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The Effect of Choice of IPad-Delivered Math Independent Practice of Elementary Grade Students With Attention-Deficit/Hyperactivity Characteristics

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THE EFFECT OF CHOICE OF IPAD-DELIVERED MATH INDEPENDENT PRACTICE OF ELEMENTARY GRADE STUDENTS WITH ATTENTION-DEFICIT/HYPERACTIVITY CHARACTERISTICS

By

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ABSTRACT

THE EFFECT OF CHOICE OF IPAD-DELIVERED MATH INDEPENDENT PRACTICE OF ELEMENTARY GRADE STUDENTS WITH ATTENTION-DEFICIT/HYPERACTIVITY

Nora A. Altaweel
Old Dominion University, 2018
Director: Dr. Robert Gable

A choice-making strategy is an antecedent control that has proven to be effective for students with problem behaviors. Because students with Attention-deficit/Hyperactivity Disorder (ADHD) may display disruptive behaviors and show poor academic performance, it has been suggested that incorporating choice-making strategies into academic instruction could serve to increase academic engagement and task accuracy. The purpose of this study was to examine the effectiveness of iPad-based choice-making opportunities during math independent practice on each participant's task engagement, time required to complete task, task accuracy, and task completion, as well as the teacher and participants perceptions of social validity of the intervention. A single-subject reversal design ABAB and its counterbalancing BABA design were used to examine the effects of iPad-based choices during independent work time on math performance and behavioral responses of four participants. Visual analysis and two non-parametric overlap methods (i.e., percent of non-overlapping data [PND] and percent of data points exceeding the median line [PEM]) were employed to determine treatment effect on each dependent variable and for each participant. The results of this study were mixed. As evidenced by overall PND and/or PEM calculation estimates, there was an effect of the intervention on: (a) task engagement for Participant One, Participant Two, and Participant Four; (b) time required to complete task for all four participants; and (c) task accuracy for Participant One and Participant
Three. No functional relation was established between the intervention and participants task completion. The teacher and three participants reported that the intervention was socially valid on most of the items in the social validity assessments. Potential explanations of the reported results, study limitations, and implications for future research are discuss
DEDICATION AND ACKNOWLEDGEMENTS

This dissertation is dedicated to the memory of my beloved and supportive mother, Tarfah Alsalem, who passed away a year before I started my PhD journey. She first taught me to approach every day as the day to make a positive difference in someone's life, as a learning experience to improve, and as a gift to be wrapped successfully. Your supportive words and prayers lie deep within me, especially throughout this PhD journey. I am sure you are smiling down on this.

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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Tables and Figures</td>
<td>vii</td>
</tr>
<tr>
<td>Chapter 1: Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Choice Making Strategies</td>
<td>1</td>
</tr>
<tr>
<td>Rationale for the Study</td>
<td>2</td>
</tr>
<tr>
<td>Chapter 2: Review of the Literature</td>
<td>5</td>
</tr>
<tr>
<td>Selection and Exclusion Criteria</td>
<td>5</td>
</tr>
<tr>
<td>Results of the Literature Review</td>
<td>6</td>
</tr>
<tr>
<td>Empirical Gaps in the Selected Literature</td>
<td>16</td>
</tr>
<tr>
<td>Limitations of Analyzed Studies</td>
<td>24</td>
</tr>
<tr>
<td>Recommendations for the Present Study</td>
<td>24</td>
</tr>
<tr>
<td>Chapter 3: Methodology</td>
<td>26</td>
</tr>
<tr>
<td>Research Questions</td>
<td>26</td>
</tr>
<tr>
<td>Participants</td>
<td>26</td>
</tr>
<tr>
<td>Setting</td>
<td>31</td>
</tr>
<tr>
<td>Institutional Review Board and Consent Procedure</td>
<td>33</td>
</tr>
<tr>
<td>Measurements of Independent and Dependent Variables</td>
<td>33</td>
</tr>
<tr>
<td>Experimental Design</td>
<td>36</td>
</tr>
<tr>
<td>Materials</td>
<td>38</td>
</tr>
<tr>
<td>Procedures</td>
<td>41</td>
</tr>
<tr>
<td>Treatment Integrity</td>
<td>42</td>
</tr>
<tr>
<td>Social Validity</td>
<td>43</td>
</tr>
</tbody>
</table>
LIST OF TABLES AND FIGURES

Table 3.1: Student Participant Demographics 29
Table 3.2: Dependent Variables and Measurement Instruments 34
Table 3.3: Percentage of Sessions in which OIR was Collected During Each Study Phases and During Study Sessions 46
Table 4.1: Summary Statistics for Task engagement, Task Accuracy, and Task Completion per Phase Across Participants 53
Table 4.2: Summary Statistics for Time Required to Complete Task per Phase Across Participant 64

List of Figures

Figure 4.1: Task engagement across participants 55
Figure 4.2: Time required to complete tasks across participants 60
Figure 4.3: Task accuracy across participants 66
Figure 4.4: Task completion across participants 71
CHAPTER ONE

INTRODUCTION

There is growing evidence supporting the link between attention-deficit/hyperactivity disorder (ADHD) and poor academic achievement (e.g., in writing and reading; Loe & Feldman, 2007). Behaviors associated with ADHD, such as hyperactivity and impulsivity, add to the learning problems these students often experience (Shillingford-Butler & Theodore, 2013) and, in turn, underscore the need for educational modifications. Some authorities believe that antecedent strategies (i.e., provided prior to an academic activity; Jolivette, Ennis, & Swoszowski, 2017) may play an important role in maintaining the attention and improving the performance of different populations of students with problem behaviors. Even so, compared to the widespread use of manipulation of consequences (Abramowitz & O'Leary, 1991), there is little empirical research on the effectiveness of antecedents in the classroom.

Choice-Making Strategies

Choice-making strategies are low-intensity antecedent control interventions (Jolivette et al., 2017; Powel & Nelson, 1997) that lessen the probability of problem behavior (Jolivette et al., 2017; Shogren, Faggella-Luby, Bae, & Wehmeyer, 2004), increase on-task behaviors (Sellers et al., 2013), and increase compliance with teacher commands (Landrum & Sweigart, 2014). Choice making permits students with disabilities to express their desires appropriately while working on academic tasks (Shogren et al., 2004). As a classroom-based strategy, choice making, allows students to select a preferred activity from two or more predetermined and concurrently presented alternatives (Bos, Nahmias, & Urban, 1997; DuPaul & Weyandt, 2006; Landrum & Sweigart, 2014). Per the empirical literature on choice making, choices can be
broadly divided into two types: (a) across-task choices in which a student chooses one task from a list of different tasks or activities (e.g., English assignment or math assignment) or the sequence of presented tasks to complete; and (b) within-task choices that involve options (e.g., materials, locations, partners) on how to complete a specific task (e.g., what, where, and with whom; Lane et al., 2015; Rispoli et al., 2013). The two types of choices can be offered alone or combined. For example, a student may select one academic task to complete (i.e., across-task) then select the instructional material (i.e., within-task) to complete the self-selected task (Rispoli et al., 2013).

Based on the connection between choice making and Self-Determination Theory (SDT), Brooks and Young (2011) investigated the link between student motivation and empowerment as two main constructs of the theory. Three types of motivation have been described and assessed in different contexts: (a) amotivation (i.e., having no force to act); (b) intrinsic motivation (i.e., acting for personal satisfaction); and (c) extrinsic motivation (i.e., acting for others’ satisfactions), with variations between intrinsic and extrinsic motivation. Motivation can be seen as an individual response to cues, emerging from social and/or contextual communication. Accordingly, providing students opportunities to choose triggers an increase in their intrinsic motivation and self-determination, thereby leading to an enhancement in their classroom engagement. Thus, teachers are responsible for setting the stage for a student’s motivation by providing choice-making opportunities to support student autonomy and control class attendance and assignment completion. Overall, choices, by nature, contribute to the empowerment dimension of SDT and have been defined as central to SDT.
Rationale for this Study

In a recent literature review, Royer, Lane, Cantwell, and Messenger (2017) analyzed 26 studies relating to the evidence base of choice making to improve behavioral and academic outcomes for all learners (i.e., typically developing or identified with disabilities) within a variety of K-12 school settings. Considering the quality indicators (QIs) of the Council of Exceptional Children (CEC, 2014), only three studies met 100% and nine studies met 80% of the QIs. However, all the 12 methodically sound studies (i.e., met 80% or more of the QIs) documented behavioral and academic improvements when choice making was in place. With that said, there is insufficient evidence for making conclusive statements about the effectiveness of choice making, thus warranting additional high-quality research studies to explore and verify the potential of choice making.

Choice-making strategies have been researched for almost 40 years (Royer et al., 2017), as a means of prompting student self-determination skills (Rispoli et al., 2013). Nonetheless, in a review of 81 articles on self-determination skills from 46 journals, Carter, Lane, Crnobori, Bruhn, and Oakes (2011) found limited data on the use of choice making for students with behavioral problems compared to self-management strategies. Given the limited number of studies and the need for additional robust research, choice making for the population of students with problem behaviors (e.g., students with ADHD) warrants further investigation. More specifically, because the mechanism of choice making (e.g., why it works or it does not; Lane et al., 2015) is still not clearly defined (Rispoli et al., 2013; Sellers et al., 2013), this study will address some of the limitations identified in the research on the effectiveness of choice making for students with ADHD.
The purpose of this study was to examine the effectiveness of choice of iPad-delivered math independent practice on the academic and behavioral performances of students with or at risk for ADHD. The subsequent four chapters are structured as follows: (1) chapter two presents a focused review of the literature on the use of choice making strategies for students with ADHD in academic situations, as well as the research questions guiding this study, (2) chapter three details the methodology employed to investigate the research questions, (3) chapter four details the results of the research questions, and (4) chapter five discusses the results within the experimental context and limitations offering directions for future inquiry.
CHAPTER TWO

REVIEW OF THE LITERATURE

This section highlights the literature on the effectiveness of choice-making opportunities for students with ADHD in order to identify limitations in previous research and potential applications of choice-making strategies for the students in academic situations. Three sequential phases were used to search the empirical literature and synthesize the research on the effectiveness of choice-making strategies for students with ADHD. In the first phase, researched articles to be included in the review were identified. Second, the identified studies were coded using an investigator-developed coding form. In the third phase, the similarities, differences, and gaps in available studies were summarized and directions for future research were discussed.

Selection and Exclusion Criteria

In order to locate relevant peer-reviewed research studies for review, an electronic search of educational databases, including ERIC, EBSCOhost, Education Research Complete, and Google Scholar was conducted. The key words choice and choice making and their possible derivation and synonyms were combined with behavioral disorders, behavioral disturbance, behavioral problem, attention-deficit/hyperactivity disorder, or emotional and behavioral disorders in the search of relevant articles. The key words were not limited to the title and abstract, in order to identify studies that applied choice-making opportunities solely or in combination with behavioral and/or academic interventions (e.g., motivational feedback). To be included in this review, a study had to meet the following inclusion criteria: (a) the study was published in a peer-reviewed journal and relied on a single-subject design, (b) studies published in the years spanning 1994, when the first study on choice making for students with ADHD was published (Dunlap et al., 1994), through 2018 and conducted in US schools; (c) at least two
participants in the study were in grades K-12 grade and identified with emotional/behavioral disorders (E/BD), ADHD, or learning disabilities with a history of problem behaviors or were at-risk for identification in these areas; (d) participants demonstrated poor academic and/or behavioral performance in classroom settings; (e) choice-making strategies were utilized as an antecedent control intervention in academic situations; (f) dependent variables in the study were related to student behavioral and/or academic performance during academic activities; and (h) the study was conducted in either an inclusive or self-contained settings. A hand search of the reference lists of the articles yielded additional publications for inclusion. This initial search yielded a total of 32 articles. Next, the abstract and discussion sections of each study were read to verify the inclusion/exclusion of the study in the review. A study was excluded if: (a) it was not empirical research (i.e., position papers, suggestive literature, or practical guides); (b) choices were provided for improving adaptive behaviors, preacademic activities, or classroom behaviors that were not directly related to academic situations; (c) participants were preschool-age children with a primary diagnosis of pervasive development disorders (e.g., autism); and (d) choice making was provided to students’ parents or for medical purposes. Following the process of inclusion and exclusion criteria, a total of nine articles qualified for this review. Articles reviewed are denoted by an asterisk (*) before each citation in the references.

Results of Literature Review

In order to obtain a systematic overview of each of the nine articles, the contents were summarized using a coding form. The grouping categories used to examine the research included: types and procedures for choice making, population characteristics, problem behavior students displayed, study setting and design, independent and dependent variables, reliability of data assessments, social acceptability, and treatment fidelity measures. Four themes emerged
from the synthesis of the findings of the nine articles: (a) the types of choices provided; (b) the procedural stages of choice-making strategies; (c) the reported effectiveness of choice making; and (d) the methods used to highlight the power of choices.

**Types of choices.** The reviewed literature revealed different methods and procedures for providing choices to students with ADHD during academic instruction. All of the studies focused on choices as antecedent interventions. In other words, the choices were provided before the students worked on an academic task. There were six main types of choices offered to prompt completion of academic tasks. First, students had the opportunity to choose one option from an individualized menu of choices for English or spelling activities. Each menu included six to ten activities pertaining to the daily scheduled curriculum and one to three separate academic tasks in each activity. For example, in one activity available on the English menu, a student was asked to read a paragraph, and identify and record all pronouns. The selected activities were used for student independent practice work to support task engagement (Dunlap et al., 1994).

Second, students with problem behaviors were allowed to choose one of four types of vocabulary assignments (i.e., *fill-in-the-blank, sentence writing, word map, close sentence, and multiple choice*) to be completed (Skerbetz & Kostewicz, 2013). Each type of assignment covered the same three words from the predetermined daily packet. Then the student had seven minutes to work on the chosen assignment. Similarly, students identified with ADHD could choose one of three different language arts assignments to be independently completed during the practice work time (Powell & Nelson, 1997). The assignments varied in content (e.g., spelling, grammar, or reading tasks) related to the ongoing classroom curriculum and were equivalent in the level of difficulty and length. Ennis, Jolivette, and Losinski (2017) also
CHOICE AND STUDENTS WITH ADHD

provided six students with EBD a choice of two writing prompts. The students had one minute to decide which prompt to choose to write narrative essays with 14 story elements (e.g., characters).

Third, students were provided with the opportunity to choose the sequence of assignments to be answered independently (Jolivette, Wehby, Canale, & Massey, 2001; Ramsey, Jolivette, Kennedy, Fredrick, & Williams, 2017; Ramsey, Jolivette, Patterson, & Kennedy, 2010). Specifically, the students chose which of the two math and/or language assignments (i.e., different or similar academic subjects) they wanted to work on first (Ramsey et al., 2017; Ramsey et al., 2010), and the sequence of the three math assignments (i.e., one academic subject) to be answered (Jolivette et al., 2001). Fourth, Ramsey et al. (2017) presented students with two math tasks and asked them to choose where to complete the tasks. No places in the classroom were predetermined as choices, so the students selected any open seat.

Fifth, Stenhoff, Davey, and Lignugaris (2008) employed two different levels of math assignment demands as choices. The demands were introduced as either a classroom assignment or an alternative assignment. Both assignments included the same number and type of questions (e.g., labeling a diagram). However, in the alternative assignment, the questions were written on the right side of the assignment sheet and the answers were on the left side. The students were asked to identify the answers from the left side and rewrite them on the question side. Sixth, Daly, Garbacz, Olson, Persampieri, and Ni (2006) utilized various types of instructional methods (e.g., modeling, guided practice) as choices for fluently reading predetermined criterion texts. Students were also asked to choose the amount of instructional time they needed to attain the fluency criterion. Overall, six types of choices were addressed in the reviewed studies. The choices centered on a menu of activities, types of assignments, the sequence of assignments,
where to complete tasks, levels of assignment demands, and types of instructional methods. All the choices were used to prompt independent work on academic skills.

A meta analysis conducted by Shogren and colleagues (2004) suggested that no one type of choice across the 13 studies was more effective than the other in reducing the level of problem behavior. Thus, the reported types of choices might have been equally effective in decreasing problem behaviors. Von Mizener and Williams (2009) indicated that the different types of choices used in 40 experimental studies on the effectiveness of choices in educational settings were linked to several factors. Choice-making factors included: the nature of academic tasks, instructions provided while presenting academic tasks, and rewards for task achievement. Considering such factors, Dunlap et al. (1994) examined the nature of the assignments in the academic choices. For example, one participant was given a range of six to eight options of English assignments, with one to two tasks in each, while another participant was given a range of eight to ten options of spelling assignments, with two to three tasks in each. It seems plausible to conclude that the nature of the task (e.g., grammar or spelling) was taken into consideration in determining the number of alternatives provided.

In contrast, some reviewed literature lacked experimental control of the aforementioned factors. As an illustration, Powell and Nelson (1997) provided three different language assignments as alternatives during choice conditions, but the assignment varied in content (e.g., grammar exercise, spelling exercise). Although speculative, the nature of the content might play a role in increasing or decreasing the impact of instruction. Accordingly, in the present study, the level and type of content across the academic alternatives will remain constant.

**Procedural stages of choice-making strategies.** In the literature reviewed, the structure/format of choice-making strategies in the academic instruction was divided into four
sequential stages. First, prior to providing choice-making opportunities, students were asked whether or not they wanted to choose an alternative to complete an academic assignment (Daly et al., 2006; Dunlap et al., 1994). If an affirmative response was selected, the second stage was presented and the student was given ten to 15 seconds or one minute of wait time to think and select a choice (Ennis et al., 2017; Ramsey et al., 2017; Stenhoff et al., 2008; Skerbetz & Kostewicz, 2013), followed by the third procedural stage--student independent work on the self-selected academic activities (Dunlap et al., 1994; Ennis et al., 2017; Jolivette et al., 2001; Powell & Nelson, 1997; Ramsey et al., 2017; Ramsey et al., 2010; Skerbetz & Kostewicz, 2013; Stenhoff et al., 2008). Last, permission to change the choice after being selected, or reviewing the materials prior to providing a choice occurred in only one study (Dunlap et al., 1994). In the majority of studies, the choices led directly to student independent work on academic tasks (i.e., offered during the independent practice time), unlike one study by Daly et al. (2006) in which alternatives led indirectly to independent work (i.e., offered before the independent practice time). That is, the alternatives consisted of a variety of instructional strategies (e.g., modeling) to be used to help students reach a predetermined criterion level of reading.

In addition to the procedural stages previously mentioned, two studies combined behavior management procedures as a consequence manipulation, along with choice-making opportunities (i.e., antecedents). In the first study, after students were given opportunities to choose from the menu of spelling or English activities, Dunlap and colleagues (1994) offered identical behavior management procedures (e.g., reinforcement with exchangeable points for task completion, removal for short period of time for disruptive behavior, ignoring mild off-task behavior) throughout the study conditions. It is important to state that this equivalency in behavior management procedures could be perceived as an effort to control consequence manipulations.
Second, when Daly et al. (2006) asked the participants to choose an instructional strategy to be implemented by the teacher during the ten minutes of a reading session, they were informed of the contingency and points they would earn when they achieved criterion level on the reading task (e.g., fluent reading within 30 seconds with a maximum of two errors). Further, performance feedback was provided after every 30 seconds of reading aloud so teachers could count the errors and decide the exchangeable points the students could receive for reading fluency. These researchers suggested that this combination of choice making and reinforcement contingencies increased the rate of participants’ responding, as well as reading fluency. They further reported that choices triggered greater opportunities for academic responding. Most importantly, the significance of choice was reflected by an increase in students responding only when the motivational variables were added (e.g., contingencies). In contrast, Powell and Nelson (1997) examined the power of choice after isolating such behavior management procedures and found that choice-making opportunities were sufficient to produce positive outcomes (e.g., decrease undesirable behaviors).

Effectiveness of choice making. A review of the nine studies identified that choice making was overwhelmingly effective across a variety of educational settings and age groups of students with problem behaviors. For example, during academic instructional situations in a residential setting, choice making played a vital role in increasing appropriate behavioral responses, such as on-task behavior and academic task completion among students 13-16 years of age diagnosed with EBD (Ramsey et al., 2010). However, in this study, there was little effect on task accuracy across the five high-school participants with EBD. This finding may have been influenced by the short time dedicated to independent practice assignments, as well as variation of the cognitive demands and/or amount of time needed for individual assignments. Further, for
the majority of nine middle school students with EBD in a residential math classroom, Ramsey et al. (2017) indicated an additional support of the effects of choice-making strategies (i.e., sequence of tasks & where to complete tasks) on increasing task accuracy and task completion, as well as decreasing disruptive behaviors. Stenhoff et al. (2008) also pointed out that when a high-school student with a problem behavior was provided with a choice within special education classroom routines, the level of productivity and academic task completion was higher compared to the no-choice condition.

Working with elementary school-age students with ADHD, Dunlap and others (1994) investigated the effects of providing choice–making opportunities in English and spelling instruction for two fifth-grade students identified with ADHD in a self-contained classroom. Compared to no-choice conditions, the students responded with higher levels of task engagement and lower levels of disruptive behaviors (e.g., vocal and nonvocal noise making). Daly et al. (2006) reported further evidence supporting choice making when the procedure was combined with reinforcement contingences. In this study, upon providing students opportunities to choose the reading instructions to be delivered in a special education classroom, student reading fluency increased. Additionally, in a self-contained setting, two of three elementary-age students showed increased academic task engagement (i.e., the number of tasks attempted) and appropriate social behavior (i.e., a decrease in off-task behavior and disruptive behaviors) when provided with the opportunity to choose the sequence of three math assignments (Jolivette et al., 2001). In a general classroom setting, Powell and Nelson (1997) provided a seven-year old student diagnosed with ADHD with a variety of language art assignments (e.g., grammar) during the independent work time and found that the level of undesirable behaviors decreased (e.g., being away from the desk). Also, based on the data of four of five fifth-grade participants with EBD,
Skerbetz and Kostewicz (2013) concluded that choice making increased task engagement, task accuracy, and task completion in a general classroom setting.

Across the nine reviewed studies, only one study concluded with a no functional relation between the choice making and an improvement in academic performance for six seventh through tenth grade students with EBD. Specifically, students were given a choice of two writing prompts to complete narrative essays with 14 story elements. While a single-subject withdrawal design (i.e., ABAB) was planned to examine the treatment effects, the study was terminated when null and/or contra-therapeutic effects existed during the first baseline-intervention contrast. There were potential explanations for the no gains including: (a) type of choices so that students could have benefited from across-activities choices (e.g., choices of writing a story, verbally describing a story, or drawing a story), (b) the lack of functionally-indicated choices in that the choice of writing prompts was avoidance-motivated (i.e., to choose one writing prompt and avoid the other) that could have not been motivating for students who enjoyed writing, and (c) the possibility of the effectiveness of choice-making strategies to improve behavioral performance (e.g., on-task behaviors), but not to improve the writing performance (Ennis et al., 2017).

Overall, the reviewed literature demonstrates that choice making positively increases academic behaviors (e.g., task completion, task engagement) across different settings from a residential facility to general classroom settings. Drawing on the results of the accumulated research, it seems that special education and general education teachers could benefit by incorporating choice-making strategies into academic routines in their classrooms. Choice making does not demand any additional teacher time, does not conflict with teacher attention to other students in the same setting (Lancioni, O'Reilly, & Emerson, 1996), and is a feasible
strategy within the context of everyday classroom routines (Jolivette et al., 2001). In general, choice making as an antecedent technique helps teachers control undesirable behaviors and, at the same time, maintain ongoing instruction, especially in the general classroom settings (Powel & Nelson, 1997). Notwithstanding these results, there is limited research (i.e., only two studies) on the effects of choice making in an inclusive setting (Powell & Nelson, 1997; Skerbetz & Kostewicz, 2013), which highlights the need for future investigation on the effects of choice making in general education classroom. Equally important, Brooks and Young (2011) asserted that in order to enhance the student motivation to its fullest, the teacher should remain consistent in offering choice-making opportunities. The other critical issue is that, without regard to offering appropriate and acceptable alternatives (e.g., fit within the setting in which the students received choice-making opportunities), the antecedent control associated with choice making may not be established (Ennis et al., 2017; Powel & Nelson, 1997; Ramsey et al., 2017).

The power of choice making. Antecedent manipulations, such as choice-making opportunities, may trigger the occurrence of a desirable behavior, but they do not necessarily maintain the behavior (Stenhoff et al., 2008). Thus, other variables may have influenced the effectiveness of choice making on student outcomes. First, it is unknown whether choice making has an additive effect on students’ academic performance. Morgan (2006) questioned if access to preference affected the students’ performance, more than the opportunity to choose (i.e., the act of choosing) per se; three studies addressed this controversial issue (Skerbetz & Kostewicz, 2013). In the first study, data on four of five students with EBD who were exposed to choice-making strategies revealed positive improvement on their task engagements, task accuracy, and task completion. Most students chose the same type of assignment across choice conditions, with different scores, which might support the value of accessing preference. In contrast,
compared to no-choice conditions, the scores of most students were better across choice conditions, supporting the additional effect of choice making, unexplained by preference (Skerbetz & Kostewicz, 2013). The second explanation was supported by a study conducted by Stenhoff et al. (2008). Keeping in mind that when students were provided with a choice of assignment demand, the target students consistently chose the higher demand level of assignment for independent practice. The choice was sufficient to serve as a controlling variable to increase the students’ task completion. That is, choice making influenced the reinforcing value of the choices provided. Third, due to the sensitive nature of students’ preferences that change over time, Dunlap et al. (1994) yoked the second no-choice condition to the first choice condition in an ABAB experimental design. To elaborate, the same alternative that was selected by a student to be completed in the first choice condition was assigned in the following no-choice condition. This procedure was used to distinguish the effects of preferences and choice making and represent the power of choice making, regardless of the level of preferred choices. The yoking procedure resulted in the positive effects of choice making (e.g., increased task engagement). Presuming these are representative outcomes, there is reason to believe that it may not be necessary to assess the need for preintervention preferences.

Second, researchers looked at providing choices that are equal in length (e.g., number of math problems in each alternative) and level of difficulty (i.e., amount of time estimated to complete the problems in each alternative) as another approach to reduce the effect of the extraneous variables (Jolivette et al., 2001; Powell & Nelson, 1997). Also, the researchers controlled newness in the format of math problems. Choices were developed in typical formats to exclude the novelty in alternatives as a potential extraneous variable. Last, one way that has been attempted to control for confounding variables is adhering to strict experimental control.
For example, counterbalancing single-subject designs (e.g., ABAB design with BABA design) would make the link between the independent variable and outcomes stronger (Dunlap et al., 1994; Ramsey et al., 2017; Ramsey et al., 2010).

In sum, in the literature reviewed, several procedures were highlighted to support the functional relation between choice making and treatment effects. The emphasis was on increasing the power of choice-making strategies by assessing the additional effect of choice making compared to accessing preferred activities (Skerbetz & Kostewicz, 2013; Stenhoff et al., 2008), controlling the equivalency in the length and level of difficulty in the choices provided (Jolivette et al., 2001; Powell & Nelson, 1997), excluding the novelty in the alternatives (Jolivette et al., 2001), and strengthening the experimental design using a counterbalance approach (Dunlap et al., 1994; Ramsey et al., 2010). Overall, the procedures indicated that choice-making opportunities were sufficient to produce student positive outcomes (e.g., decrease undesirable behaviors).

**Empirical Gaps in the Selected Literature**

Previous research on the benefits of choice making for students with ADHD is limited by some empirical gaps that warrant further investigation. The gaps mainly center on: (a) the lack of research for students with ADHD in classroom settings, (b) the need to control the function of choices exclusive from possible extraneous variables, and (c) and limited research on the use of mobile technology in choice-making applications. Viewed together, these gaps underscore the importance of the present study.

**Lack of research for students with ADHD in inclusive settings.** Despite the apparent consensus regarding the effectiveness of choice-making strategies for different populations of students with disabilities, such as intellectual disabilities (e.g., Dibley & Lim, 1999; Kern,
Mantegna, Vorndran, Bailin, & Hilt, 2001), there has been little empirical research targeting students with ADHD and on those students being served in inclusive classrooms. This review revealed that for the past 22 years (1994-2017), only three empirical studies have been conducted to examine the effectiveness of choice making with school-age students diagnosed with ADHD (Dunlap et al., 1994; Ennis et al., 2017; Powell & Nelson, 1997). Further, the majority of the studies reviewed applied choice-making strategies in restrictive settings (Daly et al., 2006; Dunlap et al., 1994; Ennis et al., 2017; Jolivette et al., 2001; Ramsey et al., 2017; Ramsey et al., 2010; Stenhoff et al., 2008), and only two studies were conducted in general classroom settings (Powell & Nelson, 1997; Skerbetz & Kostewicz, 2013).

Controlling the functions of choices. As previously mentioned, various methodical procedures have been used to investigate the treatment effects of choice making. In contrast, controlling the function of choices and decreasing the effects of extraneous variables are needed. First, a student’s ability to maintain the preference for choice-making opportunities when the required tasks were increasingly more difficult provides useful information regarding the extent to which the maintenance of responses mirrors the long-term effectiveness of choice-making opportunities (Sellers et al., 2013). However, Loe and Feldman (2007) pointed out that, despite the positive outcomes of behavioral interventions in the literature, there is a lack of research that examines the long-term impact of the interventions on students’ behavioral and academic performance in inclusive settings. Of the literature reviewed, only two study incorporated maintenance probes in the multiple baseline design (Daly et al, 2006; Ramsey et al., 2017). The absence of generalization and maintenance probes represented a shortcoming of the majority of studies reviewed (e.g., Dunlap et al., 1994; Ramsey et al., 2010; Skerbetz & Kostewicz, 2013; Stenhoff et al., 2008).
Second, teacher-student interactions during the provision of choice-making opportunities could have contributed to the reported effectiveness of choice making. It is possible that the teachers may have provided students with more prompts during the no-choice conditions (e.g., Jolivette et al., 2001) to encourage students to complete an assignment. It is imperative to control the frequency of teacher-student interactions across the choice and no-choice conditions (Stenhoff et al., 2008). Conversely, the majority of reviewed studies did not include attempts to monitor the fidelity of implementation of intervention strategies or to assess teacher behavior during the no-choice condition. Only one study (Dunlap et al., 1994) measured student-teacher interactions during the choice and no-choice conditions. In this study, the goal was to maintain infrequent interactions (i.e., up to 7% of the instructional time) across the sessions. In another study (Skerbetz & Kostewicz, 2013), students did not receive any feedback on their daily assignment to control for teacher-student interaction. Likewise, attention from peers may be another factor that could have affected student choices. For example, to control for this possible confounding variable, it may be prudent to attempt to prevent or reduce peer influences by asking participants to make their choices and work on tasks in a study carrel, even in the general education classroom (Stenhoff et al., 2008).

Third, the task assignments provided to students as a choice should be congruent with the level of students’ achievement (Powell & Nelson, 1997) and the function of problem behaviors (e.g., avoidance or access; Ramsey et al., 2017). Thus, one could determine different time-to-completion scores (Skerbetz & Kostewicz, 2013) or types of choice (e.g., avoidance or access-motivated choices; Ramsey et al., 2017). Not only should researchers control the equivalency of the task difficulty and interest in the choices provided to students, but also the function of the choices and ensure the choices are valid. While some choices might pose more cognitive
demands (Bennett, Zentall, French, & Giorgetti-Borucki, 2006) that could interfere with the
students’ overall performance, more attention should be given to strictly assessing the
equivalency of choice demands (Ramsey et al., 2010). In future research, it might be more
helpful to determine the functions of problem behaviors of students with ADHD, as they vary
among students (DuPaul & Ervin, 1996) and could influence student choices and academic
outcomes.

Fourth, one caution is that the students with problem behaviors might not choose the right
alternative to improve their academic performance. As an illustration, Daly et al. (2006)
expressed concern that when alternatives of effective instructional strategies for reading fluency
(e.g., modeling, practice) were provided as choices, there was no clear assurance that students
would choose the right instructional strategy. This was in spite of the fact that participants were
taught and practiced identifying the various components of each strategy using novel reading
passages.

Last, the majority of studies indicated that teachers were involved primarily in building
and selecting the assignments as alternatives drawn from the ongoing curriculum being taught
(e.g., Dunlap et al., 1994; Stenhoff et al., 2008). However, of the literature reviewed, only one
study detailed systematic considerations for selecting the alternatives. In a study by Ramsey et
al. (2010), multiple components were assessed in developing the functioning level of academic
choices to be independently completed. A number of strategies were used to identify choices at
a student’s developmental level. These included classroom observations during the independent
work time, academic objectives for the daily lessons, academic goals from each student’s IEP,
current level of performance of each student based on classroom-based assessments, and the
level of task difficulty. However, these strategies were not consistently used. More systematic criterion for developing the academic alternatives warrants attention in future studies.

**Lack of social validity.** Demonstrating the usefulness of choice-making opportunities for both teachers and students with ADHD can provide meaningful information whether choice making was feasible and well-received. While the reviewed studies provide valuable information regarding the choice-making strategies, only four studies assessed the social acceptability of using the strategies in educational situations for classroom teachers and/or participating students (Jolivette et al., 2001; Ramsey et al., 2017; Ramsey et al., 2010; Skerbetz & Kostewicz, 2013). The assessment tools for reporting social validity data in the studies reviewed involved structured Likert scales (i.e., four-point or five-point; Ramsey et al., 2010; Skerbetz & Kostewicz, 2013), a structured interview with open-ended responses (Ramsey et al., 2010), and the Treatment Acceptability Rating Form-Revised (TARF-R; Jolivette et al., 2001; Ramsey et al., 2017). The social validity assessments concerned the teachers’ perspectives on the flexibility and accessibility (e.g., for effort and time) of choices during the classroom routines (Jolivette et al., 2001; Ramsey et al., 2010), the impact of choices on student task engagement and academic performance (Ramsey et al., 2010; Skerbetz & Kostewicz, 2013), and the ease of implementing the intervention (Ramsey et al., 2010). The tools designed for assessing social validity were administered at several phases of the intervention: after the choice condition (Jolivette et al., 2001; Ramsey et al. 2010), after the no-choice condition (Jolivette et al., 2001), after collecting maintenance data (Ramsey et al., 2017; Ramsey et al., 2010), and/or during the intervention (Jolivette et al., 2001). Overall, teachers reported that choice making functioned as a non-aversive procedure that resulted in increasing on-task behaviors, appropriate classroom behaviors (Ramsey et al., 2010), and task engagement (Skerbetz & Kostewicz, 2013). The
teachers also showed their willingness to use choice making in their future classes (Jolivette et al., 2001; Skerbetz & Kostewicz, 2013; Ramsey et al., 2017). Even so, teachers reported some difficulty in preparing independent assignments for the choice-making tasks (e.g., adjusting the task demands to the time limit; Ramsey et al., 2010).

Likewise, the students’ perceptions on the usefulness of choice making to increase their academic performance and the potential usefulness of the intervention in current and future classes was reported in two studies (Ramsey et al., 2010; Skerbetz & Kostewicz, 2013). Target students expressed their satisfaction with being able to choose their assignments and indicated the desire to do so in other classes (Ramsey et al., 2010). Some students specifically stated that choice making was helpful for task completion during independent work time (Skerbetz & Kostewicz, 2013). Overall, given the small number of studies that collected quantitative and qualitative data on the socially relevant effects of choice making, future studies should include assessments on the social validity of choice-making intervention by both the classroom teacher and students with ADHD.

Absence of technology-administered choices. Because students with disabilities might need to complete tasks in a modified manner, instructional technologies can provide alternative access and enhance teaching and learning, triggering an increase in academic performance. Thus, the need to apply instructional technology interventions has become more important as students with disabilities increasingly receive services in the general education settings (Edyburn, 2013). Specifically, with mobile technology (i.e., new handheld devices such as tablets and smartphones) expanding rapidly in today's schools, it may serve as a new potential for accessing and engaging in learning. Integrating mobile technology into instructional strategies has recently received attention in special education literature for several reasons. First,
looking at the overall educational trends, initiated by school districts and individual teachers, there appears to be a shift toward the use of new technologies for sound educational purposes (Falloon, 2013; Macsuga-Gage, Schmidt, Mcniff, Gage, & Schmidt, 2015). Second, with an increase in popularity and ubiquity of mobile technology in households and schools (Maich & Hall, 2016; McClanahan, Williams, Kennedy, & Tate, 2012; Stephenson & Limbrick, 2015), not to mention many of which are students' personally-owned cell phones and tablets (Bedesem & Dieker, 2014), mobile technologies might offer new potential as a nonstigmatizing instructional and learning tool (Cumming, 2013; Maich & Hall, 2016; Stephenson & Limbrick, 2015). Third, researchers have reported positive school-related outcomes when new mobile technologies have been used with diverse populations of students with disabilities (e.g., autism spectrum disorder; Rivera, Mason, Jabeen, & Johnson, 2015).

In the area of teaching students with problem behaviors, two recent studies examined the effects of integrating mobile technology into instructional practices versus typically-delivered practices using an alternating treatments design. First, Haydon et al. (2012) measured the effects of iPad and worksheet instructional conditions on the behavioral and academic performance of three high-school students diagnosed with EBD. Following the teacher's instruction and depending on the instructional condition of the day, the students independently completed iPad or worksheet math problems. In comparison to traditional worksheet conditions, all three students answered a significantly higher numbers of correct math responses per minute and demonstrated higher levels of active engagement with the use of mobile technology. Second, Flower (2014) extended the previous work with a more controlled number of minutes allocated for each condition (e.g., ten minutes of independent practice time). Three elementary-aged students with EBD were asked to complete reading and math independent assignments in both
worksheet and iPad conditions. The results asserted that the use of iPads prompted a higher level of on-task behavior comparable to their typically developing peers, for all three students.

Within the self-monitoring literature, researchers have reported a consistent increase of on-task behavior and/or decrease of off-task behaviors when mobile technology was integrated into one or more components of self-monitoring procedures (Bedesem, 2012; Bruhn, Vogelgesang, Fernando, & Lugo, 2016; Bruhn, Vogelgesang, Schabilion, Waller, & Fernando, 2015; Gulchak, 2008; Szwed & Bouck, 2013; Vogelgesang, Bruhn, Coghill-Behrends, Kern, & Troughton, 2016; Wills & Mason, 2014). Despite these encouraging outcomes, the reviewed literature did not include a study that delivered choices through mobile technology. Even so, the positive gains from using new technologies should prompt researchers to broaden the variety of instructional practices when using new mobile technology in future research.

**Summary of the empirical gaps in the reviewed literature.** In summary, the literature reviewed revealed a paucity of research on the effectiveness of choice making on behavioral and academic performance for students with ADHD in inclusive settings. The review indicated a need to include a larger number of students with ADHD, as well as students from across the spectrum, in future studies (Stenhoff et al., 2008). The need for increasing the power of choice making also was noted. There appears to be inconsistent consideration of the function of choices (e.g., choice demands), and control for confounding variables (e.g., teacher-student interactions) that might interfere with the power of choices. In addition, the measurement of academic responses in analyzing the effects of choice making was missing from the majority of studies. Also, only a limited number of empirical studies reported social validity data. Given that mobile technology holds significant potential to support instructional practices, there was an absence of research that incorporated mobile technology devices into choice-making strategies.
Limitations of Analyzed Studies

The review of empirical studies with students with ADHD and related disabilities included. Even though the nine studies reviewed met the inclusion criterion to specify the focus on the mechanism and effectiveness of choice-making strategies as an antecedent control for students with ADHD, the review excluded other studies that may have provided valuable descriptions of the mechanism of choice making as consequence control (e.g., choose type of feedback after completing an assignment; Bennett et al., 2006). Also, including other types of student populations who demonstrated problem behaviors in inclusive settings, such as autism (e.g., Moes, 1998), may add to the knowledge base on choice making. Second, the aim of the adopted inclusion criteria was to encapsulate all relevant articles for review. Still, there is a possibility that some publications might have been inadvertently omitted. Accordingly, further research in wider educational databases would be necessary.

Recommendations for the Present Study

The purpose of the present study is to add to knowledge regarding the effectiveness of choice-making strategies on the behavioral and academic performance of students with ADHD in the classroom (Skerbetz & Kostewicz, 2013). This study will extend the literature on choice-making strategies by taking into account the following modifications: (a) evaluating both behavioral and academic performances as intervention outcomes, (b) incorporating mobile technologies in delivering the intervention in order to complete academic tasks, and (c) attempting to control confounding variables extracted from previous research (i.e., teacher-student interactions, nature of the tasks, equivalency of the activities provided; Dunlap et al., 1994; Jolivette, Wehby, Canale, & Massey, 2001), and (d) assessing the social acceptability of
choice-making strategies in the classroom. The following three research questions will be addressed by this study:

a) When implemented with fidelity, does providing elementary-grade students identified with ADHD in a classroom with iPad-based choice-making opportunities with math concepts during seven minutes of independent work increase students’ behavior and academic performance as measured by the: 1) percent of task engagement, 2) total amount of time required on assigned or chosen tasks, 3) percent of task accuracy, and 4) task completion?

b) What are the classroom teacher’s perceptions of the use of iPad-based choice-making opportunities for students with ADHD in the classroom?

c) What are the perceptions of elementary-grade students with ADHD of the use of iPad-based choices for independent work in a math class?
CHAPTER THREE

METHODOLOGY

The purpose of this chapter is to present the methodology used to examine the effectiveness of iPad-based choice-making opportunities with math concepts during seven minutes of independent work on increasing students’ behavior and academic performance. Specifically, it includes the research questions, a description of participants and setting, measurements of independent and dependent variables, experimental design, research materials and procedures, and data analysis. Further, this chapter details the assessment of treatment fidelity, social validity from the teacher's and students' perspectives, and inter-observer agreement. The following is a description of the methodology employed in this study.

Research Questions

The three research questions guiding this study were: (a) when implemented with fidelity, does providing elementary-grade students identified with ADHD in a classroom with iPad-based choice-making opportunities with math concepts during seven minutes of independent work increase students’ behavior and academic performance as measured by the: 1) percent of task engagement, 2) total amount of time required on assigned or chosen tasks, 3) percent of task accuracy, and 4) task completion?, (b) what are the teacher’s perceptions of the use of iPad-based choice-making opportunities for students with ADHD in the classroom?, and (c) what are the perceptions of elementary-grade students with ADHD of the use of iPad-based choices for independent work in a math class?

Participants

Prior to the study, the elementary school director was asked to nominate six students from elementary-grade classrooms for participation in the study. The participants’ nomination
criteria was adapted from Jolivette et al. (2001) and Skerbetz and Kostewicz (2013) as follows: (a) the student was identified with or at risk for ADHD, (b) demonstrated one to two years delay in their math performance, (c) consistently displayed problem behavior in the form of off-task behavior in the classroom, (d) was eligible for special education services based on state regulations for special education eligibility in public or private schools, (e) received most of their academic instruction in the classroom, and (f) agreed to being videotaped during the study sessions. The recruitment process was applied sequentially as follows: 1) providing the elementary school director with a list of previously stated nomination criteria; 2) the researcher explained each item in the inclusion criteria to the elementary school director to nominate students; and 3) the elementary school director suggested a list of identified students in a third-grade classroom that best met the nomination criteria. Since only one student in the suggested grade level was formally identified with ADHD, the list included other students who were reported as exhibiting off-task behaviors and/or weaknesses in the area of math. Finally, four students were assigned to participate in the study.

It was proposed that the elementary school director would randomly pick four students from the identified list by writing students names on equal size cards (i.e., one student name on each card), shuffling them, and picking four cards with four names. However, getting access to only one five-student classroom (i.e., third grade math classroom) made the randomization process unnecessary. To verify the application of nomination criteria, the experimenter reviewed the individualized instruction plan (IIP) of the identified students and conducted a brief observation of their behaviors in the classroom before final selections were made.

Because some students received special education services but could have not been identified with a primary diagnosis, developing survey questions was necessary. That is, the
elementary school director would send all or some of the following questions to the parents as an initial screening tool: (a) Explain any areas of difficulty (i.e., behavioral and/or academic areas) you believe your child is having in school? (b) What do you think needs to be addressed first? (c) Does your child have an IEP or 504 Plan? (d) Does the IEP or 504 plan include any behavioral and/or academic objectives? If so, please list what they are. (e) Please identify all the behavioral and/or academic challenges that you think may interfere with your child’s performance. (f) Does your child receive special services to address these behavioral and/or academic problems? If so, explain what types of services your child receives. (g) Are there any additional services that you think would benefit your child (for example, behavior management)? (h) Does your child require medicine on a daily basis during the school day? If yes, what is the name of the medication and why it is prescribed? These survey results were added to the recruitment materials to assist the elementary school director when limited information was available to identify and verify that each nominated student had met the criteria.

In order to reduce participant attrition, the researcher reviewed issues related to family stability (e.g., military status of parents and moving plan) and students’ medical status (e.g., absences from school). If the information gained from the review revealed that a student might not be able to consistently participate in the study procedures, he/she would not be assigned as a participant. Thereby, in case of participant attrition, four students were considered initially for participation.

As presented in Table 3.1, each participant was randomly assigned an identification number from one to four for identity protection purposes. All primary diagnoses were based on the most recent psycho-educational evaluation or individualized educational plan. Although the grade levels across participants varied, all participants performed at the third grade math level
and received instructions in one math classroom. The current level of math functioning was identified based on the Wide Range Achievement Test (WRAT-IV) with scores of age-based standard scores (SS) and grade level equivalency (GE). The WRAT-IV was completed for each participant within the year prior to the study. Further, all participants had been recommended for the study because each particular evidenced difficulties with remaining on-task during independent work. The following is an overview description of student participants as stated in each IIP.

Table 3.1

Student Participant Demographics

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Ethnicity</th>
<th>Primary Diagnosis</th>
<th>Grade</th>
<th>WRAT-IV Math Computation</th>
<th>STAR Math</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9</td>
<td>Male</td>
<td>Caucasian</td>
<td>ASD</td>
<td>3</td>
<td>SS 86, GE 2.7</td>
<td>GE 4.2</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>Female</td>
<td>Pacific Islander</td>
<td>OHI</td>
<td>3</td>
<td>SS 95, GE 2.4</td>
<td>GE 2.9</td>
</tr>
<tr>
<td>3</td>
<td>12</td>
<td>Male</td>
<td>Caucasian</td>
<td>ADHD Acrocephalasia</td>
<td>5</td>
<td>SS 72, GE 2.7</td>
<td>GE 1.9</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>Male</td>
<td>Caucasian</td>
<td>SLD</td>
<td>4</td>
<td>SS 94, GE 3.2</td>
<td>GE 2.5</td>
</tr>
</tbody>
</table>

Note: ASD = autism spectrum disorder; OHI= other health impairment; ADHD= attention deficit/hyperactivity disorder; SLD = specific learning disabilities; WRAT-IV = Wide Range Achievement Test; SS = Standard Scores; GE = Grade Equivalent.

Participant One. Participant One was a 9-year-old Caucasian male in third grade and in his first year of enrollment at the school. On the Kaufman Assessment Battery for Children (Second Ed), he scored within the average range of intellectual ability, short-term memory, visual processing, fluid reasoning, and general knowledge. With regard to areas of challenges, the recent psycho-educational evaluation (i.e., completed within two years prior to the study) indicated a primary diagnosis of Autism Spectrum Disorder with accompanying language impairments. Academically, Participant One demonstrated a below-average level in the areas of
CHOICE AND STUDENTS WITH ADHD

reading and math. Based on teacher assessment and observation, areas of weaknesses included processing information, phonological skills, memory, auditory discrimination skills, and words decoding. His processing speed affected the ability to complete math cognitive tasks such as calculation. Further, Participant One was reported to exhibit avoidance behaviors (e.g., talking about off-topic subjects when asked to complete a task), impulsivity, and inattention. Overall, he struggled with following directions and completing tasks.

Participant Two. Participant Two was an 8-year-old Pacific Islander female, who had been diagnosed with left-side hemiparesis (i.e., within a year prior to the study) and received special education services under other health impairment. Participant Two was in her first year of attendance at the school. Her most recent psycho-educational evaluation revealed areas of cognitive abilities including fluid reasoning, working memory, and visual processing. Academic skills within the average included basic reading, phonological processing, decoding words, math problem solving, computation, and written expression. However, based on her scores on the Kaufman Test of Educational Achievement, she demonstrated a below-average level in reading comprehension and oral expression. Teacher assessment and observation indicated that Participant Two had difficulties maintaining attention when asked to complete tasks and demonstrated a lack in mental and physical stamina.

Participant Three. Participant Three was a 12-year-old Caucasian male in fifth grade and in his first year of enrollment at the school. According to the most recent psycho-educational evaluation (i.e., completed within four years prior to the study), he had a primary diagnosis of ADHD and achondroplasia. The Wechsler Intelligence Scale for Children IV indicated academic and cognitive strengths including: an average processing speed, vocabulary naming, and picture matching skills, while a low-to-average level of intellectual ability was
identified. Participant Three was reported by the teacher to have academic difficulties with decoding words, motors skills, information processing, and remaining on-task, with a demonstration of impulsivity and inattention.

**Participant Four.** Participant Four was a ten-year old, Caucasian, male in fourth grade and in his second year at the school. He had been diagnosed with specific learning disabilities (i.e., within three years prior to the study), with low average intellectual ability as indicated by the Differential Ability Scale-2. The teacher reported that Participant Four performed well in basic math facts (i.e., addition and subtraction through 20), word sight, and sound blend. His academic challenges included reading comprehension and math fluency based on the scores of the Woodcock Johnson (Third Ed). According to the teacher report and observation, Participant Four exhibited low information processing and was easily distracted, affecting his performance during independent work.

**Setting**

The study was conducted in a third-grade classroom of a private, self-contained elementary school in the southeast of the United States. The school was chosen because the teachers in the school were equipped with the knowledge in behavioral and academic intervention for students with ADHD and demonstrated the desire to use evidence-based interventions in the classroom. Specifically, The teacher participating in the study had a minimum of 11 years experience in the field of education of exceptional students. She holds master's and bachelor's degrees in subject area she taught (e.g., math instruction for students with special needs). Further, the teacher annually attended and/or provided two to four professional development programs for teachers and/or parents on teaching students with special needs.
The elementary school consisted of five classrooms with a total of 29 students. The third-grade classroom in which the study procedures were conducted consisted of five students with a range of disabilities including Autism, ADHD, SLD, and physical disabilities. The study procedures and data collection were conducted during the first seven minutes of the regularly scheduled math sessions, during the independent practice time. Although math sessions were usually held Monday through Friday during the second hour of the school day (i.e., after the snack break at 9:50 am), review sessions usually occurred on Mondays and Fridays. Thus, the study procedures were conducted during the math independent time on Tuesdays, Wednesdays, and Thursdays in an attempt to control the level of familiarity across study sessions. During the study phases, the classroom included five students, the classroom teacher, and the primary researcher. The classroom contained individual desks and chairs that could easily be moved for different seating arrangements and a smart board used as a teaching tool on a daily basis.

Students usually sat in rows during most of the math instructional activities, especially during the independent work time. At times, the teacher might ask students to move their desks and sit in circles for cooperative assignments (e.g., math games). The classroom also contained some flexible seats and cushions on a floor mat located in a quiet corner. In addition, there was a half round activity table that might be used for students who needed fewer distractions and continuous prompting in order to complete instructional activities.

The lower elementary director indicated that the students in the classroom used iPads on an average of two to four times per week, depending upon the teacher’s choice and the content being taught. The classroom activities for which the students used iPads included: (a) independent practice (i.e. IXL math, splash math, map activities), (b) research activity (e.g., looking up facts about a particular topic for the school academic fair), (c) brain break (i.e.,
games); and (d) center/station activities (e.g., spelling, alphabetizing, math facts, geometry, geography).

**Institutional Review Board and Consent Procedure**

The approval to implement the study was requested from the University Institutional Review Board (IRB) at the university where the researcher was a doctoral student. After the elementary school director selected four students based on the previously mentioned inclusion criteria, she gave each of the four students a consent letter (see Appendix A) to be given to their parents. The elementary school director emailed the parents to ask them to read the consent letter. The consent letter described briefly the study purpose, benefits and risks associated with participating in the study, confidentiality of data, and the fact that voluntary participation. The parents were informed that the study sessions would be videotaped for the purpose of data analysis.

The students whom their parents signed the consent form and allowed them to participate in the study were given the assent letters (see Appendix B). The researcher met individually with each student and read the assent letter to the student. The students were told to take the letter home, read it again, sign it if he/she approved, and turn it back in. Students who agreed to participate in the study and sign the assent letter were included in the final list of identified students. Overall, after receiving a permission letter from the U.S. IRB and consent forms from the parents and the students, the study was initiated.

**Measurements of Independent and Dependent Variables**

In this study, the independent variable was the provision of choice and no-choice conditions during independent math work. A math teacher implemented the two conditions in a third-grade classroom serving students in third to fifth grade. First, in the no-choice conditions,
participants were assigned to complete one write math worksheet (i.e., typical paper format) during the seven-minutes of independent work time. Second, during the choice conditions, participants were given the opportunity to choose one of three write iPad-based math tasks from a math problems pool to be completed during the seven-minute independent work time. The dependent variables in this study were 1) student task engagement, 2) time required to complete task, and assessment of academic performance as measured by 3) task accuracy, and 4) task completion. Based on the nature of each dependent variable, the frequency and/or duration of behaviors were measured across intervention sessions. Specifically, the following table delineates the operational definition and data-recording procedure for each dependent variable.

Table 3.2

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Operational Definition</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task engagement</td>
<td>Participants’ working on assigned or self-selected iPad-based assignment (i.e., defined by study conditions) with eyes and hands on the math task (Jolivette et al., 2001). Task engagement involves making appropriate motor responses (e.g., using hands to count or gently hitting the table or chair to count; Weeden, Will, Kottwitz, &amp; Kamps, 2016). The participant is considered off-task if he/she: is out of seat, waves arms or materials in the air, talks with peers without permission, disassembles or plays with the materials (e.g., pencil; Blood, Johnson, Ridenour, Simmons, &amp; Crouch, 2011), veers away from</td>
<td>Using a 10-second interval recording system, partial interval sampling is used to score each interval in which a participant is engaged or not during the seven-minute independent math task, (Jolivette et al., 2001). Observers use vibration signals to cue them to record the occurrence or nonoccurrence at any time during the interval (Gast &amp; Spriggs, 2014). The percent of task engagement (i.e., dividing the number of on-task intervals by the total number of intervals observed and multiplying by 100) is used to assess task engagement (Skerbetz &amp; Kostewicz, 2013).</td>
</tr>
</tbody>
</table>
Unusual circumstances of participants’ behavior (e.g., sickness & coming late) also were reported in anecdotal notes (Jolivette et al., 2001) to exclude the data on the dependent variables that might be affected by circumstantial variables. Further, because the intervention phases required minimum interactions between the teacher and participant during math independent work time, data on teacher-student interactions were collected as a controlling variable.
Teacher-student interactions were defined as the teacher’s physical (i.e., including gestures and facial expressions) or verbal prompts, cues, responses, comments, or feedback while a participant was working on independent math assignments. When any of these verbal or physical communications cue occurred after the teacher described the assignments to the student (i.e., including directions and clarifications), it was considered a teacher-student interaction. Though the teacher had to respond to participant communications only when a technical issue on the iPad occurs, coding teacher-student interaction served as a measure of procedure fidelity. The same 10-second partial interval sampling described in recording and calculating the percent of task engagement (see Table 3.2), was used for recording and calculating the percent of teacher-student interaction during independent work time. This was to ensure the lowest level of teacher-student interaction frequency during all phases of the research. If the percentage of intervals with teacher-student interactions across choice and no-choice conditions averaged less than 8%, the interactions were considered infrequent (Dunlap et al., 1994).

**Experimental Design**

A single-subject reversal design (ABAB) was used to examine the effects of iPad-based choices during independent work time on the participants’ math performance and behavioral responses. No-choice conditions were provided in the two baseline phases (i.e., A1 and A2) while choice conditions were applied in the two intervention phases (i.e., B1 and B2). Each phase had a minimum of five data points. Overall, the number of sessions in each phase varied, depending on the stability in the trend and level of each student’s data. Stated differently, the stability of data in the consecutive study phases was considered before providing or reversing the intervention. For example, when the study began with the first baseline phase (A1), the next intervention phase (B1) would not be implemented until the stable data points were observed
(i.e., when at least 80% of data points were on or within 25% of the median line of the previous phase), and the same applied to the second baseline and each intervention phase (Gast & Spriggs, 2014).

There were five main reasons for choosing an ABAB reversal design to answer the research questions of the proposed study. First, the previously mentioned dependent variables had the potential to be readily reversible. In simpler terms, the participants’ behaviors would likely maintain the similarity to the baseline levels when choice-making strategy was not provided (Gast & Spriggs, 2014). Second, the pattern of participants’ behaviors might be predicted and verified. Specifically, it was predicted that participants’ low level of responses in the first baseline phase would reoccur in the second baseline phase. The participants’ low levels of responses after being exposed to choice conditions in the first intervention phase also were predicted to reoccur in the second intervention phase (Plavnick, 2013). If positive results occurred in both intervention conditions, then the replication of the cause-effect of the intervention for each participant might strengthen the internal validity of the results. In addition, observing a functional relation between the dependent and independent variables across a minimum of four participants would support the external validity of the results (Gast & Spriggs, 2014). Third, five empirical studies had applied ABAB reversal design to evaluate the effects of choices on the performances of students with EBD and learning disabilities in academic situations (Dunlap et al., 1994; Powell & Nelson, 1997; Ramsey et al., 2010; Skerbetz, & Kostewicz, 2013; Stenhoff et al., 2008). None of these studies reported any design-related limitations.

Fourth, even though students in the school were familiar with using certain iPad applications to learn academic concepts, they were encouraged, but not required, to use such
CHOICE AND STUDENTS WITH ADHD

applications. However, the threat of familiarity of using iPad applications as an extraneous variable might increase and interfere with the results. Therefore, the replication of the intervention effects within an ABAB design would control such extraneous variables that might affect the outcome (Perdices & Tate, 2009). Finally, because the iPad-based choices were introduced as a novel intervention in the school, it was important to establish the straightforward functional relation between this intervention and participants’ responses (Gast & Spriggs, 2014).

In order to strengthen the selected design of the proposed study, the ABAB design was counterbalanced with a BABA design. Using random selection procedures, half of the participants in the third-grade classroom followed the ABAB design while the other half followed the BABA design (Ramsey et al., 2010). This procedure was intended to control the order effects of the design and other confounding variables that could come into play in such a multi-element design (Moes, 1998).

Materials

Using the existing third grade math curriculum (i.e., Macmillan/McGraw-Hill Math Connects, 2009), the teacher participating in this study adapted write math assignments on the daily math concept being taught and emailed them to the researcher. The researcher developed three alternatives of write math assignments for choice conditions. Answers to the assignments were expected to include only numbers and/or letters, so coloring or drawing responses were controlled. The reason for developing one type of response format (i.e., write assignments) was to fit well with the rationale for controlling the level of task demands. That is, Choose and Drag and Drop assignments, as examples, might have motivating value as the student could pick the answer (i.e., lower demand) instead of typing the answer (i.e., higher demand). Accordingly, it was anticipated that providing three choices of write assignments might control the level of
cognitive demands. Specifically, when a math concept was about fractions, the participants might be asked to write a specific portion that represents a specific numeric fraction, write the numeric fraction that represents a pictorial fraction chart, or write the correct numeric fractions that represent portions in different presented pictures (e.g., quarter circle, half triangle, and half square). Each math problem included six to ten short problems to be answered in one session. The math problems in each choice were equal in the efforts and time needed for completion, based on teacher and researcher estimations (Jolivette et al., 2001).

When the three write math problems were established in worksheets, the researcher used the commercial GoWorksheet iPad application (i.e., item number APP-GWS-07W) to convert the printed worksheets to digital forms. The application was copyrighted by Attainment Company (https://www.attainmentcompany.com/goworksheet-maker) and retailed for $19.99 for teacher/professional version and for free for the student version. The application was downloaded from the Apple's iTunes store and loaded onto four fifth-generation Apple iPads (i.e., Wi-Fi-32-gigabits models) for each participant. The four iPads were preconfigured to restrict Internet access and adjust to school firewalls (Wills & Mason, 2014). The teacher version of GoWorksheet allowed for the creation of iPad-based math problems for the choice conditions. Some general features of GoWorksheet were used to program, share, and score math assignments including: (a) fill-in-the-blank short answers with number and/or letter entry and (b) zooming features to focus on specific elements. During choice conditions, GoWorksheet application presented participants with three titles/options for three write math assignments. The participants clicked on the play icon next to each title to play the file and answer or view the file before choosing. The participants handed in a completed worksheet to the teacher version via Airdrop using the school Wi-Fi connectivity. Then, a check mark with the statement "your work
is handed in" was displayed. Another way to hand in a completed worksheet was by walking to

the researcher and handing in the iPad so the researcher screenshot the worksheet or sent it to the
teacher version of the GoWorksheet. The GoWorksheet math problems were programmed to

award one point (i.e., by digit) for providing any answer (i.e., task completion) for scoring

purposes. Then, the researcher rewarded one point for each completed and/or correct problem.

For the purpose of this study, the feedback features (e.g., presenting summative scores or not

allowing incorrect answers to be entered; Attainment Company, n.d.) were controlled.

The application was chosen for this study as it adhered to some critical considerations.
First, the application had data storage capability to document data over several sessions for later

access to make decisions on participants’ progress. Second, the application had the capacity to

store data securely and protect participant confidentiality (Bruhn, Waller, & Hasselbring, 2016).
Third, the use of GoWorksheet had the potential to be advantageous over traditional practices,
because it could adjust the question and response formats (i.e., with some programming features)
for completing independent math practices (Nordness, Haverkost, & Volberding, 2011).

The researcher signed up for a study account on the application and created files for the
daily math concepts. Each file was titled with the date and the daily math concept. In each file,

the researcher organized the daily assignment pages by the specific choice of write math
assignment (i.e., choice 1, choice 2, choice 3). The researcher was able to access the account,

find the daily math assignments for each participant, grade the assignments, and send the scores
to a secure database. Overall, the iPad academic account in the GoWorksheet application was

used as a main tool by the teacher during the sessions across all choice conditions of the study.
Procedures

The researcher trained participants to use the *GoWorksheet* application (i.e., 20-minute training session for each participant) to complete math assignments, provided them opportunities to practice, and worked with the participants until they become independent enough to use the application. Also, setting and explaining the rules on the use of the iPad during the math instructional process added to the quality and functionality of the technological choice-making device, as well as demonstrated compliance with school polices (Bruhn et al., 2016).

During intervention, the teacher provided math instruction on the daily math concept by applying three instructional procedures: (a) modeling, (b) discussing, and/or (c) group guided practice. Every school day, Monday through Friday, the teacher spent an average of 45 minutes providing the instructional procedures as she normally did. Next, at the end of the daily math-teaching lesson (i.e., before the independent practice time), the teacher distributed the independent practice worksheets to all students in the classroom (i.e., including participants in the no-choice condition) and prompted them to begin working for seven minutes. The teacher then went to the participants in the choice condition, distributed the iPad devices to them, and reminded them of the directions for using the iPad application for their independent practice. The participants had seven minutes to solve the problems while the teacher moved through the class to make sure that each participant was not having any technical problems and to assist the other student in the classroom. The researcher and the classroom teacher devised a seating arrangement during the practice sessions to secure other students' confidentiality while videotaping the sessions. Not only did the seating arrangement secure that only teacher and participants were videotaped, but also maintained the smoothly running math sessions (i.e., with a naturalistic classroom arrangement) for all students in a typical classroom environment.
In the no-choice condition (A1), the participants were assigned to work on one write math problem presented on the typical math worksheet. During the choice conditions (B1 and B2), the teacher asked participants to spend 15 seconds choosing one of the three write math problems presented on the iPad screen. Once a participant chose a math problem, a minimum of six math problems based on the daily math concept appeared and the timer was set for seven minutes. Appendix C presents detailed procedures for each phase of the study.

**Treatment Integrity**

Prior to the study, the researcher taught the third grade teacher to implement the choice and no choice procedures in the classroom. The teacher was given an intervention protocol for the prescribed intervention procedures that would be implemented (see Appendix C). In addition, scripted scenario cards was given to increase teacher adherence to the procedural fidelity checklist. The cards provided a simplified version of the intervention protocol in more naturalistic language. It is expected that the teacher would achieve optimal implementation fidelity when she reviewed the scripted scenario of choice and no-choice conditions prior to each session.

The teacher was kept blind to the purpose of the study and the dependent variables. The researcher informed the teacher when and how the conditions were delivered. The teacher was trained through modeling and role-play activities (Jolivette et al., 2001) on how to implement the procedures and use the features of the iPad application for choice making activities during independent work time. Two data collectors coded whether or not the teacher followed the prescribed intervention with fidelity to determine content and procedural fidelity. When the teacher followed the intervention protocol with 100% accuracy for one training session, the study was initiated. Then, treatment fidelity was calculated on 100% of the sessions, across all
conditions. Mean treatment integrity was across all conditions for all participants was 100%, with zero standard deviation. Also, teacher-student interactions averaged 0% with 0 standard deviation across both choice and no-choice conditions, revealing an ideal control of the teacher's prompts or feedback during the study sessions.

**Social Validity**

Three instruments was used to assess the usability and feasibility of the iPad choice-making intervention. The first instrument was a questionnaire that was given to the third-grade math teacher at the end of the second study phase (see Appendix D). This allowed the researcher to monitor teacher perceptions after sequentially experiencing both choice and no choice conditions in either ABAB or BABA designs. The teacher filled out the questionnaire separately for each of the four participants. The questionnaire used a five-point Likert scale, ranging from strongly agree (5) to strongly disagree (1), and three open-ended questions. The questionnaire was intended to measure the teacher's perceptions of the participants’ engagement in the math instruction while applying choice making. Specifically, it evaluated four aspects of the intervention: (1) the extent to which the student’s behavioral and academic performance during choice conditions differed from that of the performance during no-choice conditions (i.e., intervention effects; Gast & Spriggs, 2014), (2) the ease of implementing choice-making strategies in the classroom, (3) the extent to which the teacher might use the intervention in the future/current classes and with other types of student populations (e.g., students with learning disabilities), and (4) the teacher's perception of the time and effort needed for the intervention (Ramsey et al., 2010). The second assessment was a semi-structured interview that occurred at the termination of the study. For the sake of reducing researcher bias risk, the teacher received an email inviting her to share perceptions with a Word document attachment to read, answer
CHOICE AND STUDENTS WITH ADHD

questions, and resubmit the document to the researcher (see Appendix E). The interview questions gathered additional information on teacher acceptability of the choice-making intervention, teacher suggestions for modifying the intervention, and the overall usefulness of the intervention for the participants. The teacher also was asked to discuss any additional issues, thoughts, or concerns not previously discussed. E-mail interviewing was a convenient method that allowed the teacher to respond within her time frame (Seidman, 2006) and minimized the transcription errors that could be anticipated from video or audiotapes (Hamilton & Bowers, 2006). A third instrument was developed and given to the participants. It was a survey that included a 3-point Likert scale, using a happy face for strongly agree, neutral face for agree, and sad face for disagree. The content of the survey was adapted from Ramsey et al. (2010) and designed to gather feedback on whether choice making was a factor in student engagement with the math tasks (see Appendix F).

Data Collection and Inter-Observer Agreement

Two graduate students from the special education program at Old Dominion University were trained to serve as data collectors. The study sessions were videotaped for the purpose of data analysis. Also, videotaping allowed the primary researcher and data collectors to reanalyze a video if further analysis was needed. The observers used a specially designed observation sheet to code daily data on the dependent variables and on supplemental data (e.g., teacher-student interactions) (see appendix G). During math sessions, the classroom teacher provided daily math instruction and asked students to practice and review the concepts. After practice, the intervention sessions began during the independent work time. The observers then began collecting data using one datasheet for each student in each study session.
The videotapes were the documented materials to secure interrater reliability between two data collectors and enhance procedural fidelity. The data and videotapes were stored in a secure server (i.e., in a password protected computer) accessible only to the researcher and data collectors. Reliability was calculated by dividing the number of agreements by the number of agreements plus the number of disagreements, and multiplying by 100 for each of the four dependent variables (Gast & Spriggs, 2014).

**Training of data collectors.** Prior to the onset of the study, the graduate students were trained to reach a minimum of 85% interrater reliability agreement on two consecutive independent work sessions. This was achieved by watching the last seven minutes of math practice sessions, observing participants engaged in independent work, collecting data on the developed datasheets, and discussing the interrater agreement with the researcher. When data collectors failed in maintaining 85% interrater reliability, a booster training session was conducted.

When the study was initiated, interrater reliability was calculated on a minimum of 33% of the sessions in each study phase and for each dependent variable with each participant. Data coders had to achieve a minimum of 85% interrater reliability for each dependent variable before computing the overall interrater reliability (OIR) for the dependent variables in each session (i.e., the mean percentage of interrater reliability across the four dependent variables in each session). OIR was collected during 65% of study sessions for Participant One (i.e., 11 out of 17 sessions), 60% of study sessions for Participant Two, (i.e., 12 out of 20 sessions); 50% of study sessions for Participant Three (i.e., ten out of 20 sessions), and 59% of study sessions for Participant Four (i.e., ten out of 17 sessions). In details, Table 3.3 presents the percentage of sessions of which OIR was calculated for each participant in each study phase, as well as within the study sessions.
Across study sessions, the values of OIR ranged from 96% to 100% for Participant One ($M = 99\%$), from 97% to 100% for Participant Two ($M = 99\%$), from 94% to 100% ($M = 99\%$) for Participant Three; and from 97% to 100% for Participant Four ($M = 98\%$).

Table 3.3

<table>
<thead>
<tr>
<th>Participant</th>
<th>A1</th>
<th>B1</th>
<th>A2</th>
<th>B2</th>
<th>Study Sessions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>83%</td>
<td>67%</td>
<td>33%</td>
<td>33%</td>
<td>65%</td>
</tr>
<tr>
<td>2</td>
<td>38%</td>
<td>86%</td>
<td>33%</td>
<td>33%</td>
<td>60%</td>
</tr>
<tr>
<td>3</td>
<td>60%</td>
<td>50%</td>
<td>33%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>4</td>
<td>80%</td>
<td>60%</td>
<td>33%</td>
<td>50%</td>
<td>59%</td>
</tr>
</tbody>
</table>

Data Analysis

Visual analysis was employed to evaluate the level, trend, and variability of graphed data within and between the study phases (Horner et al., 2005). First, the mean and the median of students’ performance in each phase reflected the level. Absolute level change between A and B conditions determined the immediate effects on dependent variables following the introduction or reversal of choice making. Also, relative level change was reported to indicate the change in the behavior after the introduction or reversal of choice making (i.e., not necessarily the immediate change). Second, trend referred to the direction of “the best-fit straight line” or the dependent variables data path in each study phase (i.e., accelerating, decelerating, or zero-celerating; Horner et al., 2005). Split-middle analysis was used to estimate the overall trends within each condition and determined changes in trend between A and B conditions. Third, variability demonstrated the fluctuation of data around the mean. Data were said to be stable if 80% of data points within each condition fall on or within 25% of the median and trend lines (Gast & Spriggs, 2014). In addition, proportion of non-overlapping data points (PND) in the design phases was calculated to determine effect size (Horner et al., 2005; Ramsey et al., 2010).
In order to analyze data, four line graphs were dedicated to each participant in either the ABAB group or the BABA group. It was hypothesized that data might show that task engagement, task accuracy, and task completion in the intervention phases (i.e., B1 and B2) increased with ascending trends, and time required to complete task decreased with descending trends.
CHAPTER FOUR

RESULTS

This study was designed to examine the effectiveness of iPad-based choice-making opportunities as an antecedent event to improve the academic and behavioral performances of students with ADHD during math independent practice. This chapter is organized around the three research questions which guided this study. First, it reports on the effectiveness of iPad-based choice-making opportunities with math concepts during seven minutes of independent practice on each of four participant's task engagement, time required to complete task, task accuracy, and task completion. Second, it examines the teacher’s perceptions of the use of iPad-based choice-making opportunities with students with ADHD in the classroom. Third, it evaluates the perceptions of elementary-grade students with ADHD on the use of iPad-based choices during independent work in a math class.

The research activities took place over a four-month period, starting with recruiting students for participation and ending with collecting social validity data. Data were collected on four student participants to evaluate the first and third questions and the classroom teacher participant to assess the second research question. Systematic visual analysis of an ABAB reversal design was the primary data analysis method to answer the first research question. Teacher and student satisfaction surveys were administered to collect and analyze data for the second and third research questions. Results of each research question are reported and analyzed separately in the following three sections.

Research Question 1

When implemented with fidelity, does providing elementary-grade students identified with ADHD in a classroom with iPad-based choice-making opportunities with math concepts
during seven minutes of independent work increase students’ behavior and academic performance as measured by the: (1) percent of task engagement, (2) total amount of time required to complete assigned or chosen tasks, (3) percent of task accuracy, and (4) task completion?

The purpose of this section is to present the effects of iPad-based choice-making opportunities during math independent practice on each participant's task engagement, time required to complete task, task accuracy, and task completion. An ABAB reversal design and its counterbalancing BABA design were used to assess the first research question. This created two groups of participants (i.e., ABAB group and BABA group), to which each participant was randomly assigned to one group or the other. The independent variable (i.e., iPad-based choice-making opportunities) was provided in two phases (B1 and B2) for each participant, followed or preceded by the baseline phases (A1 and A2).

The results were examined primarily through visual analysis by observing behavioral (i.e., task engagement and time required to complete task) and academic (i.e., task accuracy and task completion) changes during the ABAB or BABA phases. Using Microsoft Excel, four line graphs were generated for each dependent variable (i.e., one for each participant). Five aspects of data were analyzed as outlined by Gast and Spriggs (2014), in order to understand the types of functional relations that may have been established in the study (Horner et al., 2005). First, data were examined with regard to the changes in the phase means and levels, within and between phases. Second, the immediacy of the effect was examined, with the measurements of both absolute and relative changes in level between two conditions. Absolute change in level was calculated by finding the positive or negative difference between the last data point and the first data points of the two sequential phases. Relative change in level was measured by finding the
positive or negative difference between the medians of the last half and first half of data points between two sequential phases. Third, the trend line in each phase was analyzed to determine the directionality of data points was in a therapeutic or contra-therapeutic direction. Trend line of data in each phase was determined as accelerating, decelerating, or zero accelerating (i.e., flat). All trend lines in the study phases were generated by Microsoft Excel (i.e., right click on add trend line). Fourth, stability of levels and trends was inspected. For data to be considered stable, at least 80% of data had to fall within a 25% stability envelope. This established stability envelope refers to the two lines drawn above and below median data points and/or trend lines, within 25% range of the median. As compared with the baseline phase, lower variability during the intervention could be a potential treatment effect (Horner, Swaminathan, Sugai, & Smolkowski, 2012).

A fifth method of analysis considered the lack of overlapping data between two phases. Though the usefulness of inferential statistics in single-subject designs has its limitations, two non-parametric overlap methods were used to determine treatment effect size on each dependent variable and for each participant. The first metric was the points of non-overlapping data (PND) in two baseline-intervention or intervention-baseline contrasts of each data graph. This PND metric is widely used in single-subject methodology (Parker, 2010). It links to the core of visual analysis with a presentation of the exact overlapping data (Parker & Hagan-Burke, 2007; Parker, Hagan-Burke, & Vannest, 2007) toward "greater discriminability" (Scruggs & Mastropieri, 1994, p. 888). The PND score reflects the percentage of data points in the second phase of AB exceeding the single highest (i.e., if higher levels of data show improvement) or lowest (i.e., if lower levels of data show improvement) data point of the first phase (Parker et al., 2007; Parker, Vannest, & Davis, 2011). The same is applicable with BA pairs, but with a consideration of the
highest and lowest data point if each was in a contra-therapeutic side. Since there were two AB or BA pairs in each line graph (i.e., ABAB or BABA), the overall PND of the two pairs was determined. Based on the PND guidelines stated by Scruggs and Mastropieri (1994), treatment effect is considered very effective with PND score greater than 90%, moderately effective with PND score greater than 70%, questionably or weakly effective with PND score between 50% and 70%, and not effective with PND score lower than 50%.

The PND metric may be influenced by the number of data points in a phase (Wolery, Busick, Reichow, & Barton, 2010) which requires more data points (i.e., up to 10 data points) within each phase toward a convincing effect size (Scruggs & Mastropieri, 2013). In contrast, the highest number of data points within a phase in this study (i.e., across all ABAB and BABA phases) was seven. Parker and Hagan-Burke (2007) indicated that a low reliability could be the case when the "data set is short" (p. 97). That is, the confidence intervals (i.e., obtaining similar effects when replicated) could be low, despite a convincing effect size. Further, the PND metric relies on the extreme value of the first phase (i.e., the highest or lowest data point; Scruggs & Mastropieri, 1994). However, floor and ceiling effects and probably outliers (Campbell, 2013) appeared in some phases in this study, which accounts for zero PND (i.e., inflating or deflating the treatment effect; Chen & Ma, 2007; Ma, 2006). Taken together, it seems advisable to add a second metric that estimates the percentage of data points exceeding the median line (PEM) of the first phase in AB or BA, in order to minimize the impact of extreme values (Lenz, 2013; Ma, 2006; Ma, 2009; Wolery et al., 2010) and lessen the conservativeness of PND in variability (Lenz, 2013) for treatment effect determination. Further, in a comparison of overlap methods, Wolery et al. (2010) indicated that the PEM metric had lower error percentage (i.e., 16.5%) than that of the PND (i.e., 19%), revealing additional support for the use of the PEM metric in this
study. The calculation of PEM score, then identification of treatment effect, follows the previously mentioned PND guidelines, but with the consideration of the median data point instead of the extreme data point of the first condition in each AB or BA pairs.

Each participant's transition through phases was independent (i.e., from the other participants), based on each participant's performance data within the phase and attendance/absence records. Overall, movement decisions through ABAB or BABA phases were based on three factors. First, accumulated research on assessing the effects of choice-making opportunities measured task engagement overwhelmingly (e.g., Dunlap et al., 1994; Jolivette et al., 2001; Ramsey et al., 2017; Ramsey et al. 2010; Skerbetz & Kostewicz, 2013), and solely in some studies (e.g., Dunlap et al., 1994; Jolivette et al., 2001; Powel & Nelson, 1997). Thus, task engagement outcomes stood as a yardstick for each participant's movement through study phases. Second, a minimum of five data points was required in each phase (Horner et al., 2005). However, following the data points collected in the first two phases for each participant (i.e., AB or BA), the teacher expressed the need to move more quickly through the curriculum with more time for guided practices than independent practices. Thus, the minimum number of data points in each phase was reduced to three data points in the second half of the study phases. Third, if variability was noted in the date within a study phase, the last three data points of the phase were assessed to determine whether or not to move to the following phase (Gast & Spriggs, 2014).

The effect of the independent variable on the four dependent variables and across the four participants is presented in the following four subheadings, starting with a brief overview of the overall results across participants, followed by a detailed description of the data of each participant. Summary statistics also are provided to assist visual analysis. Refer to Table 4.1 for
CHOICE AND STUDENTS WITH ADHD

53

summary statistics of participants' performances on task engagement, task accuracy, and task completion and Table 4.2 for their performances on time required to complete task.

Table 4.1

Summary Statistics for Task Engagement, Task Accuracy, and Task Completion per Phase

Across Participants

<table>
<thead>
<tr>
<th>ABAB Group</th>
<th>DV</th>
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<th>Baseline</th>
<th>Intervention</th>
<th>Baseline</th>
<th>Intervention</th>
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<tbody>
<tr>
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<td>M (SD)</td>
<td>Range</td>
<td>M (SD)</td>
<td>Range</td>
<td>M (SD)</td>
<td>Range</td>
</tr>
<tr>
<td>TE%</td>
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<td>35 (22)</td>
<td>0 - 67</td>
<td>82(12)</td>
<td>65-94</td>
<td>52(18)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>61 (22)</td>
<td>29 - 88</td>
<td>73 (15)</td>
<td>55-86</td>
<td>59 (34)</td>
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<td>TA%</td>
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<td>50-70</td>
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<td>69 (23)</td>
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<td>60 (36)</td>
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<td>88 (18)</td>
<td>58-100</td>
<td>93 (12)</td>
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<tr>
<td></td>
<td>2</td>
<td>70 (28)</td>
<td>29-100</td>
<td>85 (20)</td>
<td>50-100</td>
<td>73(43)</td>
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</table>

<table>
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<th>BABA Group</th>
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<th>Intervention</th>
<th>Baseline</th>
<th>Intervention</th>
<th>Baseline</th>
</tr>
</thead>
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<td></td>
<td>M (SD)</td>
<td>Range</td>
<td>M (SD)</td>
<td>Range</td>
<td>M (SD)</td>
<td>Range</td>
</tr>
<tr>
<td>TE%</td>
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<td>92(13)</td>
<td>72-100</td>
<td>92(14)</td>
<td>67-100</td>
<td>98(3)</td>
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<td>75-90</td>
<td>92(5)</td>
</tr>
<tr>
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<td>44(20)</td>
<td>17-67</td>
<td>61(35)</td>
</tr>
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<td>4</td>
<td>90(7)</td>
<td>80-100</td>
<td>72(31)</td>
<td>21-100</td>
<td>93(8)</td>
</tr>
<tr>
<td>TC%</td>
<td>3</td>
<td>96(10)</td>
<td>78-100</td>
<td>98(4)</td>
<td>89-100</td>
<td>100(0)</td>
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<td></td>
<td>4</td>
<td>96(6)</td>
<td>89-100</td>
<td>94(13)</td>
<td>70-100</td>
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</tr>
</tbody>
</table>

Note. DV = dependent variable; M = mean; SD = standard deviation; TE = task engagement; TA= task accuracy; TC = task completion.

Effects on task engagement. Figure 4.1 presents graphically the percentage of intervals in which participants displayed task engagement across phases. Table 4.1 demonstrates the mean percentages, standard deviations, and ranges of task engagement results for each
participant across phases. Collectively, task engagement data showed slight to clear improvements across Participant One, Participant Two, and Participant Four toward higher mean levels of performance when the intervention was introduced in the first AB or BA contrasts (i.e., from 35% to 82%, from 61% to 73%, from 82% to 92%, respectively). The changes in the mean levels of task engagement were more pronounced across all participants in the second AB or BA contrasts (i.e., from 52% to 91%, from 59% to 94%, from 83% to 98%, and from 76% to 92%, respectively). Although there appeared some variability in the level of task engagement data (i.e., during all phases for Participant One, A1B1A2 phases for Participant Two, and A2 phase for Participant Three and Participant Four), the variability was less pronounced during intervention phases for all participants. This was excluding task engagement data showed by Participant Two, as the level of variability in A2 and B2 phases was equal. Further, the lowest data points during the first and second AB or BA contrasts across all participants occurred in the baseline phases. Considering a total of eight intervention phases across participants (i.e., two for each student), four intervention phases went in a therapeutic direction (i.e., B1 and B2 for Participant One, B1 for Participant Two and Participant Four), with trend stability ranging from 71% to 100% of data points within the established stability envelope. Likewise, with a total of eight baselines phases, five phases followed a contra-therapeutic (i.e., decelerating) trend line. The intervention effect size on task engagement varied by participant as evidenced by PND and PEM statistics. A detailed description of the changes across phases for each participant follows.
Participant One. Task engagement data of Participant One are graphically presented in the upper left panel of Figure 1. During the initial baseline, level of task engagement was low (mean $M = 33\%$, range = 0% -67%) and highly variable (i.e., only 33% of data were within the stability envelope). Although the trend line appeared accelerating, only 17% of data were within the stability envelope, reflecting higher variability in comparison to baseline level variability. After introducing the intervention in the second phase, task engagement increased substantially over the baseline levels to a mean rate of 82% (range = 65% - 94%), with a positive absolute level change of 45% (i.e., from 43% to 88%) and relative level change of 33.5% (i.e., from 35% to 86%). The intervention level of task engagement remained stable within the phase (i.e., four
out of five data points were within the stability envelope). The intervention trend line appeared accelerating and stable, too. Reversal of the intervention in the third phase produced an immediate decrease of task engagement level ($M = 59\%$; range = 31\% - 64\%) with a negative absolute change of 30\% (i.e., from 64\% to 94\%) and relative change of 20.5 \% (i.e., from 84.5\% to 64\%). This reversal phase was associated with a decreasing trend with 67\% of data within the stability envelope of both level and trend lines. By reintroducing the intervention phase (i.e., fourth phase), there was a relative full return to high level of task engagement ($M = 91\%$; range = 75\% - 100\%) and stable improving trend, as established in the first intervention phase. Also, the immediacy of effect on task engagement level was positive with an absolute and relative change of 15\% (i.e., from 60\% to 75\%). Overall, a distinct separation was apparent in the two AB pairs with an overall PND of 90\% and PEM of 100\%, indicating a very effective intervention for Participant One.

**Participant Two.** The upper right panel of Figure 4.1 shows the task engagement data graph for Participant Two. During the initial baseline, Participant Two was engaged during an average of 61\% (range = 29\% - 88\%) of intervals and showed a decreasing trend. However, there was high variability with regard to the level and trend, with only 29\% and 43\% of data points within the stability envelope, respectively. When the intervention began in the second phase, task engagement increased to a mean rate of 73\% (range = 55\% - 86\%) with an increasing trend. This indicated positive changes in level, with an absolute change of 15\% (i.e., from 29\% to 44\%) and a relative change of 14\% (i.e., from 67\% to 81\%). As compared with the initial baseline, data were less variable during the intervention in regard to both the level and trend lines, with five out of seven intervention points falling within the stability envelope. Returning to baseline in the third phase, Participant Two exhibited a lower rate of task engagement ($M =$
59%; range = 23% - 90%) and higher variability (i.e., 33% of data points falling within the stability envelope), consistent with the initial baseline. The immediate decrease in the level of task engagement was found with negative absolute and relative changes of 21% and 16%, respectively. Also, Participant Two followed the decreasing trend line established in the initial baseline with some variability (i.e., 67% of data points falling within the stability envelope). With the reintroduction of the intervention, and despite a descending trend observed (i.e. 71% stability), Participant Two demonstrated the highest level of task engagement with a mean rate of 94% (range = 90% - 100%), as compared to the three preceding phases and remained highly stable throughout the phase (i.e., 100% of data points were within the stability envelope). This second baseline-intervention contrast indicated positive absolute and relative changes in level of 77%. With regard to effect size, no clear separation was noted in the two baseline-intervention contrasts, resulting in a PND of 33.5% (i.e., no effect). However, PEM calculation estimates showed an overall effect of 86%, suggesting an effective intervention for Participant Two.

**Participant Three.** As noted in the lower left panel of Figure 4.1, Participant Three appeared highly engaged in both the initial intervention and baseline phases, with a stable level rate at 92% (range = 72% - 100% and 67% - 100%, respectively). However, initial intervention observations indicated a stable and slight downward trend, while a stable upward trend was found in the following reversal phase (A1). Although Participant Three maintained the mean level of 92%, there was negative movement from the initial intervention to reversal in both absolute and relative changes in level, scoring 13% and 20% respectively. With the reintroduction of the intervention in the third phase (B2), Participant Three showed the highest mean level of task engagement at rate of 98% (range = 93% - 100%) with stability, yet again replicated a slight decreasing trend, which occurred in the initial intervention. Upon return to
baseline (A2), Participant Three's task engagement decreased to the lowest mean rate of 82% (range= 67% - 100), with a stable decreasing trend. No absolute and relative changes were found in the levels upon the movement from the first baseline to second intervention and from the second intervention to the second baseline. Across phases, the lowest data points across the first and second intervention-baseline contrasts occurred in the baseline phases (i.e., 67% in A1 and 64% in A2). The effect size estimates suggested no effect to a weak treatment effect, as evidenced by an overall PND of 44% and PEM of 53%.

**Participant Four.** As depicted in the lower right panel of Figure 4.1, the initial intervention phase for Participant Four produced a high and stable level of task engagement on an average of 97% (range = 83% - 100%) of the intervals. Following a stable improving trend, the intervention was reversed in the second phase (A1) and an immediate effect was noted with negative absolute and relative changes in level at 24%. Task engagement stabilized at a lower mean level ($M= 82%$; range = 75% - 90%) than of the initial intervention, although an accelerating trend remained. Task engagement rose again to a mean level of 92% (range = 88% - 100%) when the intervention was reinstated in the third phase (B1). This indicated positive absolute and relative changes in level of 20% and 11%, respectively. However, there was a stable decreasing trend (i.e., contra-therapeutic direction). Upon entering the final phase (A2), the level of task engagement declined to a mean rate of 76% (range = 50% to 91%) with a clear downward trend. Yet, the absolute and relative changes in level were very limited (i.e., 0% and 1.5%, respectively). In terms of intervention effect, different effect sizes were obtained with an overall PND of 47% (i.e., no effect) and PEM of 84% (i.e., effective intervention level).

**Effects on time required to complete task.** Figure 4.2 displays the amount of time (i.e., in minutes and seconds) each participant required to complete math independent practice across
phases. Table 4.2 presents the data means and ranges for each phase across participants. All participants required a lower average time to complete tasks during intervention phases in comparison with that of the corresponding baseline phases, excluding Participant Three's data in the second intervention-baseline contrast. Across participants, the trend lines in seven intervention phases (i.e., out of eight) showed decreasing trends (i.e., therapeutic direction), while only three baseline phases showed increasing trends (i.e., contra-therapeutic). Further, no clear and consistent replication of effect was noted in the level or trend variability in either ABAB or BABA phases. Considering the overall PEM calculation estimates, all participants demonstrated a functional relation between the intervention and improvements in time to completion. Visual analysis of each participant's data points across phases will follow.
Figure 4.2. Time required to complete tasks across participants

**Participant One.** Figure 4.2, upper left panel, depicts the time duration in which Participant One completed tasks across phases. During the initial baseline, Participant One completed tasks an average of 5 min 34 s (range = 1 min 47 s – 7 min). The level was variable, with two data points out of six baseline points falling within the stability envelope. The trend line was decelerating (i.e., contra-therapeutic), yet highly variable (i.e., 33% of data points were within the stability envelope). When the intervention began in the second phase, Participant One's time required to complete task decreased to a mean of 4 min, with less variability (i.e., 60% of data points were within the stability envelope) than of the preceding baseline phase. The trend line appeared accelerating, but highly variable. This movement from A1 to B1 was
associated with negative absolute and relative changes in level of 3 min and 1 min 39 s, respectively. However, the negative changes were maintained upon the movement to the reversal of the intervention in the third phase (i.e., absolute level change = -2 min 56 s; relative level change = -2 min 12 s). During the implementation of the reversal phase (A2), Participant One completed tasks in the longest mean level of time duration (i.e., 7 min), with two data points out of three reversal points falling within the stability envelope of an increasing trend line. Upon the reintroduction of the intervention in the final phase, time required to complete task again decreased to mean level of 4 min 23 s (range = 2 min 12 s – 6 min 23 s), similar to the first intervention phase. This revealed negative absolute and relative changes in level of 2 min 25 s. Also, the trend line went in a therapeutic direction, with two points out of three B2 points falling within the stability envelope. With regard to treatment effect, visual analysis showed an effective level on time required to complete task for Participant One, as evidenced by an overall PEM of 80%. However, PND calculations estimated a no effect level at 17%.

**Participant Two.** The upper right panel of Figure 4.2 shows the amount of time Participant Two required to complete tasks in each phase. During baseline, Participant Two required a mean of 5 min 54 s (range = 2 min 2 s – 7 min) to complete given independent practices. The level was stable with six out of seven baseline points falling within the stability envelope. After implementing the intervention in the second phase, Participant Two required less time to complete task averaging 5 min 10 s (Range = 2 min 10 s – 7 min), but with more variability than in the initial baseline (i.e., four of seven intervention points were within the stability envelope). An immediate effect was noted with a negative absolute change in level amounting to 57 s. Yet, the relative change in level that was positive, although limited, and scored 24 s. Returning to baseline in the third phase (A2), a little increase in the mean level of
time required to complete tasks was found at 5 min 15 s (range = 3 min 37 s – 7 min), closer to that of the initial baseline. The movement to this reversal phase produced an immediate effect, as evidenced by positive absolute and relative changes in level amounting 4 min 50 s and 57 s, respectively. Across phases, the highest level of variability was found in this reversal phase (i.e., only 33% of data were within the stability envelope). On entering the final phase (B2), Participant Two showed much improvement as evidenced by the lowest mean level of time required to complete tasks ($M = 3$ min 19 s; range = 2 min - 4 min 12 s). As compared with the reversal phase (A2), the level stability improved with two out of three B2 points falling within the stability envelope. This final movement from the reversal to the second intervention was associated with negative absolute and relative changes in level scoring 57 s. Across phases, the trend line was decelerating (therapeutic direction), yet it stabilized only in the second intervention phase with 100% of data falling within the stability envelope. Overall, visual analysis provides evidence of the effect of the intervention on the time required to complete tasks for Participant Two, as reflected by an overall PEM of 86%. However, PND calculation estimates scored 0%.

**Participant Three.** As noted in the lower left panel of Figure 4.2, Participant Three completed the task in a mean level of 3 min 10 s (range = 1 min 36 s - 4 min 53 s) during the first intervention phase. The level was highly variable (i.e., only 33% of data were within the stability envelope), but the trend line was in a therapeutic direction (i.e., decreasing), with four out of five intervention points falling within the stability envelope. Immediately following the reversal of the intervention in the second phase, a positive absolute change of 2 min 28 s and a positive relative change of 3 min 56 s in level were found. This reversal phase revealed a higher mean level of time required to complete tasks ($M = 4$ min 47 s; range = 2 min 30 s - 7 min), as
CHOICE AND STUDENTS WITH ADHD

compared with the preceding intervention phase. The trend line changed to accelerating (i.e., contra-therapeutic direction), but appeared variable with one out of four baseline data points falling within the stability envelope. When the intervention was reintroduced in the third phase, Participant Three followed the decreasing trend established in the first intervention phase, with four out of six B2 data points falling within the stability envelope. The mean level of time required to complete task appeared lower than the first reversal phase ($M = 4\text{ min 15 s;}$ range $= 1\text{ min 53 s – 4 min 15 s})$. This movement from the first reversal to the second intervention produced negative changes in level with an absolute change of 3 min 2 s and a relative change of 1 min 27 s. Returning to baseline (A2), Participant Three demonstrated the lowest mean level of time required to complete task at 3 min 9 s (range $= 2\text{ min 20 s – 3 min 47 s})$ and maintained the decreasing trend line established in the intervention phases, inconsistent with the first reversal phase. Further, the lowest trend and level variability was observed in this second baseline phase. Conversely, the movement to the second baseline was associated with positive absolute and relative change in level at 1 min 27 s. With regard to treatment effect for Participant Three, PEM calculation estimates reveal an effective level at 74%, while no effect appeared with the PND calculation estimates (i.e., PND = 20%).

**Participant Four.** During initial intervention, Participant Four required a mean of 2 min to complete task (range $= 43 s – 5\text{ min 3 s})$ and showed a decreasing trend (i.e., therapeutic direction). The level was highly variable with only one out of six baseline data points falling within the stability envelope. Following the reversal of the intervention in the second phase (A1), a slight increase in the mean level of time to completion was found ($M = 2\text{ min 15 s;}$ range $= 1\text{ min 39 s – 3 min 1 s})$. This indicated positive absolute and relative changes in level at 44 s and 1\text{ min 2 s}, respectively. During the reintroduction of the intervention in the third phase,
Participant Four showed the lowest mean level of time to completion, amounting to 1 min 44 s (range = 1 min 20 s – 1 min 58 s). Although the movement to this second intervention was associated with a positive absolute change in level at 19 s (i.e., contra-therapeutic), the relative change in level was negative at 26 s. On reversing the intervention in the final phase, the mean level of time to completion increased again to 2 min 55 s (range = 2 min 20 s – 3 min 43 s), closer to that of the first reversal phase. This revealed positive absolute and relative changes in level, amounting to 1 min 54 s and 2 min 8 s, respectively. Overall, Participant Four maintained a decreasing trend across phases. Further, in each intervention-baseline contrast, less variability in level was found during the intervention phases, unlike the trend variability that was more pronounced during the intervention phases. Visual analysis provides significant evidence of the effect of the intervention on time required to complete tasks for Participant Four, as noted by an overall PEM of 100%. Yet, calculation estimates of the overall PND revealed a questionable level of effect at 50%.

Table 4.2

Summary Statistics for Time Required to Complete Task per Phase Across Participants

<table>
<thead>
<tr>
<th>ABAB Group</th>
<th>Participant</th>
<th>Baseline</th>
<th>Intervention</th>
<th>Baseline</th>
<th>Intervention</th>
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<td>M</td>
<td>Range</td>
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<td>3:15-7:00</td>
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<td>2:10-7:00</td>
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</table>

<table>
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<th>Baseline</th>
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</tr>
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<td>0:43-5:03</td>
<td>2:15</td>
<td>1:39-3:01</td>
<td>1:44</td>
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</tbody>
</table>

Note. M = mean.
Effects on task accuracy. The graphed data presenting the effect of iPad-based choice on each participant's task accuracy is shown in Figure 4.3. Table 4.1 presents statistics summary of each participant's task accuracy across phases. Overall, all participants showed task accuracy improvements as evidenced by a higher mean level when the intervention was provided in each AB or BA contrast, as compared with the preceding (i.e., in ABAB) or subsequent (i.e., in BABA) baseline phases, excluding for Participant Four in the second BA contrast (i.e., $M$ during B2 = 93%, $M$ during A2 = 97%). The same was true with level stability of data between phases. If data in AB or BA were different in level and/or trend stability, more variability appeared in baseline phases than of its corresponding intervention phases. Further, the lowest data points in each AB or BA pairs occurred during the baselines phases, excluding the second BA contrast for Participant Four. Across participants, half of the trend lines during intervention phases were in a therapeutic direction (i.e., increasing or flat at high level), as appeared in the graphs of Participant One, Participant Two, and Participant Four. Treatment effect calculations revealed that the effect of the intervention on task accuracy varied by participant. Next is the visual analysis of task accuracy for each participant.
Figure 4.3. Task accuracy across participants

**Participant One.** As illustrated in the upper left panel of Figure 4.3, Participant One's task accuracy during initial baseline demonstrated a low mean level ($M = 35\%$; Range $= 0\% - 67\%$) and was unstable (i.e., only $33\%$ of data points were within the stability envelope). The trend line appeared accelerating, but highly variable with only one out of six baseline data points falling within the stability envelope. Following the introduction of the intervention in the second phase, an immediate change was noted with higher mean level of task accuracy ($M = 60\%$; range $= 50\%-70\%$) and less variability (i.e., $60\%$ of data points were within the stability envelope). A positive absolute level change of $16\%$ and stable improving trend line also were observed. However, relative level change in level was negative at $14\%$. When the intervention was
reversed in the third phase (A2), Participant One maintained a mean level of task accuracy ($M = 61\%$; range $= 50\% - 70\%$), level variability (i.e., $67\%$ of data points falling within the stability envelope), and increasing trend found in the preceding intervention phase (B1). Yet, this reversal phase produced negative absolute and relative changes in level at $19\%$. Upon the reintroduction of intervention in the last phase (B2), Participant One demonstrated the highest mean level of task accuracy and leveled out at $85\%$ (range $= 75\% - 90\%$) with an observed flat trend. Considering the changes in levels between phases, positive absolute and relative changes from A2 to B2 phases were the highest pronounced differences at $27\%$. Overall, visual analysis suggests possible evidence of a functional relation between the intervention and Participant One's task accuracy, with an overall PND of $70\%$ and PEM of $100\%$.

**Participant Two.** The upper right panel of Figure 4.3 shows the graphed data points of Participant Two's percentage of task accuracy across study phases. During the baseline phase (A1), Participant Two showed a mean level accuracy of $58\%$ (range $= 33\% - 100\%$). Data were highly variable within the established stability envelope for both the level (i.e., only two out of seven A1 data points were within the stability envelope) and accelerating trend lines (i.e., no data points were within the stability envelope). Upon the implementation of the intervention in the second phase, Participant Two achieved a higher mean level of task accuracy at $69\%$ (range $= 30\% - 94\%$), with less variability than of the first baseline (i.e., three out of seven B1 data points were within the stability envelope). Compared to the initial baseline phase, data were in a therapeutic direction with less variability (i.e., $71\%$ of data falling within the stability envelope of trend line). However, absolute level change from baseline to intervention was negative at $20\%$ and relative level change was limited at $4\%$. Returning to baseline in the third phase, a slight decline in the mean level of task accuracy was observed ($M = 60\%$; range $= 20\% - 90\%$).
Task accuracy for Participant Two replicated the previously high variability found in the initial baseline (i.e., 33% of data points were within the stability envelope). No differences were found in the absolute and relative changes in level on the movement from the first intervention to the reversal phases. On entering the final phase (B2), Participant Two displayed an improved rate of task accuracy ($M = 70\%$; range = 50% - 100%) with positive absolute and relative changes in level of 30%. The level of variability also decreased, with 67% of B2 data points falling within the stability envelope, lower than it was in the preceding reversal phase (A2). Data were in a contra-therapeutic direction in the final intervention phase as evidenced by a stable decelerating trend line. With regard to treatment effect, visual analysis provides no clear evidence of a functional relation between the intervention and Participant Two's task accuracy as evidenced by an overall PND of 17% (i.e., no effect) and PEM of 60% (i.e., questionable).

**Participant Three.** The lower left panel of Figure 4.3 displays task accuracy data points for Participant Three. Introduction of the intervention in the first phase (B1) was associated with a moderate to high level of task accuracy ($M = 69\%$; range = 44% - 83%), but with a slow descending trend line. The level and trend were unstable, with four out of six intervention data points falling within the stability envelope. When the intervention was reversed in the second phase (A1), the mean level of task accuracy decreased to 44% (range = 17% - 67%) with 14% and 36% negative differences in the absolute and relative changes in level, respectively. Task accuracy data for Participant Three remained variable, as it was in the preceding phase. Although a slowly increasing trend was observed, only 40% of A1 data points were within the stability envelope. Upon resumption of intervention in the third phase (B2), there was an immediate increase in the mean level of task accuracy ($M = 61\%$; range = 16% - 100%). This movement from A1 to B2 produced positive absolute and relative changes in the level scoring
16% and 46%, respectively. However, the descending trend line was sharper than it was in the first intervention phase (B1), with three out of six B2 data points falling within the stability envelope. Returning to baseline in the final phase (A2) produced a significant decline in task accuracy as noted by the lowest mean level at 37% and the highest variability level (i.e., 33% and 0% of A2 data points were within the stability envelope of level and trend lines, respectively). The change in task accuracy level also was supported by a negative absolute and relative change of 80% between B2 and A2. Visual analysis provides questionable to moderate evidence of a functional relation between the intervention and task accuracy for Participant Three as noted by a PND of 54% and PEM of 84%.

**Participant Four.** As depicted in the lower right panel of Figure 4.3, Participant Four achieved high and stable level of task accuracy ($M = 90\%$; range = 80\% - 100\%), but with a slow descending trend line during the first intervention phase. Concomitant to the movement to the following reversal condition (A1) were negative absolute and relative changes in level of 10% and 12%, respectively. Also, this reversal condition led to a decrease in the mean level of task accuracy at 72% (range = 21\% - 100\%) and an increase in level variability (i.e., three out of five A1 data points were within the stability envelope). The trend line was declining, but variable. With return to intervention condition in the third phase (B2), the mean level of task accuracy returned to a high and stable level at 93% (range = 83\% - 100\%), similar to data in B1. The trend line appeared improving and stable. Although no absolute level change was observed between A1 and B2 phases, relative level change was positive at 31%. Participant Four maintained the high level of task accuracy ($M = 97\%$; range = 92\% - 100\%) and improving trend line on reversal of intervention in the final phase. This final movement produced a negative absolute level change, although limited, at 8%. In regard to treatment effect, no clear separations
between the first and second intervention-baseline contrast were apparent as evidenced by an overall PND of 20% and PEM of 47%.

**Effects on task completion.** Figure 4.4 displays graphically the percentage of task completion across phases for each participant. Summary statistics of each participant's task completion data across phases also are presented in Table 4.1. Overall, Participant One and Participant Two achieved higher mean levels of task completion and with less variability during the intervention phases in each of the AB pairs. Participant Three and Participant Four showed high and stable levels of task accuracy across phases, but with no or very limited absolute and relative changes in level on the most movements between phases. Further, trends across phases stabilized in accelerating or flat lines. There was no evidence of a treatment effect of the intervention on task completion for any of the four participants, as evidenced by PND and PEM calculation estimates. What follows is a detailed description of the task completion data by participant.
Figure 4.4. Task completion across participants

**Participant One.** As illustrated in the upper left panel of Figure 4.4, Participant One started with a mean level of 61% during the initial baseline (range = 0% - 100%) with some variability (i.e., 60% of A1 data points were within the stability envelope). The trend line was accelerating but unstable (i.e., 50% of A1 data points were within the stability envelope). The mean level of Participant One's task completion improved upon the introduction of the intervention in the following phase (B1) and stabilized at 88% (range = 58% - 100%). This indicated positive, although limited, absolute and relative changes in level at 9% and 6%, respectively. There also was a stable increasing trend line during this initial intervention phase. During the following two phases (i.e., A2 and B2), Participant One reached higher rates of task.
completion and stabilized at 93% and 92%, respectively. No absolute and relative changes in level were seen upon the movement from B1 to A2 and from A2 to B2 phases. Treatment effect estimation provides no evidence about the effect of the intervention on task completion for Participant One, as demonstrated by a PND of 0% and PEM of 33%.

Participant Two. As noted in the upper right panel of Figure 4.4, Participant Two completed tasks at a mean level of 70% during initial baseline phase (range = 29% - 100%), but with high variability (i.e., with 29% of A1 data points falling within the stability envelope). The trend was accelerating and variable. Upon the introduction of the intervention (B2), Participant Two completed tasks at a higher mean level than of the preceding baseline phase ($M = 85\%$; range = 50% - 100%), with a notable decrease in level and trend variability (i.e., 71% of B1 data points were within the stability envelope). However, the movement from baseline to intervention phases was associated with, although small, negative absolute and relative changes in level at 10% and 14%, respectively. Returning to baseline in the third phase reproduced a similar mean level of task completion as in the initial baseline ($M = 73\%$; range = 20% -100%). Again, little increase in the level variability (i.e., 67% of A2 data points were within the stability envelope) was found during the reversal of the intervention, as compared with the preceding intervention phase. The trend line in this reversal phase was flat, but with no data falling within the stability envelope. When the intervention was reinstated in the final phase (B2), Participant Two stabilized at 100% task completion throughout the phase. No absolute or relative changes in level were observed between phases (i.e., from B1 to A2 and from A2 to B2). Overall, in each baseline-intervention contrast, the lowest data point was found in the baseline phases (i.e., 50% in A1 and 20% in A2). Visual analysis reveals no evidence of the effects of the intervention on task completion for Participant Two, as supported by a PND of 0% and a PEM of 43%.
Participant Three and Participant Four. As illustrated in the lower left and right panels of Figure 4.4, Participant Three and Participant Four appeared to do well in both baseline and intervention phases and maintained stability at 100% task completion throughout the phases. No absolute or relative changes in level were found between phases, excluding between B1 and A1 where Participant Three showed a positive absolute change of 11%, while Participant Four revealed a negative absolute change of 30%. Further, no observable effect of the intervention on task completion was found for either Participant Three or Participant Four, as estimated by PND and PEM calculations (i.e., PND and PEM values of 0%).

Summary of visual analysis. For most AB or BA contrasts across participants (i.e., 25 out of 32 AB or BA contrasts), all participants performed at higher mean levels on the four dependent variables during intervention phases. Excluding the conditions where the data points were stable, consistent decreases in level variability were noticed during the intervention phases of task engagement, task accuracy, and task completion. However, there was no consistency in the trend line directions during baseline and intervention phases. As evidenced by overall PND and/or PEM calculation estimates, there was an effect of the intervention on: (a) task engagement for Participant One, Participant Two, and Participant Four; (b) time required to complete task for all four participants; and (c) task accuracy for Participant One and Participant Three. No functional relation was established between the intervention and participants’ task completion.

Research Question 2

What are the teacher’s perceptions of the use of iPad-based choice-making opportunities for students with ADHD in a math class?

At the end of the second phase for each participant (i.e., after completing the first AB or BA), the teacher was given a five-point Likert scale questionnaire. The teacher completed the
questionnaire on each participant to determine if the iPad-based choice making was socially acceptable. The questionnaire was followed by five open-ended questions to solicit additional feedback.

For all participants, the teacher found that the implementation of iPad-based choice making did not interrupt other students' learning and required minimal time and effort. The teacher reported that she would use the intervention in future/current classes if there were a technology for developing choices. For three of the four participants (i.e., except Participant One), the teacher reported that the intervention was easy to implement in the classroom and did not conflict with her teaching activities. The teacher neither agreed or disagreed with statements concerning the effects of the intervention on being more engaged, completing more math assignments, providing more accurate answers, and completing the assignments faster, in comparison with their performance during the no-choice conditions. The teacher's answers to the open-response questions of the questionnaire revealed that the intervention provided chunked assignments as choices (i.e., smaller number of assignments), which could have assisted students with slower processing abilities. The teacher indicated that choice making would work with fact math problems, and it could be difficult when participants are given complex tasks (e.g., word problems). The teacher pointed out some difficulties in running choice-making opportunities included the limited time dedicated to independent practice, the absence of accommodations, and the need for her to teach until the end of class to reinforce concepts. In order to improve choice-making intervention during her math instruction, the teacher would add more accommodations (e.g., visual aids) and increase the amount of time to complete tasks.

After the data in ABAB or BABA phases were collected for each participant, the teacher responded to six interview questions via email. On the basis of teacher's responses, choice
making allowed participants to choose a preferred assignment, but it was necessary to include accommodations to increase academic success. The teacher suggested incorporating technology or project-based assessment in choice making and allocating specific instructional time for choice-making activities. The most difficult step of preparing or implementing choice making was reported to be stopping the instruction and providing choices for independent practice on days the teacher needed to teach the entire time.

Research Question 3

What are the perceptions of elementary grade students with ADHD of the use of iPad-based choices for independent work in a math class?

A 3-point Likert scale questionnaire with five statements (see Appendix F) was administered to each participant two weeks following the last time the researcher collected data for the first research question. The classroom teacher read aloud each statement to the four participants, described each statement with one or two specific examples from their experiences during the study phases, and asked each participant to check mark their responses, one by one. Three participants (i.e., Participant Two, Participant Three, and Participant Four) agreed or strongly agreed with the statements "I completed my work in class when I chose the math assignments," "I was on good behavior when I chose my assignments," and "I would like to choose my assignments during independent practice." Participant Two disagreed with the statements "I completed more correct answers when I chose the math assignment" and "I would like to choose my assignments in other classes." Participant One put a check mark in the sad column for each statement the teacher read.
CHAPTER FIVE

DISCUSSION

The purpose of this section is to interpret the results stated in the previous chapter. It is divided into three sections: (a) a discussion of the results of the three research questions by summarizing the results and comparing the present results with those produced in the accumulated research on choice-making opportunities for students with ADHD, (b) the limitations of the results and future directions, and (c) the implications for research and practice.

Discussion of Results

The present study was designed to explore the effectiveness of iPad-based choice-making opportunities on the behavioral and academic performance of students with ADHD during math independent practice, as well as the teacher and students perceptions of social validity of the intervention. The following three research questions were evaluated: 1) When implemented with fidelity, does providing elementary-grade students identified with ADHD in a classroom with iPad-based choice-making opportunities with math concepts during seven minutes of independent work increase students’ behavior and academic performance as measured by the percent of task engagement, total amount of time required to complete assigned or chosen tasks, percent of task accuracy, and task completion?, 2) What are the classroom teacher’s perceptions of the use of iPad-based choice-making opportunities for students with ADHD in a math class?, and 3) What are the perceptions of elementary grade students with ADHD of the use of iPad-based choices for independent work in a math class? A discussion of each research question follows.

Results of the first research question. It was hypothesized that providing elementary-aged students with ADHD iPad-based choices for math independent work would increase task
engagement, task accuracy, and task completion while decreasing time required to complete task in the intervention phases (i.e., B1 and B2). Through the visual analyses employed, some aspects of data showed the effectiveness of the intervention on the behavioral and/or academic performance for all or some participants. First, consistent with the findings published in the previous literature (Dunlap et al., 1994; Jolivette et al., 2001; Powell & Nelson, 1997; Ramsey et al., 2017; Skerbetz & Kostewicz, 2013), three participants demonstrated a functional relation between the intervention and task engagement improvements, with different levels of treatment effects ranging from moderate to very effective.

Specifically, the significant evidence of the functional relation between the intervention and task engagement improvements was observed for Participant One, as evidenced by a PND of 90% and PEM of 100%. As compared with baseline phases, Participant Two and Participant Four showed higher mean levels of task engagement following the introduction of the intervention in B phases, with overall PEM of 86% and 84% (i.e., moderate effect), respectively. Participant Three appeared to do well in both intervention and baseline phases with no treatment effect, as noted by a PEM of 53%. Upon the second reversal of intervention in the second BA, A2 phase for Participant Three showed a stable and sharp decreasing trend with the existence of the lowest data points across phases, suggesting a contra-therapeutic direction. Across participants, improvements in task engagement data in regard to mean level and level stability were more pronounced during intervention phases of the second AB or BA contrast. A point worth mentioning is that the task engagement in this study was defined by some motor and physical behaviors (e.g., eyes and hands on the math tasks), of which Participant One showed the lowest baseline mean levels across participants. Given that Participant One showed the most significant effect on task engagement (i.e., with PND of 90%), it is possible that the iPad-based
choice-making opportunities were more effective for students displaying a higher frequency of motor problem behaviors than for those displaying only attentive problem behaviors.

Second, consistent with a finding produced by Skerbetz and Kostewicz (2013), participants required less time overall to complete task during the intervention phases, as compared with the preceding or following baselines phases (i.e., in ABAB or BABA). Excluding the second BA contrast for Participant Three, all participants exhibited a lower mean level of time to completion during the B phase in each AB or BA contrast. Visual analysis provides moderate to strong evidence of a functional relation between the intervention and time to completion as evidenced by the overall PEM of 80% for Participant One, 86% for Participant Two, 74% for Participant Three, and 100% for Participant Four.

Third, task accuracy data across participants showed improvements in the mean level and level stability during the intervention phases, with the lowest data points occurring in baseline phases of each AB or BA contrast. The exception was when Participant Four demonstrated the same high level of task accuracy in both B2 and A2 phases with the lowest data points occurring during the second intervention phase. The functional relation between the intervention and the positive task accuracy effect was established for Participant One (i.e., PND = 70%; PEM = 100%) and Participant Three (i.e., PND = 54%; PEM = 84%). This positive finding appears consistent with previous research investigating the effects of academic choice on task accuracy and reporting positive treatment effects (e.g., Daly et al., 2006; Ramsey et al., 2017; Ramsey et al. 2010; Skerbetz & Kostewicz, 2013). Participant Two and Participant Four did not demonstrate a clear effect of the intervention on their task accuracy. Still, this finding might be consistent with a recent study on students with EBD, where choice of writing prompts had no
positive effects on writing 14 story elements (e.g., setting, time, main characters) for narrative essays (Ennis et al., 2017).

Fourth, Participant One and Participant Two demonstrated a higher mean level of task completion during intervention phases, as compared with the preceding baseline phases. Participant Three and Participant Four maintained the same high level of task completion across phases, ranging from 94% to 100%. Overall, all participants appeared to do well in task completion across phases, as noted by data points scoring above 85% frequently in both A and B phases. As evidenced by PEM and PND scores, there was no evidence of a functional relation between the intervention and task completion improvements. This result is at odds with the previous research (Ramsey et al., 2017; Ramsey et al., 2010; Stenhoff et al., 2008), where all students completed more tasks during intervention phases. An explanation for this is supported by a teacher report, as discussed further in the second research question, that all participants had no issue with task completion and could complete tasks in both choice and no-choice conditions.

Task completion appeared to be an area of strength among participants such that the intervention did not necessarily trigger an improvement.

Taken as a whole, the data show that the academic and behavioral effects of the intervention were compromised with some data variability and/or trend lines going against the predicted direction in some phases. Across 16 phases per participant (i.e., with a total of 64 phases), there continued to be some variability within more than half of the phases (i.e., 40 phases with a minimum of 6 phases for each participant). Also, the trend lines (i.e., Excel-generated) in approximately 29 of the 64 study phases showed variability or trending against the predicted direction. Despite the fact that the data ranges were large during baseline phases and more restricted during intervention phases in most of AB or BA pairs (i.e., with some
improvements in level or trend stability), the power of intervention might have been affected (Hawkins et al., 2015). Based on both formal and informal observations, it is difficult to identify an exact source of variability or trending. That is, the level and/or trend variability might be due in part to various potential sources. The identified variability sources can be broadly categorized along five aspects including: (a) variations in choices across sessions, (b) restricted operational definitions and the recording system, (c) variations in session context, (d) non-representative sample issues, and (e) an insufficient number of data points within a phase. What follows is a discussion of some potential influences that could have contributed to level and/or trend variability within study phases.

**Variation in choices across sessions.** In this study, the choices in each session were constant in terms of length (e.g., equal number of math problems in each of the three alternatives) and level of difficulty (i.e., amount of time estimated to complete the problems in each alternative; Jolivette, et al., 2001; Powell & Nelson, 1997). The classroom teacher estimated the appropriate number of items included and time period needed to complete each alternative. However, there were no systematic verifications of the equivalency of the alternatives in each session. Future research may involve at least a panel of three independent teachers and special education teacher estimations and feedback (Jolivette et al., 2001). It is tantamount to establish the equivalency of alternatives across sessions. In other words, factors such as (a) the amount/type of instruction received, (b) the level of difficulty/familiarity of the daily taught math concept, and (c) the cognitive demands in the choices across sessions (e.g., simple facts or word problems) varied and could have served as confounds affecting participants' responses. For example, there were occasions when a participant received intensive guided practice right before a study session (i.e., amount/type of instruction received), was asked to
choose from a number of alternatives on simple facts (i.e., low cognitive demands), or was not
given alternatives on a newly-acquired math concept, which could have induced higher
responses. This could explain variability in the responses across sessions independent of the
effectiveness of the intervention. Future research may investigate these interfering aspects that
occurred prior to or within each session. For example, in future implementation of choice
making, the teacher can provide students with choice-making opportunities two sessions after
delivering a new concept to control the level of familiarity in the alternatives across sessions.

**Restricted operational definitions and the recording system.** In this study, four
dependent variables had been operationally defined to encapsulate their properties, so that the
data coders would refer to the definitions in determining the occurrence of each at specific points
(i.e., percentage or time duration). The operational definitions of the target behaviors (e.g., task
engagement) were research-backed (Blood et al., 2011; Jolivette et al., 2001; Skerbetz &
Kostewicz, 2013; Stenhoff et al., 2008) with some modifications based on the teacher's
descriptions and a brief informal observation of the participants' behaviors in classroom.
However, in some cases, the operational definition seemed too broad or too narrow to capture the
target behavior for each participant. The operational definition of task engagement, in particular,
could contribute to some observation ambiguity. In one instance, a participant looked up to the
ceiling from a task for eight seconds (i.e., for two intervals), before returning to the task and
answering accurately. It is very likely that such a veering away behavior was not a reflection of
off-task behavior, as aligned with the previously stated definition (see Table 3.2). It might have
otherwise been a participant's way to count or think of the answers. Further, the wide ranges of
off-task behaviors (i.e., in defining task engagement) across participants might tell a different
story. For example, while Participant One demonstrated the lowest percentage of task
engagement behavior during the initial baseline with a zero score in one session, the other participants appeared to do better during the baseline phases. Still, the baseline data of the three participants contradicted the teacher report of high off-task behaviors for all participants. One explanation might be that the operational definition of task engagement was too narrow for the three participants, in that it focused on motor behaviors and overlooked other possible off-task behaviors (e.g., attentive). It could have been more accurate and representative if the operational definition had been tailored to each participant based on the type and frequency of target behavior exhibited, as well as corresponding problem behaviors (e.g., Dunlap et al., 1994). Thus, there appears to be a need for functional behavioral assessment (i.e., systematic process of describing the context of problem behavior) in an attempt to understand the dimension and topography of problem behaviors (Ramsey et al., 2017; Restori, Gresham, Tae, Lee, & Laija-Rodriquez, 2007; Sugai, Horner, & Sprague, 1999; Sugai, Lewis-Palmer, & Hagan, 1998). In doing so, the operational definition could be specified and, better yet, the motivation function of problem behavior could be matched with the type of choices (e.g., Ramsey et al., 2017; Reid & Nelson, 2002).

With the previously mentioned limitations in the operational definition of task engagement, there also was a major issue related to the recording system of task engagement contributing to the data variability. Using a 10-second interval recording system, this study employed partial interval sampling to score each interval in which a participant was engaged or not during the seven-minute sessions. Although 10-second intervals appeared shorter than previous studies (e.g., 15-second intervals; Dunlap et al., 1994; Skerbetz & Kostewicz, 2013), there was still room for inaccurate estimation of the occurrence/nonoccurrence of task engagement. In other words, 10 seconds could be a large window for a participant displaying
high frequency behavior, which could have accounted for less accuracy in capturing the off-task behaviors (i.e., underestimate of off-task behavior while observing task engagement). The converse is true when it comes to overestimating the occurrence/nonoccurrence of task engagement. For example, some participants exhibited one off-task behavior, but it lasted for two intervals (e.g., the last three seconds and first three seconds of two sequential intervals). In this case, two intervals were marked for off-task behaviors. This number might be an exaggeration, especially if the participant answered in a shorter amount of time (i.e., therapeutic) during intervention phases. In other words, with the shorter number of whole intervals (i.e., less time to completion), intervals for one off-task behavior might have been overestimated.

Together, it is important to consider a recording system based on the severity and frequency of the problem behaviors for each participant. Shorter intervals (e.g., five seconds) might also lead to a more accurate estimation in future research (Liu-Gitz & Banda, 2010).

**Variations in session context.** The study phases were a part of the natural teaching repertoire and occurred during the math independent practice time in which it was feasible for choice-making practices. However, there were contextual issues that could not be controlled constantly across study sessions. Several factors in relation to session arrangement and context emerged, creating possible sources of variability. First, given the fact that the researcher was allowed to prepare and run the study sessions during only the first seven minutes of the daily independent practice, there was no control over the antecedent and subsequent events. For instance, Participant One and Participant Two were aware of math coloring activities occurring right after session five (i.e., once they submitted their independent practices). It is very likely that such a consequence event (i.e., coloring activity) was motivating and partly responsible for the high rate of task engagement and the short time to completion. As yet another example, the
primary researcher remained in the classroom during the seven-minute independent practice, setting up the cameras (i.e., for videotaping) and helping the classroom teacher in disseminating iPad or paper-based assignments. The researcher also served as a technical supporter if needed during the study sessions. Although the researcher made efforts to be unobtrusive and not available until needed (e.g., walking away from the classroom or sitting in the back of the classroom), it is very likely that the participants perceived the researcher as a related factor to their independent practice (i.e., not a natural routine). The mere physical presence of the researcher during the independent practice could have been responsible for participants' increased attention toward their academic or behavioral performance, resulting in some variability.

Second, seating arrangements could be another contributing issue that broadened data variability. Given the fact that the movement through study phases varied by participant (i.e., depending on their data meeting the established standards; see Chapter 4), there were some occasions when three participants sat in close proximity to each other as a group for either a baseline or intervention session. Conversely, Participant Two was absent an entire week, so she sat alone during the last two sessions of her second intervention phase; whereas the remaining participants had completed all study phases. On the basis of informal observations, sitting close to other participants could have induced higher off-task behaviors (e.g., looking at others' work), while sitting alone could have increased task engagement. Overall, controlling contextual variables, such as antecedent events and seating arrangements, during the study phases is needed in future practice.

Non-representative sample issues. Within the participant recruitment process, the researcher explained each item in the inclusion criteria to the elementary school director who
nominated students for participation. Due to the time constraints for conducting the study, the recruitment process was initiated as soon as the participants were identified by the elementary school director and classroom teacher. It is possible that the classroom teacher might have exaggerated the level of problem behaviors when asked for participant nomination (Levine & Ducharme, 2013). Given that participation would require the teacher to work with individuals (i.e., providing individual instructions) and work with a small group simultaneously with no assistant teacher available to move more quickly through the curriculum, she might have exaggerated minor or incident problem behaviors. Accordingly, sporadic problem behaviors (e.g., off-task and low rate of task completion) occurred during the study phases, though the sources may have varied. With this in mind, some variability in the present study could be traced back to the non-representative sample issue. Since participant recruitment relied solely on teacher reports, it is recommended that the experimenter review the academic records of the nominated students and conduct at least three direct observations of behavioral responses in the classroom before final selections are made. It also would be of interest to collect some pre-study baseline data to predict the pattern of data stability later when the study is actually conducted.

*An insufficient number of data points within a phase.* Central to level and trend stability is a sufficient number of data points collected within phases. Parker and Hagan-Burke (2007) suggested ten data points in some cases to establish a convincing effect. In this study, there was a standard for collecting a minimum of five data points in each phase and some additional data if visual analysis revealed variability (Gast & Spriggs, 2014). However, there were scheduling constraints due to the teacher's tight classroom schedule, which necessitated more guided practice than independent practice, coupled with the limited time dedicated to study procedures in the classroom (i.e., spring semester). Thus, the standard was adjusted from a
minimum of five data points in the first AB or BA pairs to a minimum of three data points in the 
second AB or BA pairs. Although the researcher considered the trend and level of the last three 
data points within a phase in task engagement data (see Chapter 4) for movement decisions (i.e., 
between task engagement phases), it is still difficult to estimate the sufficiency of data points 
within the phase. The challenge inherent in collecting sufficient data points could have been 
aggravated by the movement decisions between phases relying heavily on task engagement data, 
though this was the established variable in previous research. Future research should allow a 
more extended period of time to collect stable data for baseline and intervention phases on each 
dependent variable.

**Results of the second research question.** To assess the teacher's views of the 
acceptability of iPad-based choice making, she completed a researcher-developed satisfaction 
questionnaire (see Appendix D) at the points in the study: (a) after the first two phases with each 
participant and (b) at the conclusion of the study (i.e., e-interview questions; see Appendix E). 
Overall, teacher found the intervention feasible, as it required minimal effort and did not conflict 
with instructional activities or other students' learning. With the exception for Participant One, 
who needed more prompts to follow directions, the teacher indicated that the intervention was 
easy to implement in the classroom for the remaining three participants.

In contrast to previous studies (Jolivette et al., 2001; Ramsey et al., 2010; Skerbetz & 
Kostewicz, 2013), the teacher was not positive about the effects of the intervention on task 
engagement, time required to complete tasks, task accuracy, and task completion. Looking at the 
data extracted from the two social validity assessments collectively, there were four areas that 
could have affected the teacher's level of satisfaction. First, the teacher had a particular concern 
about the type of choices given across sessions, which might have influenced participants'
responses. That is, she felt the intervention would work only with simple math facts and shorter assignments, while it would be difficult to use with complex and long problems. Choices, such as word problems, might be overwhelming for some participants with low processing skills.

Second, the teacher implied that relinquishing power to students to choose their own independent work alone was not sufficient to produce successful academic responses. That is, the successful implementation of choice making did not undermine the importance of other academic accommodations (e.g., visual support, manipulative aids, calculators). This could suggest that the power of iPad-based choice making would be more apparent in combination with academic accommodations.

Third, the teacher would like to provide the intervention in her current and future classes only if choice-making technology were accessible (e.g., an iPad application that creates and programs choices). Given that programming the choices into the GoWorksheet application was mostly researcher-mediated, the teacher could have been less amenable to build specific time for integrating mobile technology into choice making, as it might have demanded some professional training. It is possible, perhaps likely, that the teacher would benefit from some technical trainings on locating and using mobile technology materials and features to enhance instructional practices. Future research may take into account the skills of teachers in regard to mobile technology and professional development needed.

Last, other difficulties and improvement suggestions that the teacher expressed were study-related issues rather than intervention-related issues. On some days, the teacher wanted to teach the entire time with more guided practices rather than allocating specific time (i.e., three days a week) for study procedures (i.e., choice and no-choice conditions) during independent practice work. This was in spite of the fact that the teacher suggested ahead of time (i.e., before
the initiation of the study procedures) that seven minutes three days a week would be an appropriate time for participants to answer a specific number of math assignments for independent practice. The contradiction occurred between the time constraints on collecting data in the school (i.e., Spring semester) and the changes made to the scheduled independent practice for the sake of providing more guided practice. This issue might be perceived as a vestige of the research-to-practice gap reported in special education literature. Greenwood and Abbott (2001) attribute research-to-practice gaps to the lack of functional communication between research and practice communities. Snell (2003) proposed comprehensive collaboration between researchers, practitioners, faculty at universities, state departments of education, and the federal department of education toward narrowing the research-to-practice gaps. Accordingly, and part of comprehensive collaboration, researchers need to take the role of framing their research questions on school-based data and involve teacher judgments. Though practitioners, including teachers, have demands to use research-based content (e.g., on the implementation of research in school) and provide data to reflect improvement evaluations, they often perceive participation in research as secondary to their ongoing teaching obligations. Future researchers need to put extra effort to support mutual functional communication between the researcher and teacher when implementing research interventions. To this end, future researchers should extend the time period dedicated to study procedures in order to examine the feasibility of the intervention in the classroom in a flexible manner (i.e., with expected changes in instructional activities). Taken together, investigating the four areas extracted from the teacher's responses would support the examination of the feasibility and practicality of iPad-based choice making in future inquiry.

Results of the third research question. With the exception of Participant One, three participants agreed that iPad-based choice making was valuable as to the positive impact on task
engagement (i.e., being in good behavior) and task completion. The three participants also agreed that they would like to choose their assignment during independent practice. Participant Three and Participant Four felt the positive effects on task accuracy and would like to choose their tasks in other classes. Of these three participants, Participant Two neither felt the positive effects of iPad-based choice making on completing more correct answers nor wanted to choose her tasks in other classes. Overall, these findings seemed consistent with the previous two studies (Ramsey et al., 2010; Skerbetz & Kostewicz, 2013) where choice making was viewed by most participating students as socially valid.

Despite the fact that the notable treatment gains were found mostly for Participant One (i.e., positive treatment effect on task engagement, time required to complete tasks, and task accuracy), he was the only participant who rated the intervention as not acceptable in all the five assessment statements. A possible explanation for this, which also warrants caution in the interpretation of the previously mentioned positive acceptability effects, was the three-week time gap between the last data point in the final phase for Participant Two (i.e., the last one completing the study phases) and the administration of the social validity assessment. This time gap resulted from the expiration of the original IRB approval and the three weeks time taken to receive a renewed approval letter. It is possible, and perhaps likely, that the participants’ satisfaction levels had been influenced by the time gap, which potentially affected the internal validity of the reported results.

Future researchers should maintain participant input during the study phases and soliciting qualitative feedback (e.g., with open-ended interview questions) from each participant. Anecdotal notes and/or other supplemental data could be an important determinant of the naturally occurring expressions during the iPad-based choice and no-choice conditions. To this
end, behavioral expressions can be defined as smiles, vocalizations, or physical movements (e.g., clapping hands) that reflect the student’s excitement or complaints about the academic assignments across the study conditions (Lancioni et al., 1996). The goal is to use different metrics for both quantitative and qualitative data toward validating the level of intervention acceptability among participants.

Limitations and Recommendations for Future Directions

The findings of the present study should be interpreted in light of some limitations. First, bias might have existed affecting the reliability of data. Although considered, it is not enough to assume that the data coders were blind to the hypothesis of the study, because both the choice and no choice conditions were obvious. Another concern exists as the primary researcher observed and coded data in each session to ensure the consistency of understanding the operational definitions across sessions. Although the researcher's scores were not included for calculating inter-rater reliability between the assigned two data coders, a bias in capturing the target behavior at specific levels might have been present.

Second, a limitation that might affect the generalizability of the findings in real-world classrooms was the lack of teacher involvement in establishing iPad-based choice making opportunities. The entire process of selecting or developing mobile technology and GoWorksheet application for choice-making, making decisions, and programming or setting up the application was mostly researcher-mediated. This raises the question as to whether delivering choice-making strategies through mobile technology would make the intervention cumbersome in the classroom. With this in mind, future inquiry should investigate the capacity for teachers or school staff to use mobile technology and lead related decisions independent of researcher support (Blood et al., 2011; Bruhn et al., 2016). Further, it seems necessary to
develop and examine a problem-solving model to help teachers be better informed about the integration of mobile technology into choice-making strategies and enhance the feasibility of this integration in the everyday classroom. The model would define how to link mobile technology to choice-making (i.e., without impacting the treatment fidelity) and student needs, as well as describe some related features and conditions (e.g., Macsuga-Gage et al., 2015).

Third, there were intervention phases with improved levels as compared with the corresponding baseline phases, but they were compromised with trend lines going in contra-therapeutic directions. The same was true with baseline data points showing therapeutic directions despite the lower mean levels. As discussed in the preceding discussion section (i.e., potential sources of variability), this issue was resolved by considering the trend of the last data points within the phases. Yet again, future researchers might obtain a higher number of data points within a phase until trending and stable data are established toward a convincing conclusion.

Fourth, when comparing iPad-based practices and traditional practices, the novelty of the iPad in classroom might have induced higher responses (Haydon et al., 2012). That is, novice learners showed excitement at the beginning of the study, but it was unknown whether the level of excitement would fade over time. Although the novelty threat was minimal in this study with the participants being accustomed to using iPads (i.e., routine access to iPad within classroom activities; Vogelgesang et al., 2016), collecting comparative baseline data (i.e., comparing the effects of iPad-based choice-making and traditional choice-making) remains an internal validity area to be strengthened in future research. That is, the baseline conditions in the study excluded typical choice making strategies, while the intervention phases included the iPad-based choice making. The intervention data, thereby, were compared to non-comparative baseline conditions.
There was no clear assurance whether the use of the iPad per se or the incorporation of the iPad into the choice-making strategies was responsible for the documented improvements.

Fifth, though the focus of this study was to examine the effectiveness of iPad-based choice-making opportunities for students identified with ADHD, not all participants were clearly identified with ADHD. Since the researcher was limited to recruiting students for participation from only one self-contained classroom in the school, some other students identified with different diagnoses (e.g., autism) also were included. To establish internal validity, the researcher ensured that the participants were reported to exhibit relatively the same behavioral and academic characteristics (e.g., off-task behaviors, poor math performance). Still, strengthening internal validity by following strictly the participants' nomination criteria posted in Chapter 3 is needed in future research. Sixth, small sample of participants (i.e., only four participants), the restricted classroom setting (i.e., one self-contained classroom), and specific content area (i.e., third grade math concepts) all posed barriers for external validity assessment.

Last, this study added PEM calculation estimates, in addition to PND, to determine the effect size. The decision to use PEM was influenced by the high variability and ceiling/floor effects which occurred in some phases. It would be prudent to collect a greater number of data points in each phase so that a more conclusive statement about the effectiveness of the intervention could be made. Viewed together, for each limitation there are corresponding corrective actions for future research and practice.

**Conclusion and Implications**

Looking at the findings collectively, several implications for educational research and practice arise. As for research value, it seems timely that this study has examined the integration of mobile technology into choice-making strategies. It might align with contemporary
CHOICE AND STUDENTS WITH ADHD

educational practices, where teachers look for new and better ways to complement classroom- or individual-based instructional practices (Cumming, 2013; Heintzelman, 2016). Since there is still much to be explored in the field of integrating mobile technology into instructional practices, this study could lay the groundwork for further research by (a) analyzing the effects of iPad-based choice making on behavioral and academic performance for students with ADHD, (b) soliciting teacher and students feedback on the social acceptability of the iPad-based choice making in everyday classroom routines, and (c) providing suggestions for future implementation of iPad-based choice making. Additionally, this study addresses the lack of evidence base stated by Royer et al. (2017) for the use of choice making to supplement behavioral and/or academic improvements and provides potential support for the power of choice making. Although the reported limitations have restricted the power of iPad-based choice making to wider conditions and a larger population sample, this study provided some corresponding directions for future inquiry. Again, strengthening the power of iPad-based choice making for students with ADHD by controlling the previously stated sources of data variability (e.g., contextual variables) in future research will add to the existing knowledge base. Overall, this study adds to the literature in terms of defining some factors related to the mechanism of choice making (e.g., why it works or it does not; Lane et al., 2015; Rispoli et al., 2013; Sellers et al., 2013) including (a) the types of choices in each session, (b) the control of teacher-student interaction during the choice conditions, and (c) the use of mobile technology to facilitate choice making. Practically viewed, the effects of providing elementary-aged students with ADHD iPad-based choices for math independent work time appears mostly positive, that is, the results show some improvements in behavioral and academic performance in the classroom. Also, the classroom teacher reported the
feasibility of incorporating iPad-based choice making into her academic routines for most participants.

In conclusion, this study addresses some limitations of previous research in three ways. First, it examines the incorporation of technology-based choice making for math instruction. Second, it focuses on the social validity of the intervention as perceived by both students and the classroom teacher. Third, it addresses some of the design and interfering variables present in some of the reviewed studies (e.g., teacher-student interactions). Thus, the results of this study have the potential to provide classroom teachers with a promising strategy that might decrease interfering behaviors and positively influence academic performance for students with ADHD. When provided with choice-making options, students with ADHD may display higher rates of on-task behavior, and more frequently complete assignments faster and more accurately, which may lead to ultimately an increase in their math academic performance.
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http://journals.sagepub.com/doi/abs/10.1177/016264341102600402


*Ramsey, M. L., Jolivette, K., Patterson, D. P., & Kennedy, C. (2010). Using choice to increase time on-task, task-completion, and accuracy for students with emotional/behavior disorders in a residential facility. *Education & Treatment of Children, 33*(1), 1-21. doi: 10.1353/etc.0.0085


Appendix A. Informed Consent

INFORMED CONSENT DOCUMENT

OLD DOMINION UNIVERSITY

PROJECT TITLE: The Effect of Choice on an IPad-Delivered Math Independent Practice of Elementary Grade Students

INTRODUCTION
The purposes of this form are to give you information that may affect your decision whether to say YES or NO to your child’s participation in this research, and to record the consent of those who say YES. The research study will be on the effect of choice on an iPad-delivered math independent practice on elementary grade students identified with or at risk for ADHD. This study will be conducted during math independent work time over the spring semester/2018.

RESEARCHERS
Responsible Project Investigator:
Dr. Robert Gable
Darden College of Education
Department of Communication Disorders & Special Education
Old Dominion University

Investigator:
Nora Altaweel, Doctoral student
Darden College of Education
Department of Communication Disorders & Special Education
Old Dominion University

DESCRIPTION OF RESEARCH STUDY
A choice making strategy involves providing students with opportunities to choose what and when to do a task in the classroom. This strategy has proven to be effective for students with problem behaviors. Because students with ADHD may display off-task behaviors and show poor academic performance, incorporating choice making strategies into instructional activities could increase academic engagement and performance. However, the direct relations between choice-making and the behavioral and academic performance of students with or at risk for ADHD during academic activities still needs to be investigated. This study will allow for clarification of the potential relations.

If you decide to permit your child to participate, your child will be given opportunities to choose one of three iPad-based math assignments to be completed independently during math independent work time. The teacher will provide the choice making strategy in the last ten minutes of daily math sessions (five sessions per week). If you say YES, then your child’s participation will last for approximately four to ten weeks in the math classroom. Approximately four similarly situated students will be participating in this study.
EXCLUSIONARY CRITERIA
The elementary school director should have referred your child to the study. The elementary school director has been instructed how to do a random selection so that the researcher does not see an identified list of students. Your child is attending third grade in elementary school and showing low performance in math. There is no reason to exclude your child from the study. The researcher will not see the identified list of students in the nomination process and will be provided with the final list that includes only the nominated students who submitted the signed consent and assent letters.

RISKS AND BENEFITS
RISKS: There are no foreseeable risks associated with the study procedures because all of the strategy procedures are similar to the classroom procedures to which the child is normally exposed.

BENEFITS: There are no direct benefits for participating in this study. It is hoped that the results of the study can be useful in helping researchers identify how and why choice-making can be effective, which will improve the student’s academic and behavioral performance, as well as the teacher’s instructional practices. Your permission will allow us to provide knowledge on the effectiveness of choice making strategies.

Upon your consent, you will receive a brief description of the study procedures.

COSTS AND PAYMENTS
You will not be asked to pay any cost for your child’s participation. Your child will also receive a $20 Amazon gift card after completing the study as a small token of appreciation.

NEW INFORMATION
If the researchers find new information during this study that would reasonably change your decision about participating, then they will give it to you.

CONFIDENTIALITY
Two observers will collect data on the child’s academic engagement and performance during the math independent practice time. Videotaping your child during the study sessions will be used only for data collection and analysis. Your child would not be identified by name in any use of the videotapes. If you agree to be in the study, videotapes will be taken.

Your child’s data, information, and videotapes will be considered confidential. All data and videotapes will be stored securely unless disclosure is required by law. The data and videotapes will be stored in a secure server (locked file accessible only to the study investigators and data collectors in the child center at ODU, Room 224). The results of the study might be published in academic journals or conferences. The information on the study results might be shared in academic conferences, research reports, professional presentations, academic books, and/or journal publications. The child’s name will not be used and a code number will be used instead. In general, the identifiers will be removed and destroyed.
WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and withdraw your child from the study - at any time.

COMPENSATION FOR ILLNESS AND INJURY
If you say YES, then your consent in this document does not waive any of your legal rights. However, in the event of harm arising from this study, neither Old Dominion University nor the researchers are able to give you any money, insurance coverage, free medical care, or any other compensation for such injury. In the event that you suffer injury as a result of participation in any research project, you may contact Dr. Tancy Vandecar-Burdin the current IRB chair at 757-683-3802 at Old Dominion University, or the Old Dominion University Office of Research at 757-683-3460 who will be glad to review the matter with you.

VOLUNTARY CONSENT
The decision to allow your child to participate in the study is yours and voluntary. By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them:

Nora Altaweel
(832) 231-6898
Email: nalta001@odu.edu

If at any time you feel pressured to permit your child to participate, or if you have any questions about your rights or this form, then you should call Dr. Tancy Vandecar-Burdin, the current IRB chair, at 757-683-3802, or the Old Dominion University Office of Research, at 757-683-3460.

And importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher should give you a copy of this form for your records.

<table>
<thead>
<tr>
<th>Parent / Legally Authorized Representative’s Printed Name &amp; Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

INVESTIGATOR’S STATEMENT
I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws,
and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent form.

<table>
<thead>
<tr>
<th>Investigator's Printed Name &amp; Signature</th>
<th>Date</th>
</tr>
</thead>
</table>

Appendix B. Assent Form

Choice-Making Study

My name is Nora Altaweel. I work at Old Dominion University.

I am asking you to take part in a research study because I am trying to learn more about your opportunities to choose your math assignment during math independent work time. I want to learn about the effects of your choice.

If you agree, you will be asked to choose one of three of iPad-delivered math assignments to complete during math independent work time. Choosing the assignment and completing it will take seven minutes in each math session over the spring semester.

You do not have to be in this study. No one will be mad at you if you decide not to do this study. Even if you start, you can stop later if you want. You may ask questions about the study.

If you decide to be in the study I will not tell anyone else what you say or do in the study. Even if your parents or teachers ask, I will not tell them about what you say or do in the study.

When this study is completed, you will receive a $20 Amazon gift card as a thank you.

Signing here means that you have read this form or have had it read to you and that you are willing to be in this study.

Signature of subject______________________________________________________

Subject’s printed name _________________________________________________

Signature of investigator________________________________________________

Date____________________
Appendix C. Procedural Fidelity Checklist for Study Phases

**Procedural Fidelity Checklist for Baseline Phases**

<table>
<thead>
<tr>
<th>Procedures</th>
<th>Not Observed</th>
<th>Support Not Provided</th>
<th>Support Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Sessions (no-choice conditions):</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. The teacher assigns the target student in the no-choice condition to work on a math assignment presented on the math worksheet.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. The teacher emphasizes/reminds the target student in no-choice condition about the directions of the independent practice work.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. The teacher sets the timer to 7 minutes and says, “Now, you have 7 minutes to work on <em>write</em> math problems.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Teacher prompts the target student to begin and says, “Go ahead and begin.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. The teacher does not provide feedback on the target student performance in the independent work time.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IRR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total IRR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**General Procedures for Consideration If needed:**

1. The teacher asks the target student in the no-choice condition if he has any questions on the instructions for the independent practice work and answers the student’s questions.

2. Teacher says, “If you finish the assignments early, you can raise your hand or say DONE, and I will come to your desk and pick the worksheet up.”

3. Teacher prompts the student to go back to his seat to do the independent work if he is out-of-seat.

4. If target student asks for academic assistance/help, guidance, hint, and/or information (e.g., how I can answer this problem?) in answering math problems, the teacher says, "It is your independent practice time, try to think of the answer on your own.”

**Comments**
### Procedural Fidelity Checklist for Intervention Phases

<table>
<thead>
<tr>
<th>Procedures</th>
<th>Not Observed</th>
<th>Support Not Provided</th>
<th>Support Provided</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention Sessions (choice conditions):</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Teacher points to the target student iPad screen, says, “You see three <em>write</em> math assignments,” and reads the directions for each <em>write</em> math assignment.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. Teacher asks the target student, &quot;Which of these three <em>Write</em> assignments would you like to complete for independent work time?&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Teacher gives the target student 15 seconds to think which to choose.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. When the target student makes the choice, teacher sets the timer to 7 minutes and says, “Now, you have <em>seven</em> minutes to complete the assignments. Go ahead and begin.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. The teacher does not provide feedback on the target student performance in the independent work time.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Comment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IRR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total IRR</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**General procedures for consideration if needed:**

1. Teacher pauses the timer for a student who has any technical problem/question.
2. Teacher fixes the technical problem, if it occurs.
3. Teacher resets the timer once student able to begin again and says, “Now, you can go ahead and complete the assignments, you still have (...) minutes to complete the assignments.
4. If a target student does not make a choice, the teacher re-prompts the student to choose and repeats procedures (2-3)
5. After the target student makes a choice, the teacher asks if he has any questions on the instructions for the independent practice work and answers any questions.
6. Teacher prompts the student to go back to his seat to do the independent work if he is out-of-seat.
7. If target student asks for academic assistance/help, guidance, hint, and/or information (e.g., how I can answer this problem?) in answering math problems, the teacher says, "It is your independent practice time, try to think of the answer on your own."

**Comments**

Adapted from Dunlap et al. (1994) and Ramsey et al. (2010)
### Appendix D. Teacher Satisfaction Survey for Social Validity

<table>
<thead>
<tr>
<th>Item</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree or Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The student engaged in the self-selected math assignment more than when teacher-assigned assignments were provided.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>2. The student completed more self-selected math assignments than when teacher-assigned assignments were provided.</td>
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<td></td>
<td></td>
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<tr>
<td>3. The student provided more accurate answers on self-selected math assignments than when teacher-assigned assignments were provided.</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>4. The student completed the self-selected math assignments faster than when teacher-assigned assignments were provided.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Asking the student to choose a <em>write</em> of iPad-based math assignment for independent work time was an easy task to implement in the general classroom.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Implementing the procedures of choice making for the student did not interrupt my teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Implementing the procedures of choice making for the student did not interrupt other students’ learning.</td>
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<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>8. Implementing the procedures of choice making for the student required minimal time and effort.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>9. I plan on providing choice-making opportunities in my future/current classes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I plan on providing more choice-making opportunities students in the future.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. What are the benefits of using choice-making strategies for the target student in your classroom during math independent work time?

2. What are the difficulties of using choice making with target students during independent math practice?

3. What are the disadvantages of using choice-making strategies with the target student in your classroom during math independent work time?

4. What changes do you think might be done to improve the choice-making intervention during your math instruction?
Appendix E. Teacher Satisfaction Interview

1. What are the advantages of asking students with ADHD to choose a one write math assignment to be completed during math independent work, especially in the classroom?

2. In what other ways could you incorporate choice-making strategies in the classroom?

3. What would you add, modify, or omit in implementing choice making in academic instructional situations? Why?

4. What is the most difficult step in preparing or implementing choice-making strategies for the students with ADHD in the classroom?

5. If a teacher is thinking of preparing and implementing choice making strategies for students with ADHD in a general classroom, what would your recommendations be?

6. Is there any thought, concern, or question that you have for implementing choice-making strategies in the future?
Appendix F. Student Satisfaction Survey

<table>
<thead>
<tr>
<th>Element</th>
<th>😊</th>
<th>😐</th>
<th>😕</th>
</tr>
</thead>
<tbody>
<tr>
<td>I completed my work in class when I chose the math assignments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I had completed more correct answers when I chose the math assignments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I was on good behavior when I chose my assignments.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would like to choose my assignments during independent practice.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would like to choose my assignments in other classes.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adapted from Ramsey et al. (2010)
Appendix G. Data Collection Sheet

<table>
<thead>
<tr>
<th>Student Condition</th>
<th>Study Phase</th>
<th>Session #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice / No Choice</td>
<td>A1 B1 A2 B2</td>
<td>Coder</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time Start</th>
<th>Time Stop</th>
<th>Total Minutes required to complete task</th>
</tr>
</thead>
<tbody>
<tr>
<td>(in minutes)</td>
<td>(in minutes)</td>
<td>(in minutes)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># of Correct Responses</th>
<th># of Non-Correct Responses</th>
<th>Percent of Correct Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>(in number)</td>
<td>(in number)</td>
<td>(in percentage)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th># of Problems Completed</th>
<th># of Problems Uncompleted</th>
<th>Percent of Completed Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>(in number)</td>
<td>(in number)</td>
<td>(in percentage)</td>
</tr>
</tbody>
</table>

---

TE: Task Engagement  
NE: Non-Engagement  
TSI: Teacher-Student Interaction  
TRT: Time Required to Complete Task  
TA: Task Accuracy  
TC: Task Completion  

Comments:
VITA

Nora Abdulaziz Altaweel, PhD
King Saud University
College of Education, Special Education Department
P.O Box 7695 Riyadh 11472, office # 268
+966504264809; Email: noaltaweel@ksu.edu.sa

Education

August, 2018 Ph.D., Special Education with an emphasis of Emotional and Behavioral Disorders
Darden College of Education, Old Dominion University: Norfolk, Virginia, USA
• Dissertation Title: The Effect of Choice of iPad-Delivered Math Independent Practice of Elementary Grade Students with Attention-deficit/Hyperactivity Characteristics
• Dissertation committee: Dr. Robert Gable (Chair), Old Dominion University; Dr. Peggy Hester, Old Dominion University; Dr. Jo Hendrickson, University of Iowa
• GPA: 3.9 out of 4
• Passed doctoral dissertation defense with distinction
• Passed doctoral oral and written comprehensive examination with distinction

January, 2013 Diploma, Proficiency in English with emphasis of Academic English
Intensive English Program, Rice University: Houston, TX, USA
• Completed advanced level (beyond the six-level core program) exams in English Proficiency
• Achieved IELTS Score of 7.5

February, 2011 M.A., Special Education with a track of Learning Disabilities
College of Education, King Saud University: Riyadh, KSA
• Thesis Title: Implementation of Positive Behavior Support to Reduce Problem Behaviors for Student with Learning Disabilities
• Thesis Advisor: Dr. Ibrahim Abunayyan, King Saud University
• Graduated with First Class Honors and a GPA of 4.9 (out of 5)

February, 2006 B.A., Special Education with a track of Learning Disabilities
College of Education, King Saud University: Riyadh, KSA
• Graduated with First Class Honors and a GPA of 4.87 (out of 5)

Professional Experience

2019- Present Assistant Professor
Special Education Department, College of Education, King Saud University: Riyadh, KSA

2011- 2018 Lecturer
Special Education Department, College of Education, King Saud University: Riyadh, KSA

- Taught undergraduate special education courses including Introduction in Special Education; Awareness in Special Education; Teaching Students with Learning Disabilities; and Practicum in Learning Disabilities
- Developed syllabi, course work, instructional modules and all associated course materials
- Revised and modified syllabus routinely as per the changing demands and needs of the time
- Planned and developed learning activities and resources to help students interns achieve teaching competency requirements in the fieldwork courses
- Supervised special education teacher candidates during their practicum in Riyadh Public Elementary Schools within both inclusive and special education classroom settings
- Coordinated meetings between first special education teachers in Riyadh Public Schools and students interns to discuss contemporary issues on teaching and learning strategies for students with special needs.
- Served on numerous college and department committees

Spring 2015
Graduate Teaching Assistant
Department of Communication Disorders and Special Education, Old Dominion University: Norfolk, VA, USA

- Assisted Professor Sharon Raver-Lampman, in teaching and grading assignments for a face-to-face course
- Gave lectures and assisted in the general delivery of the undergraduate class: SPED 400; Legal Aspects for Teaching Students with Diverse Needs
- Performed satisfactorily, meeting the department requirements for the doctoral teaching competency

2015 - 2016
Graduate Research Assistant
Department of Communication Disorders and Special Education, Old Dominion University: Norfolk, VA, USA

- Member in Child Study Center Research Team
- Collected and coded data for a year-long study entitled: Increasing Communicative Joint Attention with Parallel Talk in Dyads with Preschoolers with Hearing Loss
- Participated in weekly meetings to present study updates, monitor the progress, and discuss/solve problems coming along
- Assisted in coordinating data collection sessions
- Monitored inter-observer reliability for data coding

2010 - 2011
Visiting Lecturer
School of Continuing Education, Imam Mohammed Bin Saud University: Riyadh, KSA
CHOICE AND STUDENTS WITH ADHD

- Served as principal lecturer for the postgraduate diploma level course: *SPED Applied Behavioral Analysis*
- Planned and delivered weekly lectures, evaluated performance, and provided written constructive feedback
- Worked with students from diverse backgrounds in various disciplines including: psychology, special education, and business administration
- Advised 20 students on virtual individualized behavior plans assignments

**2006 - 2008**  
**Teacher**  
*Alabnaa School at King Abdulaziz Military Academy: AlUyaynah, Riyadh, KSA*

- Evaluated, revised, and developed IEPs, teacher daily lesson plans, and behavior plans
- Led IEP meetings with general education teachers, school administrators, and parents
- Evaluated and revised the developed IEPs based on progress reports and IEP meetings
- Assisted in expansion of a multi-functional resource room to expand and individualize services for students with special needs in the school
- Served as lead special education teacher (by election) for two years in row, overseeing day-to-day duties of all special education teachers in the school (four
- Conducted seminars on bi-monthly basis for general and special education teachers, parents, and/or school administrators on how to best meet a variety of students' academic and behavioral needs

**2006 - 2007**  
**Teacher**  
*School of the Second at the Security Forces primary housing, Ministry of Education: Jeddah, KSU*

- Established resource room for students with special needs with fully stocked and functional learning stations
- Created IEPs including long-term goals, short-term objectives, accommodations, and data for students with special educational needs
- Evaluated students' performance and provided progress reports on a regular basis
- Facilitated IEP meetings, parent conferences, and annual reviews
- Adapted elementary school reading and math curriculum and exam materials to suit students with special needs
- Prompted general education teachers to make classroom and/or academic changes and differentiated instruction as required
- Revised some teachers' literacy informal assessments (e.g., developmental curriculum-based assessment) essential for special education referral process
- Engaged with external organizations/communities to develop bi-
CHOICE AND STUDENTS WITH ADHD

annual series of lectures on special education issues for parents and/or
general education teachers.

University Serveries

2018 - Present  Chair: Departmental committee for submitting a proposal for a partnership
with the Division of International Special Education and Services (DISES) to
co-host, as a local partner, an international special needs conference or round
tables in Riyadh in Summer 2022 or 2023, Special Education Department,
King Saud University: Riyadh, KSA

2018 – Present  Board Member: Departmental committee for Activating Scientific Research
in Special Education, Special Education Department, King Saud University:
Riyadh, KSA

2018 – Present  Board Member: College and departmental committee for preparing and
developing two-year Post-Graduate Certificate in Education (PGCE).
College of Education, Special Education Department, King Saud University:
Riyadh, KSA

2018 - Present  Board Member: Departmental Committee for Annual Reports of Quality
Assurance and Development in Special Education Department, King Saud
University: Riyadh, KSA

2014 - 2018  PhD Representative: Student Division of the Council for Exceptional
Children (SCEC), Old Dominion University: Norfolk, VA, USA

2011 - 2012  Chair: Departmental committee for coordinating and supervising
undergraduate final exams in Special Education Department. King Saud
University: Riyadh, KSA

Paper Presented at Professional Meetings

Altaweel, N. A. "Toward Powerful Emerging Practices for Students with Emotional and
Behavioral Disorders in Classroom" Paper presented at The Asian Conference on
Education & International Development (ACEID2019). The International Academic
Forum; Tokyo, Japan: March 25-27, 2019

Altaweel, N. A. "Integration of Mobile Technology into Evidence-Based Practices for Students
with Emotional and Behavioral Disorders in Classroom" Poster Presented at the Annual
Graduate Research Achievement Day (GRAD), Old Dominion University; Norfolk, VA,
USA: March 29 March 29, 2018

Altaweel N. A. "Classroom Examples of the Use of Mobile Technology in Antecedent-Based
Practices" Paper Presented at Virginia Council of Learning Disabilities Spring
Symposium, Marymount University; Arlington, VA, USA: April 21, 2018

Altaweel, N. A. "Practical Issues on the Integration of Mobile Technology into Antecedent-Based
Practices for Students with Emotional and Behavioral Disorders" Paper presented at The
annual Teacher Educators for Children with Behavior Disorders (TECBD) conference,
Arizona State University; Tempe, AZ, USA: October 28, 2017

Altaweel, N. A. "Story Mapping and Reading Comprehension of Students with Disabilities"
Structured poster presented at The 39th Annual International Conference on Learning
CHOICE AND STUDENTS WITH ADHD


Invited Lectures, Organized Events, and Review Works

March 25, 2019 Invited Reviewer: Credited in The Asian Conference on Education & International Development (ACEID2019) as a senior reviewer for peer-reviewing 8 submissions (i.e., scientific-educational papers): Tokyo, Japan
May 29, 2018 Invited Guest Lecturer: "Practical information on the Use of Mobile Technology in the Real-World Classrooms" Paper presented to general and special education teachers at the Office of Special Education, Arlington Public School: Arlington, VA, USA
March 26, 2018 Coordinator: Prepared and organized "Diverse Abilities Fair", Old Dominion University: Norfolk, VA, USA
October 24, 2016 Coordinator: Prepared and organized "Diverse Abilities Fair", Old Dominion University: Norfolk, VA, USA
April 9, 2007 Coordinator and Participant: Prepared and organized a Teaching and Learning Aids Exhibition for special education teachers, Provision of Educational Supervision in the Armed Forces: Riyadh, KSA
November 18, 2006 Participant: Presented helpful teaching aids in reading, Accompanying Exhibition at the International Conference of Learning Disabilities: Riyadh, KSA
Fall 2006 – Spring 2007 Invited Mentor Teacher: Supervised special education teacher candidates from Dar Al-Hekma University during their practicum in a Public elementary school: Jeddah, KSA

Publications

Professional Development

November 26, 2018
Completed a total of 5-hour program in "Outcomes-Based Learning”, Deanship of Skills Development, King Saud University: Riyadh, KSA

Spring 2017
Completed Preparing Future Faculty (PFF) Certificate, Old Dominion University: Norfolk, VA, USA

October 14, 2014
Attended The 2014 Virginia Federation of the Council for Exceptional Children (VA CEC) Annual Conference “Student Engagement & Literacy”: Virginia Beach, VA, USA

October 24-25, 2013
Attended the 35th Annual Conference on Learning Disabilities (CLD): Austin, TX, USA

December 10, 2013
Attended The Annual GCASE Law Conference “Practical and Legal Approaches to Difficult Problems for Special Education”: Houston, TX, USA

January 10, 2009
Completed 14 hours of a medical continuous learning course entitled: “The Scientific Research and Workshops in The Field of Disability”, Third International Forum of Disability and Rehabilitation: Riyadh, KSA

Honors and Awards

2018 - 2019
Recipient of Kimberly Gail Hughes Research Award: Old Dominion University: Norfolk, VA, USA

2014 - 2018
Qualified for a Membership at Golden Key International Honour society for excellent academic performance at Old Dominion University: Norfolk, VA, USA

Spring 2018
Recognition for passing Doctooral’s Level dissertation defense requirements with Distinction, Old Dominion University: Norfolk, VA, USA

Fall 2017
Recognition for passing Doctooral’s Level Written Comprehensive Exam with Distinction, Old Dominion University: Norfolk VA, USA

2006 & 2011
Received the university's highest honor in both bachelor's and master's degrees, King Saud University: Riyadh, KSA

Membership in Professional Societies/Organizations

Council for Exceptional Children (CEC), USA
Teacher Educators for Children with Behavioral Disorders (TECBD), USA
Council for Children with Behavioral Disorders (CCBB), USA
Teacher Education Division (TED), USA
Saudi ADHD Society, KSA
References

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