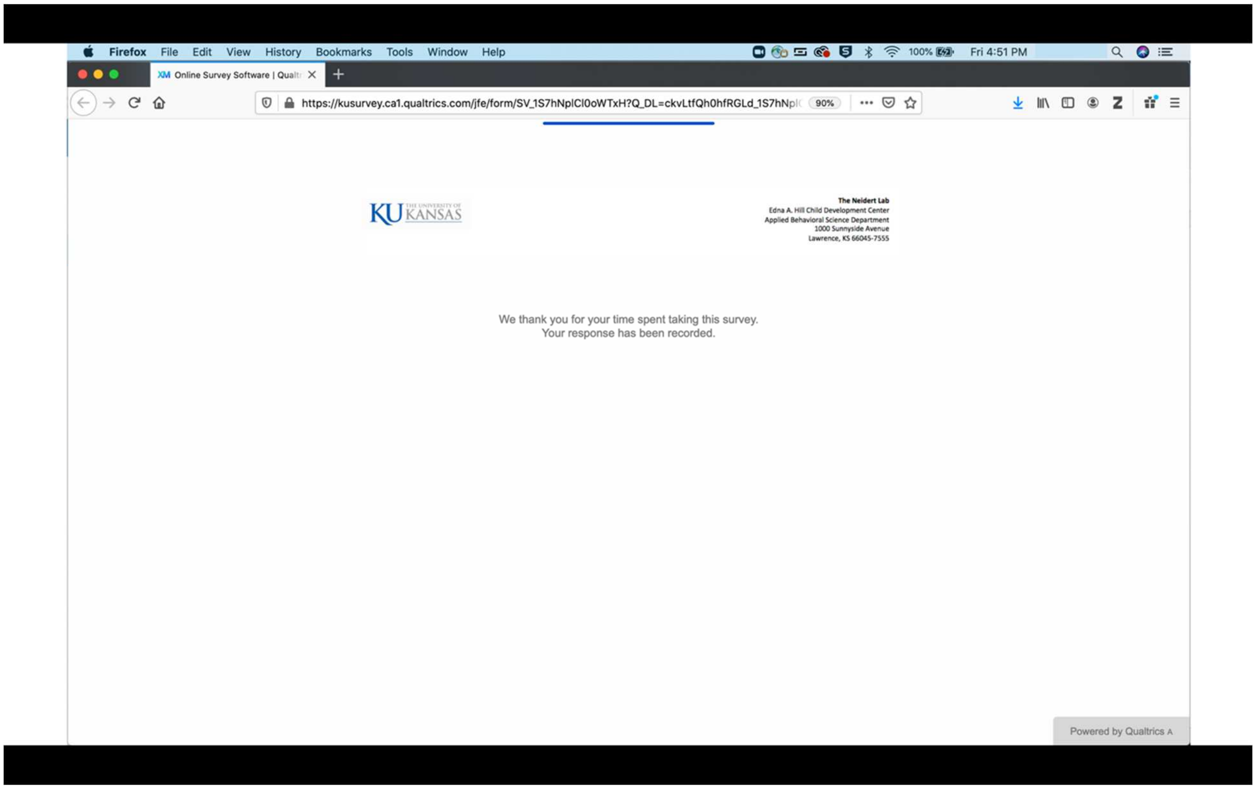
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