Brief Sheets: Examining an Intervention that Increases Academic Reinforcement

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Kyle E. Ryan

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Abstract

This study is designed to extend research on the Brief Sheets intervention. The Brief Sheets intervention involves taking a full-page assignment that is given to students to complete independently and breaking up this assignment into multiple, smaller assignments that still contain the same total number of problems cumulatively. An experiment was designed to see if students would complete more total problems when they were given Brief Sheets compared to a control assignment containing the same total number of problems, if the percentage of accurate responding would be higher for the Brief Sheets assignment, and if students would rate the Brief Sheets intervention as preferable to the control assignment. Our participants were 39 fourth-grade students in an elementary school in the southeastern United States. The experiment was conducted in one day with students completing a packet containing 2 of 3 possible assignments within it. One of these assignments was always a control 10-problem assignment presented on one sheet of paper. The other assignment was counter-balanced to be a 12-problem assignment on one sheet of paper, or a 12-problem assignment presented on 4 slips of paper with 3 problems per slip. A between-subjects design was chosen to answer our research questions. The results of this study did not support the hypothesis that the students who completed the Brief Sheets intervention would complete more work, as the number of problems completed and number of problems completed correctly were both not statistically significant between the Brief Sheets assignment and an alternative assignment of the same length. Likewise, the Brief Sheets intervention was not rated by students as statistically more favorable than the alternative assignment when comparing effort, time, difficulty, or preference for homework. Limitations of this study were that students did not complete as many problems as anticipated with the problems not being completed automatically, and that data collection took place in one day with a limited participant pool of 39 students. Future research on the Brief Sheets intervention should work with a larger participant pool and consider working with older students to see if the Brief Sheets intervention would cause more meaningful differences.

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Chapter 1

Introduction

Statement of the Problem

Although there are many interventions that been developed for students with academic skill deficits, these interventions still require students to choose to attend to and engage in the assigned work (Daly & Witt, 1996). Students can choose to not engage in academic work if they are reinforced for engaging in competing behaviors that are incompatible with academics, such as getting up out of their seat or speaking without teacher permission. Disruptive behaviors can also potentially allow the student to escape from assigned academic work if they are reinforced within the classroom (Lee, et al., 1999).

A goal within an educational setting is to make the academic work the most rewarding option that can be chosen by the student (Myerson & Hale, 1984). One method to accomplish this is by attaching rewards to assignment completion (e.g., allowing for students to perform preferred activities dependent upon their completion of an assignment). Through this process, many students develop a learning history that associates completed assignments with the rewards that are often obtained for the completed assignment. Through classical conditioning, each completed assignment becomes a conditioned reinforcer (Massetti & Fabiano, 2005; Pavlov, 1927).

An issue with attaching rewards to assignment completion is that the students typically need to fully complete the assignment (and to complete the assignment with accuracy) in order to receive the reward (Skinner, 1998). Within this system, the students most likely to receive the reward for assignment completion are those who require less

effort to complete the assignment, or those who have already been rewarded for completing the assignment previously (Skinner, Wallace, et al., 2002). For the student with weak academic skills who requires a high amount of effort to complete an assignment or who is likely to struggle to complete an assignment with accurate responding, the assumed learning history of finding assignment completion to be rewarding may not be present. In many ways, current classrooms are designed to encourage the students who are already succeeding, while not enough effort is being made to reinforce efforts put forth by the students who are currently struggling. What is needed for these students is an intervention that can provide them with more opportunities to experience assignment completion and to be rewarded for assignment progress without causing the student to dislike the academic work through providing too much work, and without watering down the student's curriculum.

Purpose of Study

This dissertation is intended to extend the Wallace, Cox, and Skinner (2003) study, the only study this author is aware of to examine the effects of the Brief Sheets intervention. The purpose of this study is to investigate the practice of Brief Sheets in the classroom during independent seatwork time. Specifically, this study is designed to answer whether Brief Sheets will lead to increased academic output from students in a general education classroom, if students within a classroom will rate Brief Sheets as a preferred method of presentation for academic work, and whether the Brief Sheets intervention can be implemented with ease and fidelity.

The term Brief Sheets here is an intervention that is designed to make independent seatwork more rewarding for students. Rather than giving the student a full-

page assignment to complete independently, Brief Sheets break the assignment up into smaller assignments that still contain the same number of total problems. This gives students the chance to reward themselves by completing multiple smaller assignments while working towards completing the total assignment, and this could potentially make their academic work more rewarding than competing behaviors.

Research Questions and Hypotheses

Research question 1: Will students participating in the Brief Sheets intervention complete more total problems? The Brief Sheets intervention is designed to provide more reinforcement opportunities while the worksheet is completed, which could have a positive effect on the total number of problems the student completes (Wallace et al., 2003). For this study it is hypothesized that the effect of the Brief Sheets intervention alone will result in more total problems being completed than for the alternative assignment sheet containing the same total number of problems.

Research question 2: Will the Brief Sheets intervention have a higher accuracy rate on problems completed? The pilot study on Brief Sheets did not result in a higher accuracy rate for problems completed (Wallace et al., 2003). Similar results were found for interspersal studies, where the intervention increased the total number of problems completed by students but did this without a significant change to the percent of accurate responses (e.g., Skinner, Robinson, et al., 1996). It is hypothesized that the accuracy rate for completed problems will not be significantly different for the Brief Sheets intervention compared to the alternative assignment sheet containing the same total number of problems.

Research question 3: Will students rate the Brief Sheets intervention as preferable

compared to an alternative assignment sheet containing the same total number of problems? The pilot study reported anecdotal evidence that their subject preferred the Brief Sheets intervention compared to Typical Classroom Procedures (Wallace et al., 2003). In this study I aim to directly ask this question to our larger participant pool, and will ask our participants then to compare the Brief Sheets intervention to an alternative assignment sheet containing the same total number of problems. This comparison will be based on multiple criteria (i.e., Which assignment would you rather complete for homework, which assignment would take longer to complete, which assignment would require more effort to complete, and which assignment is more difficult). The Brief Sheets assignment is not hypothesized to be rated favorably on these criteria compared to a control assignment containing two fewer total problems, but it is hypothesized that the Brief Sheets intervention will be rated as more favorable compared to this control than an alternative assignment that contains the same total number of problems.

Chapter 2

Review of the Literature

In school settings educators can teach and assign academic work, but little learning is likely to occur unless students choose to attend to and engage in teacher-led instruction and then apply the effort needed to complete assignments to the best of their ability (Daly & Witt,1996). When students are not academically engaged, they may be more likely to engage in undesired disruptive behaviors that not only prevent them from learning, but also hinder educators' ability to teach and classmates' ability to learn (Bru, 2009). Disruptive behaviors in the classroom can be reinforced if the student is able to escape the demand of a task that they do not want to complete by engaging in disruptive behaviors (Lee, et al., 1999).

Students may be less likely to choose to engage in academic behaviors when those behaviors require much effort (Billington, et al., 2004; Skinner, 1998; Stanovich, 1986). Students with weak academic skills typically require more effort to complete academic tasks (McCurdy, Skinner, et al., 2020; Skinner 1998; Skinner, Wallace, et al., 2002). Additionally, students may choose not to engage in assigned academic tasks when they have rarely been reinforced for those activities previously. Students also may not be reinforced for academic behavior when their responses are inaccurate (Skinner, 1998), or when they fail to complete enough of the assignment, regardless of accuracy. Students with weak academic skills are also more likely to make errors and/or require more time to complete work accurately (Daly, Neugebauer, et al., 2015; Skinner, 1998). Consequently, their academic behavior may not be reinforced because they only completed 50% of an assignment, even if all work was correct.

In typical school settings, students with strong academic skills are more likely than those with weak academic skills to choose to academically engage because in the past they have accessed rewards for engaged behaviors. Additionally, students with stronger academic skills require less time and effort to complete work to a level that will allow them access rewards (Skinner, 1998). Thus, the students who most need to be engaged so that they can enhance their academic skills are least likely to choose to engage due to reduced access to rewards (Daly et al., 2015; Skinner, 1998).

Speed of Accurate Responding

Educators often focus on what they need to do to teach, but an important facet of learning is dependent upon what students do after teacher-led instruction (Lindgren & Suter, 1985). Much of teacher-led instruction is focused on students acquiring skills, concepts, or information (Skinner, 2002; Skinner, Fletcher, et al., 1996). Teachers can describe, demonstrate, model, provide cues, and routine drill concepts for their students (Haring & Eaton, 1978). While acquisition is a critical first step to learning and skill development, it is only the first step.

After students acquire information, other activities are needed to promote speed of accurate responding, sometimes referred to as automaticity or fluency. There are numerous reasons why speed of accurate responding is important. First, students who can respond more rapidly typically require less effort to respond. These students may be more likely to engage in academic behaviors because they require less effort. Students who can respond more rapidly also typically require fewer cognitive resources to respond (Allington, 2009; LaBerge & Samuels, 1974; Stanovich, 1986). Thus, these students have more available cognitive resources (e.g., attention, working memory) to apply to other

activities. For example, those who can read rapidly and respond accurately may be more accurate across academic activities that require reading for comprehension (e.g., history assignments) (LaBerge & Samuels, 1974; Perfetti, 1985; Sweller, 1988; Sweller & Chandler, 1994).

Rewards delivered in school typically require students to complete assignments. Those who respond rapidly and accurately can also complete more assignments within a set time. Thus, these students are more likely to choose to engage in academic activities because they are more likely to access the reward for engaged behavior.

Independent Seatwork

Speed of accurate responding is a skill that is developed in the classroom by using drill and practice techniques (Haring & Eaton, 1978). For these activities to enhance fluency, students must first be responding accurately. Fluency building activities are more effective when students engage in high rates of active, accurate, academic responding (AAA responding) (Berliner, 1984). To occasion such responding, educators often assign independent seatwork (Skinner, 2002).

Independent seatwork is thought to be one of the more common learning strategies used in the classroom, and is used so that students have opportunities to practice or test their skills (Fickley, 2004). Independent seatwork typically refers to the time during the school day when the teacher has provided the student with material to be completed for the purpose of enhancing their skill development, and the student is meant to complete the material without assistance from their peers.

The material presented to the student for independent seatwork will not be useful unless the student has acquired the ability to respond accurately. Thus, independent

seatwork is designed to enhance learning (e.g., increase fluency), not to teach new skills (Choate, 2000; Wallace et al., 2003). Typically, students are permitted to ask questions during independent seatwork. Teachers need to respond to these questions to prevent students from practicing incorrect responding. However, teachers should not complete the assignment for the students, as their practice is necessary to enhance skill development (Skinner & McCleary, 2010).

There are methods that can be used during independent seatwork time that will increase the probability of the work enhancing students' skills. Independent seatwork time in the classroom can be improved through actions such as placing emphasis on goal setting and monitoring progress, limiting the amount of continuous time that students are engaged in independent seatwork, and clarifying behavioral expectations for the students during independent seatwork (Rock & Thead, 2009).

The goals students are trying to accomplish should be specifically stated, measurable, and reasonable for the student to complete while still showing progress (Rock, 2004). When these procedures are applied, students can see the progress that they are making over time. These procedures can also protect students from becoming discouraged if the gains they are making are minimal. Assigning independent seatwork in shorter frames of time is suggested because it increases the likelihood that students will complete the assignment while decreasing the potential for the student to become frustrated with the assignment (Sweeney & LeBlanc, 1996).

Independent seatwork can occasion more skill development when students are responding accurately and at high rates. Independent seatwork that requires observable responding (e.g. permanent product assignments) allows for teachers to evaluate response

accuracy and determine whether additional instruction or supports are needed for students (Skinner & McCleary, 2010). Several procedures have been designed to enhance rates of AAA responding after a high level of accuracy has been reached. One of these strategies is to provide less immediate feedback to the student, as a high level of accuracy is already assumed and time spent on accuracy evaluation is lost time could otherwise be used for fluency building, maintenance, and generalization of the skill (Coding et al., 2007). Another strategy for increasing rates is altering the response topography or modality to be more efficient, such as allowing for students to respond to a prompt verbally rather than through a written response (Skinner, Belfiore et al., 1997). The pace at which prompts are delivered to a student can also be increased to lead to more AAA responding by reducing the interval between time trials and/or the time to respond following the presentation of the stimulus (Rhymer et al., 2000; Skinner, Ford, et al., 1991).

AAA responding during independent seatwork does more than enhance fluency. Such responding can also enhance maintenance of accurate and more rapid responding (Albers & Greer, 1991; Skinner, Belfiore, et al., 1997). Additionally, AAA responding may enhance a students' ability to discriminate and generalize their responding, which involves responding accurately when the academic stimuli vary (Ivarie, 1986). Independent seatwork typically includes a variety of academic tasks. Thus, when students engage in high rates of AAA responding they learn to discriminate when a response, strategy, or concept is appropriate, and when it is appropriate to provide an alternative response, strategy, or concept (Skinner, Fletcher et al., 1996).

Choice and Independent Seat Work: The Matching Law

Researchers have identified various procedures and strategies designed to enhance

students' rates of AAA responding during independent seatwork. However, even when such procedures are applied and students can complete assignments accurately, no learning (e.g., fluency building, maintenance, discrimination/generalization) will occur unless students choose to work on assigned independent seatwork. A science of choice has been developed to predict human behavior, and this science can be applied to the classroom setting to inform educators on how to influence their students to choose to engage in independent seatwork (Skinner, 2002).

Herrnstein (1961) developed and empirically validated the Matching Law, which provides a behavioral model of choice. According to the Matching Law, individuals are continuously given opportunities for choice. When competing behaviors (i.e., options that can be chosen) require equivalent effort, the relative proportion of the choices that the individual makes can be determined by the proportional reward that the choice provides to the individual (Herrnstein, 1961). Students' behaviors can be reinforced through teacher and/or peer attention, access to tangible rewards, or escaping from an undesired task (Berkowitz & Martens, 2001). If the goal in the classroom is to increase the probability of the student choosing to engage in academic behaviors, then these academic behaviors should provide higher rates of reinforcement, more immediate reinforcement, and/or higher quality reinforcement than that given for the competing behaviors (Myerson & Hale, 1984).

Rate of Reinforcement

When students are given a choice between multiple discrete behaviors that offer the same or similar levels of reinforcement for their work, they will choose the behavior that has a richer schedule of reinforcement (Mace, McCurdy et al., 1990). Mace,

McCurdy et al. (1990) presented a 16-year old subject with preferred reinforcers on varying schedules for completing either multiplication problems or an alternative task, completing division problems. During an initial baseline phase, where no reinforcement was given to either task, the subject generally responded with even rates of completed problems for both multiplication and division problems. Based on the even rate of responding between the tasks, it is suggested there was no clear preference between the two tasks. When social praise was added on a variable-ratio 2 (VR-2) schedule, completion rates for both tasks increased slightly, but still without a clear preference. Food was added in as the reinforcer to replace social praise for the next two phases, with the food provided for each task being reversed between the tasks to control for possible subject preference. Problem completion rate increased again as food appeared to be a higher quality reinforcer for the subject than social praise, and once again no clear preference for either multiplication or division problems emerged during this phase.

With no clear preference emerging for the student for either the multiplication task or the division task, and with no clear preference emerging between either of the foods offered as reinforcers, the final two phases altered the schedule of reinforcement offered to the student. In the second to last phase, multiplication problems were reinforced on a fixed ratio - 1 schedule (FR-1) while division problems were kept on the same VR-2 schedule that was presented before. The continuous reinforcement schedule led to the highest amount of responding that the subject engaged in for the experiment up until that point, and this was the first phase that showed a clear preference between the tasks offered for the subject. The last phase reversed the schedules offered so that division problems were on a FR-1 schedule while multiplication problems were on a VR-

2 schedule, and the student in this phase showed similar rates of work completion but with a clear preference for division problems now. The food assigned to each task was held constant for the last 2 phases and the student had not shown any preference between tasks before this phase. The student's choice of what task to complete appeared to be most influenced by the schedule of reinforcement that these tasks offered rather than the quality of reinforcement offered.

Teacher attention can be a high-quality reinforcer that is capable of being manipulated in the classroom (Berkowitz & Martens, 2001). Martens, Lochner, and Kelly (1992) delivered verbal praise to two students in a fourth-grade classroom who were identified by their teacher as being off-task during a majority of their independent seatwork and displaying inappropriate behavior. Verbal praise for this study was contingent upon the student being on-task during the interval, and was defined as walking up to the subject, bending down to their level, and commenting on their behavior in a soft voice. Student engagement was measured using 10-s whole interval recording. If the student was not engaged in their independent seatwork, the verbal praise could be delayed to the next interval. Variable-interval (VI) schedules were used to provide verbal praise on schedules with mean intervals of 5, 4, 3, and 2 minutes with a 20-s minimum interval time between reinforcers.

For participant one, their baseline level of engagement was highly variable with a range of 8% to 90% of intervals (M = 45%). Subject one showed increased mean levels of engagement as the schedule of reinforcement grew richer (VI 5-min M = 33.7%, VI 4-min M = 65.2%, VI 3-min M = 86.5%, VI 2-min M = 93.7%). Subject 2 had engagement levels during baseline that ranged from 8% to 47% of all intervals (M = 28.7%). Their

engagement decreased on the VI 5-min schedule (*M* = 17.5%) but increased to a higher level on the VI-4 min schedule (*M* = 58.5%). Subject 2 did not see an expected gain in their engagement level for a VI 3-min schedule (*M* = 55%) but did increase on the richest schedule of reinforcement of VI 2-min (*M* = 79.5%). Wilkinson's method was used to match the subjects' data to Herrnstein's equation for the single-alternative matching law, and it accounted for 99.1% of the variance in academic engagement for subject one and 87.6% of the variance for subject two.

Schedules of reinforcement are capable of being manipulated by teachers to encourage academic behaviors within the classroom (Martens, Lochner et al., 1992). Relative rates of reinforcement can also explain teachers who accidentally maintain disruptive behaviors in the classroom by providing more attention to the disruptive behaviors than they do to academic engagement (Martens & Houk, 1989). The solution is for the teacher to make the academic behavior more probable by increasing the rate of reinforcement for the academic behavior and/or by decreasing the rate of reinforcement for competing behaviors such as out of seat behavior or calling out in class (Myerson & Hale, 1984).

Quality of Reinforcement

The relative quality that a reinforcer has can be judged by its magnitude, which is increased by manipulating the intensity of the reinforcement, the total number of the reinforcement provided, or the duration that the reinforcement will last for (Hoch, et al., 2002). If the rate of reinforcement and immediacy of reinforcement offered by alternative behaviors are held equal, respondents will choose the behavior that results in the higher quality reinforcement (Hollard & Davison, 1971). Neef et al. (1992) found that students

receiving special education services would respond to tasks in accordance to the proportion of reinforcement that they received from these tasks if they received the same reinforcer from all alternatives. However, their behaviors would change when one of the reinforcers was of higher quality to the students. Initially, both students in this study responded to arithmetic problems in accordance to the Matching Law by allocating resources towards alternative assignments based on the relative rate of reinforcement that the assignment offered (Neef et al., 1992). However, their response rates exceeded what the Matching Law would predict when a higher quality reinforcer was offered, showing a bias among the participants towards a higher quality reinforcer that had overridden reinforcer rate.

While both students responded similarly (i.e., higher quality reinforcers biased students to the behavior associated with that reinforcer), relative quality was idiosyncratic. For one student reinforcer X was higher quality than Y, but for the other student this was reversed. Thus, another way that reinforcer quality can be manipulated is by tailoring the reinforcers made available to the student's preferences (Hoch et al., 2002).

Immediacy of Reinforcement

Early research on the significance of the immediacy of reinforcement was conducted with nonhuman subjects. Researchers found that these subjects tended to favor immediate reinforcers even when there was an option for more powerful reinforcers available to them on a greater delay (Green & Snyderman, 1980). This is sometimes referred to as impulsive decision making, or placing a greater value on being rewarded quickly than on receiving the highest relative quality of reward. Impulsivity might not be

the guiding factor for human decision making, however, as a later study found that their human subjects tended to choose the reinforcer that would hold maximum value to them even when it was delivered later than an alternative option (Logue, Pena-Correal et al., 1986). This behavior of withholding immediate reinforcement to receive greater rewards at a later time is sometimes referred to as self-control.

Although humans as a whole may have higher levels of self-control than nonhuman subjects, there are still sub-populations of humans who may display relatively lower levels of self-control compared to other humans. Of note, young children and individuals with learning and behavioral disorders may prefer immediate reinforcement rather than greater rewards (e.g., higher relative quality) that are delayed (Horner & Day, 1991). If it were true that children tend to place greater value on immediate reinforcement than the general population, than the immediacy of reinforcement in educational settings for these students would be an important factor to consider when offering alternative forms of reinforcement.

Neef, Mace, and Shade (1993) conducted a study where 2 subjects aged 19 and 13 were incentivized with nickels to complete mathematics problems from one of 2 stacks of cards containing identical problems relative to the student. For the 19-year-old subject, the stacks were reinforced on a VI 60-s schedule for one stack and VI-120-s schedule for the other. Here, the subject allocated their responses to these alternatives in a proportion that corresponded to what the matching law would predict, with 66.6% of time allocated to the VI 60-s schedule and 73% of reinforcement obtained from the VI 60-s schedule. The VI 60-s schedule was then changed to be a delayed reinforcement, where nickels earned would be provided at the end of a 3-week period that was constant across sessions

(i.e., session one was 21 days away from the delayed reinforcement being delivered, session 2 was 20 days away from the delayed reinforcement being delivered). On this delayed reinforcement schedule, the subject allocated 32.8% of their time to the VI 60-s schedule and received 47.2% of their reinforcement from the 60-s schedule compared to the 120-s schedule that was still delivering reinforcement immediately. When they returned to a condition where both schedules were delivering reinforcement immediately again, the subject showed behaviors similar to baseline with 66.2% of time being allocated to the VI 60-s schedule and 61.6% of reinforcement being received from the VI 60-s schedule. This subject showed similar behavior as the prior delay condition when a delay was introduced to the 60-s schedule once again, this time a one-week delay, with a decrease to 39.9% of time spent on the VI 60-s schedule.

The 13-year-old subject was provided with a timer to clarify reinforcement schedules during pre-baseline training, which made her behavior more closely resemble what would be predicted by the matching law with 63.5% of time being allocated to the richer schedule. This subject had a larger gap between her VI schedules of reinforcement for cards, with one stack being reinforced on a VI 30-s schedule (the richer schedule) and the other stack being reinforced on a VI 120-s schedule. The delay for the VI 30-s schedule was one week for this subject, and the introduction of this phase showed a decrease in time spent on the VI 30-s schedule (45.2% of time allocated). When the delay was removed in the subsequent phase and both conditions offered immediate reinforcement on their schedules, this subject's choice behavior resembled what they displayed during the baseline phase.

One pattern that the 13-year-old subject showed when a one-week delay was

implemented again for the VI 30-s schedule was conditional responding, where the subject would allocate time to the schedule depending upon how close the schedule was to delivering the reward. On a session that immediately preceded the delivery of nickels on the delayed 30-s schedule, the authors noted that the subject responded exclusively to the VI 30-s schedule. On the session following these when the delay was again one full week, the subject would respond nearly exclusively to the 120-s schedule. The results of this study suggest that both students prioritized the immediacy of their reinforcement over obtaining the maximum quantity of reinforcement that could have been obtained with less impulsivity.

The immediacy of reinforcement is not only applicable to populations that are prone to impulsivity. Individuals that do display higher levels of self-control will prefer a more immediate reinforcement if the reinforcement offered with a greater delay is not of high enough value to justify the delay, and the likelihood of an individual engaging in an impulsive behavior can differ based upon the context of the situation (Tsukayama, et al., 2013). The behaviors in the classroom that teachers want students to display should be reinforced more immediately than the competing (and possibly incompatible) behaviors so that students are more likely to engage in the desired behaviors.

Effort

Every response in a classroom requires some degree of effort, and when students are given a choice between multiple behaviors, one variable that is expected to influence the choice is the amount of perceived effort that the behavior requires of the student. A study conducted by Alling and Poling (1995) found that both increasing the amount of force required for reinforcement and increasing the number of responses required for

reinforcement had similar effects in decreasing response rates. When the required effort of a task is too high for an individual, it is expected that they will engage in escape behavior to avoid the task (Miller, 1968).

When competing assignments are equivalent except for the amount of effort required to complete them, students should be expected to prefer or choose the assignment that requires less effort to complete (Cooke et al., 1993; Chung, 1965; Horner & Day, 1991). Generalizing this to competing behaviors for students in a classroom, a teacher can make their students more likely to choose to engage in academic work if the amount of effort required to complete the academic work is lessened. Lessening the effort for an assignment may also be a useful strategy for students who do not have the learning history of finishing assignments, as finishing an assignment may not be viewed as a reinforcer to these students due to the scarcity of assignments that they have completed previously (Skinner, 2002; Wallace et al., 2003).

The perceived effort required to complete an assignment can be lessened by reducing the number of problems on the assignment (Billington, Skinner et al., 2004; Cates & Skinner, 2000; Skinner, Pappas et al., 2005) or by altering the assignment to make responding require less effort and/or making assignments easier (Cooke et al., 1993). While making assignments briefer (e.g., reducing assignment from 12 problems to 6 similar problems) or making it easier (e.g., replacing 3-digit by 2- digit multiplication problems with 1 digit by 1-digit problems) may enhance the probability that student choose to engage in independent seatwork, this also amounts to watering down the curricula (Cates & Skinner, 2000). Independent seatwork is assigned to enhance students' skill development, and while watering down assignments may cause students to complete

assignments, it may also hinder students' skill development (Skinner, 2002). Procedures that enhance the probability that students will engage (i.e., choose to apply effort) with their independent seatwork while also maintaining the integrity (i.e., difficulty, amount of effort required) of those assignments are needed.

Interspersal Procedure

Skinner (2002) and colleagues developed a procedure that involved increasing effort required to complete an assignment, which also increased the probability that students would choose that assignment over a control assignment that required less effort. The procedure involved interspersing problems into an assignment that can be easily completed by the student, and doing so without removing any of the more difficult items that were going to be presented. Although this method increases the total assignment length, it can lead to an assignment that is preferred by the student.

Skinner, Robinson et al. (1996) conducted the first study of the interspersal procedure. Experiment 1 of this study was given to undergraduate college students that were given 2 separate mathematics assignments to complete. One of these assignments contained exclusively sixteen different 3 x 2 digit multiplication problems, while the other assignment also contained sixteen 3 x 2 digit multiplication problems but also interspersed six 1 x 1 digit multiplication problems into the assignment (making it 22 problems total). All mathematical problems used digits that were higher than 3 for each problem to ensure that students would have to carry for each step of the equation, and assignments were equated to each other by altering the sequence of numbers within the problem (i.e. 476 x 86 on one assignment could be 764 x 68 on the other.) The 1 x 1 digit problems were interspersed on the 22-problem assignment such that a 1 x 1 digit problem

was always followed by three 3 x 2 digit problems.

Every student was given a packet that asked for demographic information on the first page, the 16-problem and 22-problem assignments on pages 2 and 3 (with the ordering of these assignments being counterbalanced), and a last page where students reported their assignment choice and relative perception of the assignments. Students were given 305 seconds to complete each assignment and were instructed to not skip any problems while working and to not work on the other assignment if they completed their work early. When the allotted time ended for students to work on the second assignment in their packet, students were asked to rate the assignments relative to each other for effort, time to complete, and difficulty of the assignment. Students were then told that they would have to complete a third assignment that was going to be identical in presentation to either the 16-problem or 22-problem assignment with the exception that the numbers in the equations would be different, and were asked to identify which of the assignments they chose to complete.

Students completed significantly more total problems on the 22-problem assignment (M = 13.53) than they did on the 16 problem assignment (M = 9.94) with an identical average of 3 x 2 digit problems completed (M = 9.94) and an insignificant difference for 3 x 2 digit problem accuracy (72% vs. 71%). Approximately 65% of the undergraduate students rated the assignment with interspersed 1 x 1 digit multiplication problems as requiring less time to complete, 69% rated the assignment as requiring less effort to complete, and 65% rated the assignment as being less difficult to complete than the assignment without interspersed problems. Seventy-one percent of the students who completed both assignments chose the assignment with interspersed 1 x 1 digit

multiplication problems as their preferred assignment format to be completed in the future.

Experiment 2 was conducted to replicate this study while controlling for novelty effects, with a 3rd assignment being added in where 3 x 2 digit division problems were interspersed into the assignment instead of the 1 x 1 digit multiplication problems. Significantly more students still preferred the assignment with 1 x 1 digit multiplication problems interspersed compared to the alternatives, with the interspersed assignment still having significantly more total problems completed and no significant difference for total 3 x 2 digit problems completed. Of the 3 assignments given to the students for experiment 2, 77% viewed the assignment with interspersed 1 x 1 digit multiplication problems as the assignment that required the least time to finish, 70% viewed the assignment as requiring the least effort to finish, and 80% viewed the assignment as the least difficult to finish. Students were once again significantly more likely to choose to complete the assignment with interspersed 1 x 1 digit multiplication problems as their preferred assignment format to be completed in the future.

A 3rd experiment was then conducted where all interspersed problems (i.e. 1 x 1 digit multiplication problems on one assignment and 3 x 2 digit division problems on another) were removed so that each assignment contained only the 16 counterbalanced 3 x 2 digit multiplication problems that they had before. Accuracy levels and completion rates across assignments were found to have no significant differences.

Cates and Skinner (2000) designed an experiment to test whether interspersing low effort problems (i.e., 1 x 1 digit multiplication problems) into an assignment would have positive effects even if they were accompanied by more high effort problems (i.e.,

more 3 x 2 digit multiplication problems). High School students in a remedial mathematics class were given a packet containing 6 assignments within them. Three of these assignments were functionally the same, serving as control assignments with fifteen 3 x 2 digit multiplication problems to be completed. On the back of each control assignment was an experimental assignment, with experimental assignments containing 0%, 20%, and 40% more 3 x 2 digit problems than the control and an additional 1 x 1 digit multiplication problem interspersed after every third problem. Numbers present within mathematical problems, the ordering of assignments within pairs, and the presentation order of assignment pairings was counterbalanced.

After completing every sheet of paper containing one control assignment and one experimental assignment, students were prompted to record their responses to questions asking them to compare those assignments based upon the relative amount of time it took to complete the assignment, the relative amount of effort required to complete the assignment, the relative difficulty of each assignment, and for which of the assignments the student would choose to complete for homework.

The doubly multivariate repeated measures ANOVA for this experiment found no statistically different group (control or experimental) by level (0%, 20%, or 40% more problems) for total number of problems completed number of 3 x 2 digit problems completed, or percentage of 3 x 2 digit problems completed correctly. There was a statistically significant main effect for group (control vs. experimental). Specifically, students completed significantly more total problems on experimental assignments, although there was no statistical significance for total number of 3 x 2 digit problems completed or for the accuracy of completed 3 x 2 digit problems. For student preference

data, students were significantly more likely to view the experimental assignment as requiring less time to finish, as less difficult, as requiring the least effort, and as the homework choice they were more likely to choose to complete across levels (0%, 20%, and 40% more problems).

Billington, Skinner and Cruchon (2004) conducted another interspersal study that had students work from 2 pairs of mathematics assignments: assignment pair A and assignment pair B. Both assignment pair A and B contained a moderate effort and a high-effort assignment within them. The moderate effort assignment was constant for both pairs, with moderate problems differing from high-effort problems by not requiring students to carry while performing 3 x 2 digit multiplication problems. Where assignment pair A and assignment pair B differed was for the high effort assignment. The high effort assignment for both assignment pair A and B included eighteen 3 x 2 digit multiplication problems that required students to carry during calculation, but assignment B added in an additional six 1 x 1 digit multiplication problems to the assignment, with a 1 x 1 problem appearing after every three 3 x 2 problems. Thus, assignment B's high-effort assignment presented students with 24 total problems and assignment A presented students with 18 total problems.

An ANOVA revealed that there was no significant difference for percentage of problems solved correctly for assignment pair A or assignment pair B, but that students completed significant more problems in assignment pair B (X=6.75) than in assignment pair A (X=3.77). The difference for high-effort 3 x 2 digit problems on assignment B (X=4.57) was higher than the completion rate of high-effort 3 x 2 digit problems on assignment A (X=3.77), although Tukey's post hoc analysis showed no significant

difference between these 2 means.

When students were asked for their homework preference and perceptions of the assignments, significantly more students given assignment pair A chose the moderate-effort assignment for homework and rated the high-effort assignment as more difficult to complete, requiring more effort to complete, and requiring more time to complete. For assignment pair B, there was no statistical difference between the high-effort and moderate-effort conditions for any of those categories. For interaction effects, students given assignment B were statistically more likely to select the high-effort assignment for homework, perceiving it as less difficult to complete, requiring less effort to complete, and requiring less time to complete compared to the moderate effort assignment. For students that had assignment pair A, it appears that the students were most likely to engage in the assignment that required less effort to complete, although this could also be due to the discrete task hypothesis discussed below as students completed more problems in the moderate-effort assignment from assignment pair A. For assignment pair B, the discrete task hypothesis is the best explanation for why students perceived the high-effort assignment as requiring less effort and time to complete, as the students were significantly more likely to choose the high-effort assignment when the only difference was that 6 additional low-effort problems were included.

Across these 3 studies, the interspersal procedure did not decrease the amount of high-effort or targeted responses that a student could give if the problems were added onto an assignment rather than substituted into. However, the subjects across the 3 studies showed more favorable opinions towards assignments when lower effort problems were interspersed into the assignment, to the extent that they would view the

assignment as more favorable than a control even if it also contained more high-effort problems as well (Cates & Skinner, 2000).

Discrete Task Hypothesis

Although these interspersal studies appear to be counter to previous effort research, Skinner (2002) provided a hypothesis and meta-analytic data to support the findings as they relate to the rates of conditioned reinforcement obtained through interspersal assignments. Specifically, Skinner posited that when given an assignment comprised of multiple discrete tasks, each completed discrete task is a reinforcer. More specifically, Skinner posited that each discrete task is a conditioner reinforcer and that this conditioning is dependent upon a student's learning history.

Most students have a learning history of being given assignments. For these assignments, there are consequences associated with the student's performance (Skinner, 2002). Students who complete assignments with a high degree of accuracy may access various rewards including praise, gold stars, and being able to engage in a preferred activity (e.g., computer time). As this learning history is common, a completed assignment is a stimulus that can become a conditioned reinforcer because the completed assignment always occurs before receiving a reward (such as praise, a gold star, or access to computers) (Pavlov, 1927; Massetti & Fabiano, 2005).

Again applying classical conditioning, Skinner (2002) then posited how this learning history would cause each completed discrete task to become a conditioned reinforcer through higher order conditioning. If a completed assignment is a reinforcing stimulus that students that have learned through their academic history, then stimuli that reliably precede a completed assignment should also become conditioned reinforcers.

Thus, if a completed 10-problem assignment is a reinforcing stimulus, a completed ninth problem should also be a reinforcer. The reinforcer of completing the assignment as a whole is assumed to be a distinct and superior reinforcer to the assumed reinforcer of completing individual problems (Skinner, 2002).

Skinner's (2002) meta-analysis supported the discrete task completion hypothesis as a possible explanation for the interspersal research results that were discussed previously. Taking data across studies, Skinner showed that more students were likely to choose one assignment over another as the relative problem completion rates increased across assignment options. Thus, if a discrete completed problem was a reinforcer, students were more likely to choose the assignment that results in the higher rates of reinforcement. The findings from interspersal studies were consistent with basic and applied matching law studies that focused on relative rates of reinforcement (Herrnstein, 1961; Martens and Houk, 1989)

Brief Sheets

Based on the Discrete Task Completion Hypothesis, a discrete completed task may only be reinforcing when students have a previous history of being reinforced for completing assignments. Wallace et al. (2003) worked with a student diagnosed with an Intellectual Disability who may not have had a history of ever completing a math assignment. Consequently, for this student a complete discrete task may not have been a reinforcer through his learned academic history. To address this, the researcher purposefully applied a strategy that would provide the student with an opportunity to complete assignments and be reinforced for assignment completion.

Brief Sheets is an intervention that is designed to increase the amount of problems

completed by students during independent seatwork. The intervention modifies a single assignment by splitting it up into smaller sections (e.g. 5 assignments containing 6 problems rather than 1 assignment containing 30). An underlying assumption of Brief Sheets is that completing a problem on a worksheet is a reinforcing event for the student as it signals that they are closer to completing the assignment, with the completed assignment being a separate and higher quality reinforcer. Breaking down the assignment into smaller segments increases the rate of reinforcement per answer on the assignment, and gives the student more opportunities to complete smaller assignments within the total assignment. The effort required to complete the first 6-problem assignment is less than what is required to complete a 30-problem assignment, and this decreases the chance that the student will choose to not complete any of the problems presented on the worksheet(s) while increasing the probability that the student will return to complete the worksheet at a later time if it is not completed in one trial. Brief Sheets is a particularly useful intervention for students who do not have a learning history that causes completing academic assignments to be a reinforcing event.

This dissertation is intended to extend the research of a study by Wallace et al., (2003), the only study this author is aware of to examine the effects of the Brief Sheets intervention. Wallace et al. worked with a 10-year-old Caucasian male with a mild intellectual disability. He was given a modified version of his mathematics worksheet that had 30 problems on it. The student was instead given separate brief assignments containing the same problems on them, but the assignment was split into multiple assignments with 5 or 6 problems presented per assignment. The student was instructed to raise his hand or bring the completed sheet to his teacher when an assignment was

completed, and then would receive verbal praise from the teacher as well as a high-five for every assignment completed during the session (e.g., 3 high-fives after the third assignment had been completed). This continued until the student had either completed every worksheet, or until 20 minutes had elapsed.

An A-B-A-B withdrawal design was used where baseline phases were typical classroom procedures, with the exception that the student was not given any of his other assignments until he had completed his math worksheet (typically, the student was given all his worksheets at the same time). The primary dependent variable measured in this study was the number of problems completed by the student, with the following also being measured: number of problems completed accurately, number of teacher-student interactions (any verbal or nonverbal contact between student and teacher), number of teacher approvals (any positive comment or gesture given by the teacher to the student), and number of teacher disapprovals (any direction from the teacher for the student to change their behavior). The total number of problems completed and total number of problems completed accurately were both measured using permanent products, and the remaining measures were assessed using direct observation data. Approvals and disapprovals ended when the teacher and student stopped interacting for at least 5 seconds, or when the teacher stopped giving an approval and gave a disapproval (or vice-versa).

The results of this study suggest that the Brief Sheets intervention increased the number of total problems completed by the student, as well as his rate of problems completed per minute. There was a minimal difference for the percentage of completed problems that were accurately answered across phases, suggesting that the increased total

number of problems completed had little effect on the student's accuracy. During intervention phases, the total number of teacher disapprovals was lower than it was during baseline and the total number of teacher approvals was higher. The findings on teacher-student interactions were variable across the first 3 phases, but the 2nd intervention phase saw the highest number of student-teacher interactions recorded in the study with an increasing trend, suggesting that Brief Sheets might also be associated with increased interactions between student and teacher. It should also be noted that in this study the student was given social reinforcement paired with Brief Sheets, and that when the student sought social reinforcement after completing a slip of paper the student was also given access to a short break from their work.

Both teachers in the classroom are reported to have found the intervention easy to implement. Anecdotal evidence from the intervention during the second baseline phase shows that the student asked for their assignment to be broken into smaller assignments once again, and then sought reinforcement for completing a row of problems on the worksheet when there were still uncompleted problems remaining. A conclusion cannot be made from this study whether the changes in behavior found between phases can be attributed to increased opportunities for academic reinforcers, additional social reinforcement from the teacher for completing an assignment, or a combination of both of these factors, but the overall results of the Brief Sheet intervention appeared to be beneficial in the classroom.

Purpose of Study

The purpose of this study is to investigate the practice of Brief Sheets in the classroom during independent seatwork time. Specifically, this study is designed to

answer whether Brief Sheets will lead to increased academic output from students in a general education classroom, if the Brief Sheets intervention will affect problem completion accuracy rates, whether the students prefer the Brief Sheets intervention compared to a control mathematics worksheet, and if students will choose a Brief Sheets assignment over a control assignment that contains more total problems.

The term brief sheet here is an intervention that is designed to make independent seatwork more rewarding for students. Rather than giving the student a full-page assignment to complete independently, Brief Sheets breaks the assignment up into smaller assignments that contain the same total number of problems. This gives students the chance to complete assignments at a higher rate. If assignment completion is a conditioned reinforcer, this procedure should enhance rates of problem completion and be associated with positive social validity ratings in comparison to typical classroom procedures.

Chapter Three

Methodology

Design and Rationale

A between-subjects design was chosen to answer our research question, with participants completing one of two conditions while also completing a control assignment. The primary advantage of this research design was that it allowed us to gather our data using one day of data collection, and that our data was not susceptible to practice or carryover effects. The primary disadvantage of a between-subjects design is that the study will have less experimental power with the subject pool made available to it because I needed to split our participant pool into distinct groups. The order of assignments within the packets were counterbalanced so that participants did not have the opportunity to complete one assignment condition which would always precede a separate assignment condition.

Data Collection, Participants and Setting

Data were collected for this study in a fourth-grade mathematics classroom at a public elementary school in a rural setting in the southeastern United States. Four different mathematics classes took place in this room throughout the school day, and there was no clear distinction being made between the classes based on student ability level or behavioral concerns. A parental consent form that was approved by the Institutional Review Board at the University of Tennessee was sent out to students in fourth mathematics classes within the classroom. The teacher for each of these classes provided a letter of support for the study to be administered in her classroom, and the school principal provided a letter of support for the research as well. A total of 40

students returning signed parental consent forms to participate in the study. Students who returned a parental consent form were given a written assent form to complete on the day of data collection. All students with a signed parental consent and assent form were eligible to participate in the study with no exclusionary criteria being held to students enrolled in fourth-grade mathematics. Of the 40 students who returned signed consent forms, 39 students signed assent as well. Students without signed parental consent forms or students who refused to sign assent forms still participated in the same procedures as their peers but did not have their data collected. The Brief Sheets intervention was administered in the classroom with data being collected for one day near the end of the school year.

Materials

During data collection, students were given 2 of 3 possible assignments in a packet, referred to as assignments K, L, and L (Brief Sheets). These assignments are contained in Appendices A through C at the end of this document. Each of these assignments contained 2 x 2 digit multiplication problems that only contained digits higher than 3, ensuring that students had to carry for each step of the multiplication process. The choice to use 2 x 2 digit multiplication problems and a 5-minute time limit per assignment was based on teacher reports about student ability as well as by a review of the literature. These problems were expected for the students to be able to complete accurately while also not being simple enough for the students to complete all problems within the allotted time. Difficulty of problems on the assignments was equated by altering the sequence of the numbers in the problem. For example, problem #1 on assignment K could be 67 X 45 and problem #1 on assignment L could be 76 x 54. Each

assignment K and L were presented on one sheet of paper with 3 questions presented per row. These assignments differed in the total amount of problems presented to the student, with assignment K containing 10 total problems and only displaying one problem in the fourth row of the sheet, while assignment L contained 12 total problems with 3 problems presented on all 4 rows. Assignment L (Brief Sheets) contained 12 total problems as well, but was presented on 4 different slips of paper with each slip containing 3 problems on it. At the end of each assignment packet was an additional sheet included for social validity that asked students which of the 2 assignments presented to them would be preferred if it were assigned as homework, as well as questions about the time required to complete, the effort required to complete, and the difficulty level of each of the presented assignments of that day compared relatively to each other. All options on this sheet required a forced-choice response between the 2 assignments presented in the packet. Students were told before filling out this sheet that the mathematical problems presented in the future would be novel and not identical to those already completed, and were informed that they would be expected to fully complete the assignment assigned to them in the future. The sheet used to measure social validity can be viewed in Appendix D. Procedural integrity data were gathered for the data collection in all four classes by a teacher of the classroom. The procedural integrity checklist used for this study can be seen in Appendix E at the end of this document.

Experimental Procedures

Students were given a packet on the day of data collection, with each packet containing assignment K and either assignment L or assignment L (Brief Sheets). The presentation of assignments within the packets were counterbalanced so that assignment

K did not always precede assignment L/L (Brief Sheets) and was also counterbalanced so that students had an equal chance of completing either assignment L or assignment L (Brief Sheets). On the data collection day, students were read the following instructions:

"Hello, my name is [experimenter] and I am in your classroom today to learn about how different types of assignments can influence students' work. In front of you now is a packet full of mathematical problems that I would like for you to write your name on at the top of the page. When I ask you to begin, you will have 5 minutes to work on these problems to try to complete as many of them as you can. For some of you, this assignment will be made up of smaller slips of paper that are stapled together. During these 5 minutes we are asking for you to try to complete the math problems that are on all of these slips of paper. If you finish all of the problems before time is up, you can spend the remaining time double-checking your work or sitting quietly while your wait for your classmates to finish. Please do not move on to a later part of the packet until you are instructed to do so. You may begin working now, and I will let you know when your 5 minutes are up."

At the end of 5 minutes, students were read the following instructions detailing how they should proceed to their next assignment:

"Please stop your work, your 5 minutes are officially over. It is fine if you were not able to complete all of those problems, but I am going to ask you to not work on those problems any longer. Now I would like for you to turn in your packet to the next page of mathematical problems that you have. When I say to begin, you will once again have 5 minutes to complete as many of these problems as you can. Again, for some of you, this assignment will be made up of smaller slips of paper that are stapled together. During

these 5 minutes I am asking for you to try to complete the math problems that are on all of these slips of paper. If you finish all of the problems before time is up, you can spend the remaining time double-checking your work or sitting quietly while your wait for your classmates to finish. Please do not move on to an earlier or later part of the packet until you are instructed to do so. You may begin working now, and I will let you know when your 5 minutes are up."

When the allotted time for the second assignment was finished, students were read the following instructions.

"Please stop your work, your 5 minutes are officially over. It is fine if you were not able to complete all of those problems, but I am going to ask you to not work on those problems any longer. Thank you for your hard work so far, the last thing I am going to ask you to do for me today is to turn to the last page of your packet and to answer a few short questions about which of these assignments you preferred. You may turn back in your packets to review the name of the assignments, but please do not continue working on the assignments if they were not completed previously. The first question I am asking you to answer asks which of these assignments you would rather have assigned to you for homework, and we would like to clarify that you are not going to be given a homework assignment for either of these sheets. The question is only designed to find out if you were presented with new math problems you had not completed before, would you prefer to complete work on a worksheet that looked like assignment K or assignment L. When you are finished with answering these questions, you may raise your hand and we will come to your desk to collect the packet."

The experimenter reported that when he finished reading these instructions, he needed to clarify to the students within the classroom that the assignment names could be found at the top of the assignments. Students filled out a sheet at the end of the packet asking them questions of preference related to time required to complete, effort, difficulty, and willingness to complete for homework. Packets were collected once students indicated that they were finished filling out these preferences.

Planned Data Analysis

To answer our research questions relating to students' mathematical performance on Assignment L (Brief Sheets) in comparison to students' mathematical performance on Assignment L, independent samples t-tests were computed to determine whether there were statistically significant differences between the assignments with a threshold of significance being set at $p = .05$. For the t-tests Levene's Test for Equality of Variances was used to determine whether equal variances between groups could be assumed or not, with a threshold of .05 being used to determine whether variances were significantly different. Factors that were analyzed included total number of problems completed, the total number of problems completed correctly, the total number of digits correct in the final product, and the total number of digits incorrect in the final product. Descriptive data were gathered for assignment K as well, acting as the control assignment that all students completed during data collection.

To measure student perceptions of the assignments they completed, chi-squared analysis was used to test for significant differences for responses on the student preference sheet. A chi-squared analysis was done for all interactions between assignment L and assignment L (Brief Sheets) would differ when they were rated in

comparison to assignment K, with a threshold for significance being set at p =.05. These assignments were compared on variables of which assignment would be preferable to complete as homework, which assignment would require more time to complete, which assignment would require more effort to complete, and which assignment would be more difficult to complete. All data were analyzed at the group level.

Chapter Four

Results

For assignment K (standard 10-problem assignment), assignment L (standard 12-problem assignment) and assignment L (Brief Sheets) the following data were evaluated: Problems completed, problems correct, digits correct, and digits incorrect. Digits correct only took the final answer of the student into consideration. Twenty-one of the 39 students completed the Brief Sheets assignment, while 18 of the 39 students completed the alternative 12-problem assignment. All students completed the 10-problem assignment as a control.

Procedural integrity data were gathered for the data collection in all four classes by a teacher of the classroom. The procedural integrity checklist used for this study can be seen in Appendix E at the end of this document. Across the four mathematics classrooms used for data collection, procedural integrity was rated at 100%, with the experimenter implementing research protocol with high fidelity.

Descriptive data for problems completed and problems completed correctly can be seen in Table 1. For the control assignment that was completed by all students was a 10-problem assignment. On this control assignment students completed an average of 3.15 total problems (*SD* = 2.76) and 1.23 (*SD* = 1.61) correct problems. Students had an average of 7.21 digits correct (*SD* = 6.50) and 5.53 digits incorrect (*SD* = 9.26).

Our first research question posed for this study was whether students participating in the Brief Sheets intervention complete more problems than were completed for the alternative 12-problem assignment. It was hypothesized that the Brief Sheets intervention would have more total problems completed due to the intervention providing more

Table 1

Descriptive Statistics for Total Problems Completed and Completed Correctly

Assignment Type	Total Problems Completed		Problems Completed Correct	
	M	*SD*	*M*	*SD*
Control Assignment	3.15	2.76	1.23	1.61
Brief Sheets	3.57	2.89	1.76	1.97
Alternative Assignment	3.17	2.71	1.06	1.21

Note. The control assignment refers to the standard10-problem assignment completed by all subjects, while the Alternative assignment refers to the standard 12-problem assignment.

opportunities for reinforcement than were available on the 12-problem assignment (Wallace et al., 2003). The Brief Sheets assignment had a higher number of problems completed (M = 3.57, SD = 2.89) than the 12-problem assignment (M = 3.17, SD = 2.71, but a t-test showed that this difference in number of problems completed was not significant, $t(37) = .449$, $p = .656$. Our first hypothesis that the students would complete more problems when they were assigned the Brief Sheets intervention compared to the alternative 12-problem assignment was not supported by our data.

Our second research question posited whether the Brief Sheets intervention would have a higher percentage of accurate responses on it compared to the alternate 12-problem assignment. It was hypothesized for this study that the accuracy rate for completed problems would not be significantly different between these two assignments, because previous research results showed support for the interventions increasing the total number of problems completed without affecting accuracy rates (Skinner, Robinson, et al., 1996; Wallace et al., 2003). Although the Brief Sheets assignment (M = 1.76, SD = 1.97) had a higher mean number of problems completed compared to the 12-problem assignment (M = 1.06, SD = 1.21), t-test showed that this difference was not significant, $t(37) = 1.32$, $p = .195$.

Our final research question posited whether students would rate the Brief Sheets intervention as being a more preferable alternative to the control assignment than an alternative 12-problem assignment was. For this research question it was hypothesized that the Brief Sheets intervention would not be rated favorably compared to the control assignment, but that the rating for the Brief Sheets intervention would be significantly more favorable than the alternative assignment containing the same number of problems.

This was hypothesized for multiple criteria: Preference for the assignment to be completed for homework, the amount of time needed to complete the assignment, the amount of effort required to complete the assignment, and which is assignment is viewed as more difficult. The results for social validity data can be viewed in Table 3. As predicted when compared to the control assignment, a minority of students rated the Brief Sheets intervention as being preferred to complete for homework (42.86%), and as requiring more time (66.67%) and effort (66.67%) to complete. Compared to the control assignment, 66.67% of students that completed the Brief Sheets intervention rated the intervention as being more difficult as well.

The data that does not support our third hypothesis is that the alternative 12-problem assignment was not rated less favorably than the Brief Sheets assignment was when compared to the 10-problem control. For students that completed the alternative 12-problem assignment, 50% chose the 12-problem assignment as being preferable for homework compared to the control 10-problem assignment. Of the students that completed the 12-problem assignment, 52.94% reported that the assignment would take longer to complete than the control and 50% reported that the assignment would require more effort to complete. Compared to the control 10-problem assignment, 44.4% of the students rated the 12-problem assignment as being more difficult to complete.

Math performance data comparing the Brief Sheets intervention and the standard 12-problem assignment were analyzed. As displayed in Table 1, the Brief Sheets assignment had a higher number of problems completed (M = 3.57, SD = 2.89) than the 12-problem assignment (M = 3.17, SD = 2.71), but a t-test showed that this difference in number of problems completed was not significant, $t(37) = .449$, $p = .656$. This was also

Table 2

Descriptive Statistics for Digits Correct and Digits Incorrect

Assignment Type	Digits Correct		Digits Incorrect	
	M	*SD*	*M*	*SD*
Control Assignment	7.21	6.50	5.53	9.26
Brief Sheets	8.90	7.09	5.38	10.60
Alternative Assignment	7.67	6.44	5.00	7.71

Note. The control assignment refers to the standard10-problem assignment completed by all subjects, while the Alternative assignment refers to the standard 12-problem assignment.

true for number of problems completed correctly, as the Brief Sheets assignment (M = 1.76, SD = 1.97) had a higher mean number of problems completed compared to the 12-problem assignment (M = 1.06, SD = 1.21), but a t-test showed that this difference was not significant as well, $t(37) = 1.32$, $p = .195$. For digits correct in the final product, the Brief Sheets assignment (M = 8.90, SD = 7.09) was found to not be significantly different from the 12-problem assignment as well (M = 7.67, SD = 6.44), $t(37) = .567$, $p = .574$. Digits incorrect was also found to not be a significant difference between the Brief Sheets (M = 5.38, SD = 10.60) and the 12-problem assignment (M = 5.00, SD = 7.71), $t(37) = .126$, $p = .900$. The Brief Sheets assignment was not significantly different from the 12-problem assignment for problems completed, problems correct, digits correct, or digits incorrect.

Preference between assignments was measured by asking the students to compare their experimental assignment (Brief Sheets or 12-problem assignment) against their control 10-problem assignment for four variables: Preference to be completed for homework, amount of effort needed to complete, amount of time needed to complete, and difficulty of the assignment. Table 3 contains the descriptive statistics for all social validity questions. For the social validity question of which assignment the students would choose to complete for homework, 9 students chose Brief Sheets (42.86%) while 12 students chose the 10-problem control (57.14%) compared to the 12-problem assignment where 9 students chose the 12-problem assignment (50.0 %) and 9 chose the 10-problem control (50.0%). The relationship between packet completed (Brief Sheets or 12-problem assignment) and preference for homework compared to the control 10-problem assignment was not found to be significant $\chi^2(1, N = 39) = 0.19$, $p = .656$.

Table 3

Descriptive Statistics for Social Validity in Both Conditions

Social Validity Question	Brief Sheets				Alternative Assignment			
	Control Assignment		Brief Sheets		Control Assignment		Alternative Assignment	
	N	%	*N*	%	*N*	%	*N*	%
Which assignment would be preferred for homework?	12	57.14	9	42.86	9	50.0	9	50.0
Which assignment would take longer to complete?	7	33.33	14	66.67	8	47.06	9	52.94
Which assignment would require more effort to complete?	7	33.33	14	66.67	9	50.0	9	50.0
Which assignment is more difficult?	7	33.3	14	66.67	10	55.56	8	44.44

Note. The control assignment refers to the standard10-problem assignment completed by all subjects, while the Alternative assignment refers to the standard 12-problem assignment.

The next social validity question asked the students to choose between their experimental assignment (Brief Sheets or 12-problem assignment) and their control 10-problem assignment for which would require more time to complete. For this question, 14 of the 21 students with the Brief Sheets intervention reported that Brief Sheets would take longer to complete (66.67%) while 9 of the 17 students with the 12-problem assignment reported that the 12-problem assignment would take longer to complete (52.94%). One student who completed the standard 12-problem assignment failed to report an answer for which assignment would require more time. The relationship between packet completed (Brief Sheets or 12-problem assignment) and the amount of time it would be expected to take to complete compared to the control 10-problem assignment was not found to be significant, $\chi^2 (1, N = 38) = 0.74$, $p = .39$.

The third social validity question measured in our study was to compare the amount of effort that was expected to be required to complete the assignment between their experimental assignment (Brief Sheets or 12-problem) and their control 10-problem assignment. For the students that completed the Brief Sheets assignment, 14 of the 21 students (66.67%) rated the Brief Sheets as requiring more effort to complete compared to the control assignment. For the students completing the standard 12-problem assignment, 9 of the 18 students (50.0%) reported that the standard 12-problem assignment would require more effort to complete. The relationship between packet completed (Brief Sheets or 12-problem assignment) and the amount of effort it would be expected to take to complete compared to the control 10-problem assignment was not found to be significant, $\chi^2 (1, N = 39) = 1.11$, $p = .29$.

The last social validity question measured in our study was for students to choose

between their experimental assignment (Brief Sheets or 12-problem assignment) and their control 10-problem assignment for which assignment was more difficult. Of the 21 students that completed the Brief Sheets intervention, 14 (66.67%) rated the Brief Sheets assignment as being more difficult than the control 10-problem assignment. Of the 18 students that completed the standard 12-problem assignment, 8 (44.4%) rated the 12-problem assignment as being more difficult than the 10-problem assignment. The relationship between packet completed (Brief Sheets or 12-problem assignment) and the amount of difficulty it would take to complete the experimental assignment compared to the control 10-problem assignment was not found to be significant, $\chi^2 (1, N = 39) = 1.95$, $p = .16$.

Chapter Five

Discussion

The purpose of this study was to extend the Wallace et al., (2003) study and investigate the Brief Sheets intervention during independent seatwork time. It was hypothesized that when compared to an alternative 12-problem assignment, the Brief Sheets intervention would have significantly more problems completed, that these problems would be completed without a significant change to the percentage of accurate responses, and that the Brief Sheets would be rated as a preferable assignment. The assignment being preferable was measured by collecting social validity data from the students where they would compare their experimental assignment (Brief Sheets or 12-problem assignment) against a control 10-problem assignment for which the students would prefer to complete for homework, which would require more time to complete, which would require more effort to complete, and which would be more difficult to complete.

The data collected for this dissertation did not support the hypothesis that the Brief Sheets intervention would have significantly more problems completed. The Brief Sheets intervention did have a higher number of mean problems completed (M = 3.57) than the 12-problem assignment (M = 3.17), but this difference was not found to be statistically significant. One explanation for why this study did not find a significant difference between the scores is that fewer problems were completed from the worksheets than was originally anticipated. On average, the students completed between three and four problems on the Brief Sheets assignment, which would equate to only one full sheet being completed as an additional form of reinforcement to the student. Of the

21 students who completed the Brief Sheets intervention, 9 of the students completed 2 or less problems, meaning that they never completed the first slip of paper which was meant to be an additional form of reinforcement for the student (Wallace et al., 2003).

The lack of problems completed by students on the Brief Sheets assignment could explain a lower response rate from students due to the missed opportunities for reinforcement from assignment completion, but the results of students preferring the alternative 12-problem assignment to the Brief Sheets assignment do not appear to be supported by previous research. Understanding that the sheets provided reinforcement of the same quality and with the Brief Sheets being the option for the student to receive a richer schedule of reinforcement compared to the 12-problem assignment, the Matching Law suggests that the students would have preferred the Brief Sheets assignment or had no preference (Herrnstein, 1961; Mace, McCurdy et al., 1990). Rather, the students had no preference between the 12-problem assignment and the control, 10-problem assignment where reinforcement was more easily obtained.

The Brief Sheets intervention was hypothesized to create more opportunities for reinforcement to the students in part due to the discrete task hypothesis. This hypothesis posits that when an individual is given an assignment comprised of multiple discrete tasks, each completed discrete task is a conditioned reinforcer as a result of the individual's learning history (Skinner, 2002). This reinforcer signals to the individual that they are nearing the end of their assignment, or the time when they would typically be rewarded for their work if they were to be rewarded. The reinforcer of completing an entire assignment is assumed to be a distinct reinforcer that is greater in quality than completing the discrete tasks leading up to it. The Brief Sheet was designed to break

down assignments into smaller assignments, with the Brief Sheets intervention for this study containing four assignments within it of three problems each. Hypothetically this would increase the amount of reinforcement for the student per problem completed if the student viewed each slip of paper as a separate assignment, but this hypothesis was not supported by our data. One possible reason why students may not have viewed slips of paper as separate assignments within a total assignment is that the Brief Sheets were stapled together with the top sheet being labeled at the top as assignment K or assignment L, rather than labeling each slip of paper used for the Brief Sheets intervention as a different assignment. Future research may consider labeling the Brief Sheets slips of paper using a code that suggests that each of the assignments is separate from each other while also being a part of a larger total assignment, such as labeling sheets as L1 and L2.

A possible reason for why less problems were completed was the apparent method that was taught to the students to solve two-digit by two-digit mathematical problems. It was noted that across conditions students would attempt to answer the problems in the packets using the box/window method. For an example of this method in-action, the first problem from assignment K which can be seen in Appendix A is 84 x 97. Using the box/window method for this problem, the student would multiply 80 x 90, 80 x 7, 90 x 4, and 7 x 4 together. They would then add together the products of 7200 + 560 + 360 + 28 together to find the answer of 8,148. This method may have been useful for teaching the students how to complete two-digit by two-digit multiplication problems and to check their work, but it did not appear to be the most efficient strategy for answering multiplication problems. This strategy may also suggest that completing the multiplication problems was not an automatic task or something that the students had

high fluency for, thus, they may have had to allocate significant cognitive resources towards completing these problems (Allington, 2009; LaBerge & Samuels, 1974; Stanovich, 1986).

For our second research question which posited whether the Brief Sheets intervention would result in a significant increase in the percentage of problems completed accurately, our hypothesis was correct that the percentage of accurate responding was not statistically different between the Brief Sheets intervention and the alternative 12-problem assignment. This supports the result from the pilot study on Brief Sheets where the student did complete more problems but did not have their accuracy improve (Wallace et al., 2003), as well as supporting the results found in interspersal studies where the accuracy of problems completed remained stable despite more problems being completed (e.g., Skinner, Robinson, et al., 1996).

Our third research question posited whether students would rate the Brief Sheets intervention as preferable compared to an alternative assignment containing the same total number of problems, with the hypothesis being that the Brief Sheets intervention would be rated more favorably. Our data did not support this hypothesis as the ratings were not significantly different between the Brief Sheets assignment for any of the social validity data (preference for homework, time to complete the assignment, effort to complete the assignment, and difficulty to complete the assignment). In addition to the differences not being statistically significant, the 12-problem assignment was rated as favorable by a higher percentage of students than the Brief Sheets assignment for preference to be completed for homework, as taking less time to complete, as requiring less effort to complete, and as being less difficult. Of the 18 students who completed the

12-problem assignment, 8 of the students rated the assignment as being less difficult than the control 10-problem assignment.

These results were not expected as the alternative 12-problem assignment and the control 10-problem assignment were meant to represent typical classroom procedures, which the Brief Sheets intervention was rated as preferable to in the pilot Brief Sheets study (Wallace et al., 2003). Half of the students in our study that completed the 12-problem assignment rated the 10-problem assignment as requiring more effort to complete than the 12-problem assignment as well. In previous research on choice, students would rarely choose the assignment that required more effort (Billington, Skinner et al., 2004; Cates & Skinner, 2000; Skinner, Pappas et al., 2005) and the assignment containing less problems would be expected to be preferred and to require less effort to complete (Cooke et al., 1993; Chung, 1965; Horner & Day, 1991). The exception to this rule in our literature review was for the interspersal procedure, where easier problems would be interspersed into the assignment and could cause students to choose to prefer an assignment that required more effort (Skinner, 2002; Skinner, Robinson, et al., 1996), but the 12-problem assignment used in this dissertation did not intersperse easier problems into the assignment. Multiplication problems were balanced so that all problems across assignments were equated by altering the sequence of the numbers in the problem (67 x 45 could be on assignment K while 76 x 54 could be on assignment L). In this study the choice of which assignment would require more effort and more time seemed to be selected randomly. One explanation for why this may have occurred is that in previous studies when students were prompted to choose an assignment that would be completed for homework, the students were led to believe that

they would be required to complete the chosen assignment. In this study it was clearly stated to the students that they would not be required to complete their chosen assignment, and this may have influenced how our participants responded to our social validity questions. Specifically, because there was no consequence associated with their responses (e.g., the did not have to complete the higher-effort assignment that they chose), the assignments many not have influenced their responses.

Before this dissertation, the only study that this author is aware of that examined the effects of the Brief Sheets intervention was completed by Wallace et al., (2003). In this study a 10-year-old Caucasian male with a mild intellectual disability increased his total number of problems completed with a minimal difference in the percentage of problems completed accurately. It was also reported that during intervention phases the total number of teacher disapprovals was lower than it was during the baseline phase of this study, and that teacher approvals were higher during intervention phases as well. Lastly, there was an increasing trend for student-teacher total interactions during the second intervention phase, as the Brief Sheets intervention may have resulted in more interactions occurring between the teacher and student.

With a goal of this study being to extend the research to a larger population of general education students, this study was not able to replicate the results of the Wallace et al., (2003) study in our data. No significant difference was found for the total number of problems completed, the number of problems completed correctly, the number of digits completed correctly or incorrectly, or for social validity date comparing the Brief Sheets intervention to an alternative 12-problem assignment. In the Wallace et al. study (2003), the Brief Sheets intervention was combined with verbal praise and a high-five

from the teacher after assignments were completed, and this social reinforcement may have been the reason for the increase in performance for the student. When the student was receiving this social reinforcement, the student was also being given access to small breaks. Perhaps these breaks enhanced their performance. Regardless, the current results do not support the conclusion that the Brief Sheets intervention makes independent seatwork more rewarding for students.

There are limitations for our study and the data that was collected. All participants for this study were fourth-grade students from a public elementary school in a rural setting in the Southeastern United States, and our results from this experiment may not generalize well outside of this population. Another limitation of our study is that data collection needed to take place in one day, which led to a decision to gather our data using a between-groups design rather than a within-groups design. This limited the number of participants that there were in each experimental condition, and potentially made it more difficult to find statistically significant results for real differences between the two interventions.

Wallace et al. (2003) found a small increase in problems completed following the first brief sheets intervention, with large increase to follow. The design used in the current study did not allow for the evaluation of trend or cumulative effects of the interventions. Rather, the students were only exposed to the intervention a single time. Future researchers should evaluate the effects of the Brief Sheets intervention over time using a repeated measures design. This could be done with and without the inclusion of social reinforcement to determine whether repeated exposure to the Brief Sheets intervention by itself can lead to significant differences over time and/or repeated trials.

In the current study, participants did not complete as many problems as was anticipated. Consequently, most students did not complete more than one brief sheet assignment. Future researchers could address this problem by providing simpler problems, increasing the amount of time that is provided to complete the problems, working with older students who have more better developed mathematical skill, or providing few problems on a brief sheet.

Future research on the Brief Sheets intervention should implement the intervention with a more varied and larger population if possible. With the students in this study struggling to automatically complete many of the mathematical processes required of them on the assignments, working with older participants could reveal differences between the Brief Sheets intervention and an alternative assignment that are more significant than what was observed in this dissertation.

Another area of future research with Brief Sheets could be to investigate other reinforcers to combine with Brief Sheets to make it a more effective intervention. In the pilot study completed by Wallace et al. (2003) the intervention was successful for a student when paired with social reinforcement, and an area of research could be to observe the intervention when it is paired with social reinforcement that is delayed rather than immediate. Another area for future research would be to lessen the role of the teacher or grader, and to see if the research could be effective with students self-monitoring their performance or by having peers work in pairs and provide reinforcement to each other. There are still questions remaining about the Brief Sheets intervention to be addressed in research.

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Appendices

Appendix A

Assignment K

84 x 97	65 x 87	64 x 59
48 x 57	89 x 56	47 x 85
96 x 58	79 x 45	65 x 87
54 x 86		

Appendix B

Assignment L

95 x 67	46 x 89	57 x 94
48 x 76	64 x 59	85 x 47
49 x 68	56 x 97	78 x 45
94 x 86	74 x 59	65 x 98

Appendix C

Assignment L (Brief Sheets)

59 x 76	64 x 98	75 x 49
84 x 67	46 x 95	58 x 74
94 x 86	65 x 79	87 x 54
49 x 68	47 x 95	56 x 89

Appendix D

Student Preference Sheet

Please complete the following questions comparing the first assignment that you completed today (Assignment L) and the second assignment that you completed today (Assignment K). Please **do not** write your name on this sheet, and please do not skip any questions.

1) Out of the 2 assignments you completed today, if you were given a choice, which assignment would you choose to complete for homework?
    a. Assignment L
    b. Assignment K
2) Which of the assignments would take longer for you to complete?
    a. Assignment L
    b. Assignment K
3) Which of the assignments would require more effort to complete?
    a. Assignment L
    b. Assignment K
4) Which of the assignments is more difficult?
    a. Assignment L
    b. Assignment K

Appendix E

Procedural Integrity Checklist

Procedural Integrity Checklist:

Experimenter: _____

Rater: _____

Class & Time: _____

1. Experimenter distributes packets to students. _____
2. Experimenter introduced self and read first set of instructions. _____
3. Experimenter asks if there are any questions and answers any questions provided. _____
4. Experimenter times students for 5 minutes and then tells students to stop. _____
5. Experimenter reads second set of instructions. _____
6. Experimenter times students for 5 minutes and then tells students to stop. _____
7. Experimenter reads third set of instructions. _____
8. Experimenter collects packets of students as they raise their hands, ensuring that students have written their name on the packet. _____

Vita

Kyle Ryan grew up in Long Island, New York. After high school he attended the University at Albany and received a Bachelor of Arts degree in Psychology. After working in the field as a residential counselor in a group home, Kyle chose to attend the University of Tennessee to pursue a Doctor of Philosophy degree in School Psychology. His research interest includes the implementation of academic and behavioral interventions for students. After graduation, he plans to begin a position working within a school system in the Northeastern United States. He is grateful for the support that he has received within his program and excited to begin his work as a school psychologist.