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A Between Subjects Analysis Of The Additive Interspersal Technique For Multiplication Assignments

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A Between Subjects Analysis of the Additive Interspersal Technique for Multiplication Assignments

BY

Lindsay A. Nash

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
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Table of Contents

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Abstract

Adding easy problems to an assignment with more difficult target problems, known as additive interspersal, has demonstrated the potential to enhance students' perceptions of assignments and also seem to be preferred over non-interspersal assignments. The purpose of this study is to examine the additive interspersal method accomplished by using assignment types (3 x 2 multiplication) that are relevant to the participants (fifth grade students) as well as using a between-subjects design. Specifically, this study examined student's ratings of difficulty, time to complete, and effort required to complete mathematics assignments. In addition, the effects of the different pairs of math assignments on digits correct per minute (DCPM) for both total problems and target problems.

Results indicate that there were significant preferences between the four different types of assignments, with the no regrouping problem type with interspersal assignment generally being preferred over both regrouping problem type assignments (with and without interspersal), but not over the no regrouping problem type without interspersal assignment. When examining both types of regrouping problem type assignments (with and without interspersal), participants completed significantly more total DCPM on the interspersal assignment.

A Between Subjects Analysis of the Additive Interspersal Technique for Multiplication Assignments

With education legislation focusing on the improvement in academic performance of all students, it is increasingly important to focus on students in the general education classroom as well as the special education classroom. Current education legislation has laid out standards for mathematics achievement that are higher than ever (Individuals with Disabilities Education Act, 2004; No Child Left Behind Act, 2001). As a result, it is increasingly important for students in both general education and special education classrooms to be continually improving their mathematics skills. This is especially challenging due to increasing standards as well as the push for students with disabilities to be included in general education settings (Cawley, Parmar, Foley, Salmon, & Roy, 2001).

As students begin to learn more advanced mathematics concepts, they must integrate many basic concepts. For example, multiplication is a math skill which is usually introduced around the fourth grade with proficiency expected by around the sixth grade, requiring the mastery and integration of many components. Mabbott and Bisanz (2003) suggest that the essential elements of multiplication include computation, conceptual knowledge, and working memory. Computation includes accuracy and speed in solving problems; conceptual knowledge is based on one's knowledge of basic principles, which are fundamental to the process of multiplication and how they are related; and working memory involves the ability to both store and manipulate information in order to perform mental operations needed to solve a problem.

Students with mathematics learning disabilities may have a problem with any single or any combination of basic skills involved in performing math problems, including multiplication problems (Rousselle & Noël, 2008). Although it is especially important for students with learning disabilities to receive assistance in the remediation of their problems, students in general education should not be ignored. It is important for all students to be exposed to as many learning trials as possible, as trials increase learning rates (Skinner, Fletcher, & Henington, 1996). It is also important to minimize the length of time in a single learning trial to enhance efficiency in learning, but maintain the highly salient features of the learning trials to maximize the effectiveness of the intervention so the potential of learning will not be compromised (Skinner, Fletcher, & Henington, 1996). Taking these concepts into consideration, examining the methods which allow students exposure to learning trials in an effective and efficient manner can be of great utility to educators.

Interspersal technique: Discrete task completion hypothesis

Numerous investigations have demonstrated multiple benefits of using an interspersal technique in math seatwork assignments, which consists of interspersing simple math problems among those of higher difficulty in a math assignment (Billington & Ditommaso, 2003; Billington & Skinner, 2002; Billington & Skinner, 2006; Billington, Skinner, Hutchins, & Malone, 2004; Calderhead, Filter, & Albin, 2006; Cates & Dalenberg, 2005; Cates & Skinner, 2000; McCurdy, Skinner, Grantham, Watson, & Hindman, 2001; Meadows & Skinner, 2005; Montarello & Martens, 2005; Rhymer & Morgan, 2005; Skinner, 2002; Skinner, Fletcher, & Hennington, 1996; Skinner, et al., 1999). The explanation of how this method works is based upon the Discrete Task

Completion hypothesis, which states that a completed discrete task, like a math problem, may serve as a reinforcer. The completion of an assignment is assumed to be reinforcing, and stimuli that consistently occur before this reinforcement are considered to be completed discrete tasks that make up assignments. As a result, a discrete task that is completed becomes a reinforcer. Interspersing additional brief tasks has been shown in studies to support the Discrete Task Completion hypothesis as well as enhance discrete task completion rates (Billington, et al, 2004; Cates & Dalenberg, 2005; Meadows & Skinner, 2005; Skinner, 2002). Additionally, Billington and Ditommaso (2003) found that students choose interspersal assignments because those assignments have greater rates of reinforcement (i.e., more dense schedule of reinforcement). For example, within a single math seatwork assignment, there may be 20 individual math problems. The hypothesis suggests that the completion of each individual problem is reinforcing to the student, so the more problems a student completes on an assignment, the more frequently the student is reinforced (Skinner, 2002).

Logan and Skinner (1998) as well as Cates and Skinner (2000) suggest that the completion of problems in an assignment may be reinforcing because they are a signal of positive or negative reinforcement to come on a larger scale upon the completion of the assignment. If paired with a reinforcer such as praise (positive reinforcement) or being able to escape or avoid more seatwork (negative reinforcement), the completion of an assignment becomes a conditioned reinforcer. According to the delay reduction hypothesis and the concept of higher order conditioning, an event which consistently precedes a reinforcing event will take on the reinforcing properties of the reinforcing event. In the case of interspersal assignments, completing each problem precedes the

completion of the entire assignment, allowing the completion of each individual problem to take on the reinforcing properties of the completion of the entire assignment. Once problem completion becomes in itself reinforcing, schedules of reinforcement can be manipulated to enhance the effects of those reinforcers. In order for students to experience the full benefits of those reinforcers, they must respond to interspersal assignments. Hernstein's Matching Law describes how this is accomplished.

Herrnstein's Matching Law. Herrnstein's Matching Law states that one will respond at a higher rate to stimuli associated with a denser schedule of reinforcement when presented with stimuli for two incompatible responses (Herrnstein, 1961). In the case of assignments with interspersed problems, it may be assumed that the rate of reinforcement is fixed because the students are still completing the same amount of problems as they would in the same assignment without any easy interspersed problems. However, additive interspersal assignments can be considered to have a denser schedule of reinforcement, meaning that the students are actually completing more total problems in the same amount of time. The interspersed problems are solved faster than the target problems of the assignment, allowing students to move through the assignment more quickly. Overall, students are more willing to perform difficult tasks when they are mixed with easy ones (Calderhead, Filter, & Albin, 2006).

In interspersal math assignments, problems that are easier relative to the target problems are interspersed throughout the assignment. One of the most important benefits of this method is that the students will complete more problems. Billington, Skinner, Hutchins, and Malone (2004) found that problem completion rates for high effort assignments were enhanced by the interspersal of additional problems. Fifty-one

undergraduate students with a mean age of 26 from the University of Tennessee were asked to work on two different assignment pairs, Pair A and Pair B, with each assignment containing 18 three-digit by two-digit multiplication problems. Pair A consisted of one high-effort assignment and one moderate-effort assignment. Pair B consisted of one moderate-effort assignment similar to that of Pair A and one high-effort assignment similar to that of Pair A, with the exception that six additional one-digit by one-digit multiplication problems were interspersed every three problems in this high-effort assignment. Billington et al. (2004) examined the number of problems completed and results of their study showed that students completed significantly more total problems on the Pair B high-effort assignment (with the interspersed problems) than they did on the Pair A high-effort assignment. Additionally, students completed more target problems on the additive interspersal high-effort assignments than on the regular high-effort assignments (although results were not statistically significant). Students also correctly completed significantly more target problems on the additive interspersal high-effort assignments than on regular high-effort assignments.

Meadows and Skinner (2005) also showed that both total and target item completion rates were significantly increased by interspersing easy problems. It is important to note that substituting easy, interspersed problems isn't as effective as adding additional easy, interspersed problems. Substituting requires the removal of important target problems, and is therefore not as effective because it reduces the demands of the assignment. All of the benefits of interspersal can be attained by using an additive approach (Meadows & Skinner, 2005). This is because students are able to complete significantly more total problems on an interspersal assignment without completing any

less target problems or sacrificing accuracy (Cates & Skinner, 2000). The completion of each math problem is a signal of reinforcement for the completion of the whole assignment, making it a conditioned reinforcer (Montarello & Martens, 2005).

Skinner, Fletcher, and Henington (1996) conducted a meta-analysis in which they compared multiple interventions used to improve learning rates. When examining studies of interspersal and comparing a "typical" math assignment to one with additional interspersed problems which therefore required more work, the researchers found that not only did participants have higher discrete task completion rates, but they also rated the interspersal assignment as requiring less effort and time to complete. Significantly more students chose an assignment similar to that of the experimental interspersal assignment for homework.

Effects of interspersal technique on student perceptions. In addition to contributing to the completion of more total problems, the additive interspersal method in particular has many other benefits. These benefits include student perception on task difficulty, effort, time consumption and student choices. Cates and Skinner (2000) found that high school students in remedial math classes rated an interspersal assignment as less difficult, effortful, and time consuming, and students were more likely to choose a similar assignment for homework. One common finding in interspersal studies is that students rate an interspersal assignment as requiring less effort to complete.

Billington, et al. (2004) replicated these results. Their results indicated that significantly more students chose a higher effort assignment for homework and rated it as requiring less time and effort to complete when the additive interspersal technique was used. The participants also ranked the assignment with easy interspersed problems as

less difficult. An explanation for these results may be found in the meta-analysis conducted by Billington and Skinner (2006), in which results of analyzing multiple interspersal studies indicated that the amount of students who ranked interspersal assignments as less time consuming increased as the relative problem completion rates increased. The interspersal method has been found to result in the completion of more problems, and the more problems the students were able to complete, the more favorably they felt about the assignment.

It has also been found that as the number of completed problems increase, the likelihood of students choosing an interspersal assignment to complete for homework also increased. Results found by Skinner, et al. (1999) showed that not only did individuals complete more problems in the interspersal assignment as the number of digits in the target problems increased, but also that when number of problems completed increased, so did the proportion of students choosing the interspersal assignment for homework. It has also been found that more problems are completed in interspersal assignments as the density of the schedule of reinforcement increases.

Additionally, organisms are more likely to choose a behavior which requires the least amount of effort when given the choice between two behaviors (Billington, et al, 2004). The use of the interspersal method has been shown in many studies to result in students choosing assignments which require more effort for homework. With interspersal assignments, students are not only completing assignments that they prefer, but they are choosing to complete that assignment. When students choose their assignment, they are more likely to engage in it (Dunlap, DePerczel, Clarke, Wilson, Wright, White, & Gomez, 1994). Learning may be more difficult to attain unless

students choose to engage in the assignment (Meadows & Skinner, 2005). Students are more likely to engage in assignments not only when they choose the assignment, but when the reinforcement rate, quality of the reinforcer, and immediacy of the reinforcer are enhanced (Billington, et al, 2004). Interspersal assignments meet these reinforcement criteria, as suggested by the Discrete Task Completion hypothesis.

Research on choice behavior with pigeons has yielded numerous findings. Herrnstein (1961) found that when pigeons were presented with concurrent schedules for pecking on keys, the relative rate of responding matched the relative rate of reinforcement. The more frequent the reinforcement on a particular key, the more responses the pigeons made on that key. In terms of students and assignments, the rate of reinforcement is higher for interspersal assignments than for "typical" seatwork assignments, meaning that the students should choose the interspersal assignments more frequently than the "regular" assignments, indicating preference for the interspersal assignments.

Similar findings were presented by Chung and Herrnstein (1967) regarding the immediacy of reinforcement. The structure of their study was similar to that of Herrnstein (1961), but reinforcement was delayed for various time lengths from one to thirty seconds. Findings showed that the relative rate of responding matched the relative immediacy (or delay) of reinforcement. Although this research is valuable in describing behavior, it doesn't explain why this phenomenon of matching is observed. The theory of optimization is one explanation for matching behavior based on the concept of a subject attempting to obtain the highest rate of reinforcement possible. If presented with two concurrent variable interval (VI) schedules, a subject will distribute their behaviors

so that the rate of reinforcement between the two schedules overall is maximized. The theory of melioration is a second explanation for matching behavior based on the concept of a subject choosing the most beneficial option. If a subject is presented with concurrent schedules, they will begin to respond more to whichever choice has the better reinforcer to response ratio (Mazur, 2006).

Billington, et al. (2004) demonstrated that significantly more students chose a high effort interspersal assignment over a moderate effort assignment without interspersed problems compared to the students who chose a high effort assignment without interspersed problems over a moderate effort assignment. Again, the more problems that were completed, the more likely the students were to choose an assignment similar to the experimental interspersal assignment for homework. Additionally, as the rate of interspersal increased, the more likely students were to rate the assignments as requiring less time and effort to complete and as being less difficult (Cates & Dalenberg, 2005). Meadows and Skinner (2005) also found significantly more students chose an interspersal assignment for homework. These findings across studies suggest that interspersal assignments are preferential to students compared to "typical" assignments which contain only target problems.

Not only will students prefer to complete interspersal assignments with the same amount of target problems as a "regular" assignment, but as found in Billington and Skinner's 2002 study, significantly more students chose an interspersal assignment with 20% more target problems than the "regular" assignment, and even rated the interspersal assignment as less difficult and requiring less effort to complete. It has even been found that students will choose to complete an interspersal assignment with up to 40%

additional target problems over an assignment which contains no easy, interspersed math problems (Cates & Skinner, 2000). Students also prefer the use of interspersal compared to other intervention techniques, such as explicit timing (Rhymer & Morgan, 2005). Significantly more students also rated intersperal assignments as requiring less effort and time to complete, and as being less difficult than explicit timing assignments (Rhymer & Morgan, 2005).

The implications of the findings on the interspersal method are promising. Intersperal allows for students to complete assignments they prefer without affecting their level of education. This can both enhance the development of skills as well as reduce problem behaviors (Billington, et al, 2004).

As previously mentioned, interspersal assignments are rated as requiring less effort than "regular" assignments. By reducing the effort required (or perceived as required) to complete an assignment, students' perceptions of assignments as well as the probability of the students engaging in assigned work is enhanced. Additionally, the probability of students engaging in disruptive behaviors is reduced, suggesting that off-task behavior may be able to be decreased without compromising educational demands (Billington, et al, 2004).

Many studies have also shown that interspersal assignments seem as they require less time to complete than "typical" assignments, even though they require more time. Because of this, students will rate these assignments as more preferential because they feel that they will have more time to engage in more preferred activities (Billington & Skinner, 2006). Although the interspersal method has the ability to engage students in an assignment, there have been many studies that have focused on the density of the easy

interspersed assignments, which have shown that the right balance of interspersed problems and target problems must be found to keep the level of on-task behavior high. If there are too many easy problems, students may become "bored" with the assignment. If there are not enough easy problems, students may become frustrated with the assignment. Either way, this will allow the student to become more easily distracted (Calderhead, Filter, & Albin, 2006).

The interspersal method has been shown to be potentially useful as an intervention, but many of the studies have utilized the same basic methods, experimental design, and analysis. Different approaches to studying additive interspersal may allow us to better understand the effects and potential usefulness of this technique.

Limitations of the Current Research

Until recently, additive interspersal research had primarily used college or high school students as participants instead of elementary grade school students. Additionally, the mathematics problems that the older participants were completing in these studies were for the most part multiplication problems that students learn around the fifth grade. Findings may be more relevant and applicable when they are based on research involving participants of the same age as what the researchers are aiming to generalize results. Findings are also more relevant and applicable when the math problems in the experimental assignments are at the appropriate instructional level of the participants.

Rhymer and Cates (2006) used second grade students as participants and addition word problems as the math problems. While their findings that participants rated the non-interpsersal assignments as requiring more time and effort to complete and being more difficult corresponded with previous research that did not utilize school-age

participants, other findings of these previous studies (such as participants choosing to complete interspersal assignments at a significantly higher rate than non-interspersal assignments) were not replicated. The results emphasized the importance of expanding research to school-age participants.

Much of the existing research on using additive interspersal in math assignments has used a repeated measures or within-subjects experimental design. To address issues that may arise from this design, such as practice effects, the current study will use a between-subjects design. Additionally, while many additive interspersal studies have measured the number of problems that participants correctly complete (Billington & Skinner, 2002; Billington & Skinner, 2006; Billington, et al., 2005; Cates & Dalenberg, 2005; Cates & Erkfritz, 2007; Cates & Skinner, 2000; Skinner, et al., 1999; Skinner, et. al, 1996; Rhymer & Cates, 2006; Rhymer & Morgan, 2005), the current study will be measuring digits correct per minute, a more sensitive measure.

Purpose of the Present Study and Research Questions

The present study aims to investigate the effects that additive interspersal and regrouping have on students' preferences of math independent seatwork assignments as well as performance on math assignments as measured by digits correct per minute.

Research Questions

1. Will students demonstrate a significant preference for no regrouping problem type without interspersing (NRPT-NI) assignments to regrouping problem type (RPT-I) assignments with interspersing on the dimensions of time, effort, and difficulty as measured by a forced choice survey question?
2. Will students demonstrate a significant preference for regrouping problem type assignments without interspersing (RPT-NI) to NRPT-NI assignments on the dimensions of time, effort, and difficulty as measured by a forced choice survey question?
3. Will students demonstrate a significant preference for (RPT-I) assignments to no regrouping problem type with interspersing (NRPT-I) assignments on the dimensions of time, effort, and difficulty as measured by a forced choice survey question?
4. Will students demonstrate a significant preference for RPT-I assignments to RPT-NI assignments on the dimensions of time, effort, and difficulty as measured by a forced choice survey question?
5. Will students demonstrate a significant preference for RPT-NI assignments to NRPT-I assignments on the dimensions of time, effort, and difficulty as measured by a forced choice survey question?
6. Will students demonstrate a significant preference for NRPT-NI assignments to NRPT-I assignments on the dimensions of time, effort, and difficulty as measured by a forced choice survey question?

7. Which group (RPT-I, RPT-NI, NRPT-I, NRPT-NI) will complete more total problems as measured by DCPM (including both target problems and/or additive interspersal problems)?
8. Which group (RPT-I, RPT-NI, NRPT-I, NRPT-NI) will complete more target problems as measured by DCPM?

Methods

Participants and Setting

Participants for this study were 89 fifth grade students from a school district in the Southeastern United States. Thirty-five of the participants were males and 54 were female. Of all of the participants, 31 were African American and the remaining 58 were White. Student age ranged from 10 to 12 with a mean of 10.7 years. The school had approximately 150 fifth grade students total, which more than 50% of the total fifth grade enrolled participated. The district Superintendent gave written permission to conduct the study before data were collected. The experimenter obtained IRB approval and adhered to all policies and procedures outlined before the initiation of the study. Participants were asked to voluntarily participate after their parents/guardians had signed informed consent forms (Appendix A). The setting for the experiment was in a large multipurpose area in the school.

Materials

There were four different types of assignments that were presented in six different assignment pairs. The different assignment types consisted of eighteen 3 x 2 multiplication problems that either required regrouping or did not require regrouping and either contained nine additional 1 x 1 interspersed problems or did not contain interspersed problems. The four different assignment types included no regrouping problem type with interspersing (NRPT-I) (Appendix B), regrouping problem type with interspersing (RPT-I) (Appendix C), no regrouping problem type with no interspersing (NRPT-NI) (Appendix D), and regrouping problem type with no interspersing (RPT-NI) (Appendix E).

Each assignment was presented on a single side of an 8.5 x 11 inch sheet paper. The problems were presented in four rows. To decrease the likelihood of students quantitatively analyzing the number of problems, the problems were presented in an unbalanced way. This means that they were not evenly spaced, rows and columns did not contain the same number of problems, and none of the problems were numbered.

Within each experimental packet, the two assignment pairs were presented in a counterbalanced manner. The order that each individual assignment appeared in each assignment pair was counterbalanced as well as the order in which assignment pairs appeared in each experimental packet.

Procedures

Before any data were collected, informed consent forms were passed out in classrooms to each student for them to bring home, have signed by their parents, and return to the classroom teacher in order to participate.

All four assignment types were combined into six possible assignment pairs, which were counterbalanced. Each participant received two different assignment pairs in their experimental packets. See Table 1 for a list of all possible orders of assignments. Two identical sheets (i.e., questionnaire about preferences) were included after each assignment pair for participants to answer forced choice questions about the assignments after they had completed them (Appendix F). On these sheets, students were asked to choose which assignment in each assignment pair required more effort to complete, more time to complete, and which assignment was more difficult. Additionally, a form to collect demographic data from each participant was be included (Appendix G).

At the beginning of the experimental session, the experimenter ensured that participants had a pencil and enough space to complete the assignments. The experimenter then instructed (see Appendix H) students to work on the problems from left to right without skipping any and to try to do their best work. The students were asked to turn to the first page to begin working on the first assignment in their packets as the experimenter began timing for five minutes. At the end of five minutes, the students were told to put their pencils down and stop working. Students were again instructed to turn the page to the second assignment and the experimenter began timing for another five minutes. At the end of those five minutes, the students were told to put their pencils down and stop working.

Next, students were asked to turn to the next page to answer some questions about his or her preference of the assignments they had just completed and were reminded that they could look back over those assignments to help answer the questions. These questions asked the students to choose which assignment was more difficult to complete, which assignment would require more time to complete, and which assignment would require more effort to complete. When students completed this first forced choice sheet, the process was repeated for the second assignment pair. After participants completed the second forced choice sheet, they were asked to fill out the demographics page in the back of the experimental packet.

Independent Variables

There were two independent variables: type of multiplication problem (i.e., regrouping versus no regrouping multiplication problems) and interspersal procedure (interspersal versus no interspersal).

Type of multiplication problem. There were a total of four multiplication tasks. Two of these tasks had regrouping multiplication assignments (RPT-I and RPT-NI). The RPT-NI consisted of 18 high difficulty 3 x 2 multiplication problems that required carrying for all places. The RPT-I assignment contained a total of 27 multiplication problems. Of these problems, 18 were 3 x 2 multiplication problems that required carrying for all places. An additional nine brief 1 x 1 multiplication problems were interspersed every second 3 x 2 multiplication problem. The NRPT had 18 problems that were 3 x 2 problems which did not require carrying numbers until the hundreds place. The NRPT-I assignment contained a total of 27 multiplication problems. Of these problems, 18 were 3 x 2 multiplication problems that did not require carrying until the hundreds place. An additional nine brief 1 x 1 multiplication problems were interspersed every third 3 x 2 multiplication problem.

Interspersal procedure. For each type of multiplication problem, regrouping versus no grouping, interspersal was incorporated into one assignment for each type. The interspersal consisted of nine 1x1 multiplication problems. Thus, there were four types of assignments, RPT-I, RPT-NI, NRPT-I, and NRPT-NI.

Dependent Variables

There were five dependent variables that were used to evaluate the effects of the independent variables. The first three dependent variables were nominal level data measuring preference of difficulty, effort and time (i.e., force choice answer). The final two dependent variables were scale level data (i.e., DCPM for target and total problems).

Perception of difficulty. This variable was measured by a forced choice rating of a given assignment being "more difficult" or "less difficult" than a second given assignment.

Perception of time. This variable was measured by a forced choice rating of a given assignment as requiring "more time" or "less time" to complete than a second given assignment.

Perception of effort. This variable was measured by a forced choice rating of a given assignment requiring "more effort" or "less effort" to complete than a second given assignment.

DCPM of total number of problems. This variable was measured by how many total problems each participant completed on average in one minute on a given assignment. Digits correct per minute for the total number of problems was calculated by dividing the total number of correct digits on each assignment by five minutes. A digit was considered correct when it was the right digit in the correct place in the multiplication problem.

DCPM of target number of problems. This variable was measured by how many target problems each participant completed on average in one minute on a given assignment. Target problems were defined as all regrouping and non-regrouping 3 x 2 multiplication problems. The 1 x 1 interspersed problems were not considered target problems. Digits correct per minute for the target problems was calculated by dividing the number of correct digits for all target problems on each assignment by five minutes. A digit was considered correct when it was the right digit in the correct place in the multiplication problem.

Design and Analysis

A 2x2 between subjects design was utilized. Because these analyses involved nominal categorical data (i.e., for both independent and some of the dependent variables), chi square tests for independence as well as Cramer's V were used to analyze student ratings of difficulty, time to complete, and effort required to complete assignments both between assignments overall and between assignments within assignment pairs. Chi square tests corrected for continuity were used to analyze specific pairwise relationships between preferences for assignments in order to gain more specific information about the nature of the relationship between assignment type and preference.

A one-way MANOVA was used to analyze digits correct per minute (DCPM) for the total problems and DCPM for the target problems. A MANOVA can be used to determine effects of an independent categorical variable on multiple continuous dependent variables and can be used to compare several groups with respect to multiple continuous variables. This test can be used to analyze digits correct per minute across all levels of the experimental design. One-way ANOVAs were utilized to analyze specific pairwise relationships between assignment type and DCPM.

Results

Perception of difficulty. A chi square test for independence was performed to determine if participants preferred one type of assignment over the others in terms of difficulty (see Table 2). At an alpha level of .05, results indicate that assignment type and preference in terms of difficulty were significantly related, X^2 (3, N = 356) = 110.61, $p < .001$, Cramer's $V = .56$. Most of the participants rated the NRPT-NI assignment as being less difficult (74%) as well as the NRPT-I (80%). Only 14% of participants rated the RPT-NI assignment as being less difficult and only 33% rated the RPT-I as being less difficult. Follow-up pairwise comparisons using chi-square tests corrected for continuity were conducted to evaluate the differences among these proportions (see Table 3).

Perception of effort. Another chi square test for independence was performed to determine if participants preferred one type of assignment over the others in terms of effort required to complete it (see Table 4). At an alpha level of .05, results indicate that assignment type and preference in terms of effort were significantly related, X^2 (3, N = 356) = 23.14, $p < .001$, Cramer's $V = .26$. Most of the participants rated the NRPT-NI assignment as requiring less effort (63%) as well as the NRPT-I (62%). Only 35% of participants rated the RPT-NI assignment as requiring less effort and only 39% rated the RPT-I as requiring less effort. Follow-up pairwise comparisons using chi-square tests corrected for continuity were conducted to evaluate the differences among these proportions (see Table 5).

Perception of time. A third chi square test for independence was performed to determine if participants preferred one type of assignment over the others in terms of time required to complete it (see Table 6). At an alpha level of .05, results indicate that

assignment type and preference in terms of time were significantly related, X^2 (3, N = 356) = 55.51, $p < .001$, Cramer's $V = .40$. Seventy-one percent of the participants rated the NRPT-NI assignment as requiring less time, and 69% rated the NRPT-I as requiring less time. Only 28% of participants rated the RPT-NI assignment as requiring less time and only 33% rated the RPT-I as requiring less time. Follow-up pairwise comparisons using chi-square tests corrected for continuity were conducted to evaluate the differences among these proportions (see Table 7).

Analysis of Perceptions of Difficulty, Effort, and Time between Assignment Types within Assignment Pairs

Perception of Difficulty. A chi square test for independence was performed to determine if participants preferred one type of assignment over the other within each assignment pair in terms of difficulty (see Table 8). At an alpha level of .05, results indicate that assignment pair and assignment preference in terms of difficulty were significantly related, X^2 (15, N = 356) = 523.08, $p < .001$, Cramer's $V = .70$. Within the NRPT-NI and NRPT-I assignment pair, 53% of participants preferred the NRPT-I assignment in terms of difficulty, and within the NRPT-I and RPT-I assignment pair, 90% of participants preferred the NRPT-I assignment. A full100% of participants preferred the NRPT-I assignment within the NRPT-I and RPT-NI assignment pair. Eighty-eight percent of participants preferred the NRPT-NI assignment on the dimension of difficulty within the NRPT-NI and RPT-I assignment pair, and 86% preferred it within the NRPT-NI and RPT-NI assignment pair. Within the RPT-I and RPT-NI assignment pair, 78% of participants preferred the intersperal (RPT-I) assignment in terms of difficulty.

Follow-up pairwise comparisons using chi-square tests corrected for continuity were conducted to evaluate the differences among these proportions (see Table 9). Using a Bonferroni correction, the pairwise differences between many of the assignment pairs were found to be significant.

Perception of Effort. Another chi square test for independence was performed to determine if participants preferred one type of assignment over the other within each assignment pair in terms of effort required to complete it (see Table 10). At an alpha level of .05, results indicate that assignment pair and assignment preference in terms of effort required were significantly related, X^2 (15, N = 356) = 433.71, p < .001, Cramer's V = .64. Within the NRPT-NI and NRPT-I assignment pair, 53% of participants preferred the NRPT-NI assignment in terms of effort. Within the NRPT-NI and RPT-I assignment pair, 82% of participants preferred the NRPT-NI assignment in terms of effort. Within the NRPT-NI and RPT-NI assignment pair, 52% of participants preferred the NRPT-NI assignment in terms of effort. Within the NRPT-I and RPT-I assignment pair, 59% of participants preferred the NRPT-I assignment in terms of effort. Within the NRPT-I and RPT-NI assignment pair, 87% of participants preferred the NRPT-I assignment in terms of effort. Within the RPT-I and RPT-NI assignment pair, 62% of participants preferred the RPT-I assignment in terms of effort.

Follow-up pairwise comparisons using chi-square tests corrected for continuity were conducted to evaluate the differences among these proportions (see Table 11). Using a Bonferroni correction, the pairwise differences between all combinations of assignment pairs were significant.

Perception of Time. A final chi square test for independence was performed to determine if participants preferred one type of assignment over the other within each assignment pair in terms of time required to complete it (see Table 12). At an alpha level of .05, results indicate that assignment pair and assignment preference in terms of time required were significantly related, X^2 (15, N = 356) = 457.32, p < .001, Cramer's V = .65. Within the NRPT-NI and NRPT-I assignment pair, 60% of participants preferred the NRPT-NI assignment in terms of time. Within the NRPT-NI and RPT-I assignment pair, 85% of participants preferred the NRPT-NI assignment in terms of time. Within the NRPT-NI and RPT-NI assignment pair, 66% of participants preferred the NRPT-NI assignment in terms of time. Within the NRPT-I and RPT-I assignment pair, 79% of participants preferred the NRPT-I assignment in terms of time. Within the NRPT-I and RPT-NI assignment pair, 90% of participants preferred the NRPT-I assignment in terms of time. Within the RPT-I and RPT-NI assignment pair, 65% of participants preferred the RPT-I assignment in terms of time.

Follow-up pairwise comparisons using chi-square tests corrected for continuity were conducted to evaluate the differences among these proportions (see Table 13). Using a Bonferroni correction, the pairwise differences again between all assignment pairs were significant.

Analysis of Total and Target DCPM between Assignment Types

A one-way MANOVA was conducted to examine the effects of assignment type on both target digits correct per minute and total digits correct per minute. The MANOVA revealed a significant multivariate main effect for assignment type, Wilks' λ

= .13, F (6, 702) = 208.11, p <. 001, partial eta squared = .64. Power to detect the effect was 1.0.

Given the significance of the overall test, the univariate main effects were examined (see Table 14). Significant univariate main effects for assignment type were obtained for total digits correct per minute, F (3, 352) = 99.555, p <.001 , partial eta square =.459, power = 1.0; and target digits correct per minute, F (3, 352) =92.9 , p <.001 , partial eta square = .442, power = 1.0 (see Table 15). At the <.001 level, significant assignment type pairwise differences were obtained in the number of total digits correct per minute between NRPT-NI assignment (9.72 DCPM) and both the RPT-NI (4.29 DCPM) and RPT-I (5.59 DCPM) assignments. Additionally, at the <.001 level, significant assignment type pairwise differences were obtained in the number of total digits correct per minute between the NRPT-I assignment and both the RPT-NI and RPT-I assignments. The mean number of total digits correct per minute were 10.86 on the NRPT-I assignment, 4.29 on the RPT-NI assignment, and 5.59 on the RPT-I assignment. At the .05 level, significant assignment type pairwise differences were obtained in the number of total digits correct per minute between the RPT-I assignment (5.59 DCPM) and RPT-NI assignment (4.23 DCPM). Results indicated that participants did not complete significantly more total digits correct per minute on the NRPT-I assignment (10.86) than they did on the NRPT-NI (9.72) assignment. At the <.001 level, significant assignment type pairwise differences were obtained in the number of target digits correct per minute between the NRPT-NI assignment and the RPT-NI assignment as well as RPT-I assignment. The mean number of target digits correct per minute were 9.72 on the NRPT-NI assignment, 4.29 on the RPT-NI assignment, and 4.32 on the RPT-I

assignment. Additionally, at the <.001 level, significant assignment type pairwise differences were obtained in the number of target digits correct per minute between the NRPT-I assignment (9.02 DCPM) and both the RPT-NI (4.29DCPM) and RPT-I assignments (4.32 DCPM). Participants did not complete significantly more target digits correct per minute on the RPT-I assignment (4.32) than they did on the RPT-NI assignment (4.29). They also did not complete significantly more target digits correct per minute on the NRPT-I assignment (9.02) than they did on the NRPT-NI (9.72) assignment.

Discussion

Research Questions

Results indicated that there was a significant difference in the assignment that participants preferred on the dimensions of difficulty, effort, and time between the RPT-I and NRPT-NI assignments. Results indicated that participants in preferred the NRPT-NI assignment significantly more than the RPT-I assignment on all three dimensions of preference.

There was also a significant difference in the assignment that participants preferred on the dimensions of difficulty, effort, and time between the NRPT-NI and RPT-NI assignments. Based on the results, significantly more participants preferred the NRPT-NI assignment over the RPT-NI assignment on all three dimensions of preference.

Between the RPT-I and NRPT-I assignments, it was found that participants significantly preferred one over the other on the dimensions of difficulty, effort, and time. According to the results, significantly more participants preferred the NRPT-I assignment on all three dimensions of preference over the RPT-I assignment.

While results indicated that significantly more participants preferred the RPT-I assignment over the RPT-NI on the dimension of difficulty, there were no significant differences found for the dimensions of effort or time required to complete time.

Results also indicated that there was a significant preference for the NRPT-I assignment on the dimensions of difficulty, effort, and time over the RPT-NI assignment.

Between the NRPT-NI and NRPT-I assignments, it was found that there was no significant preference for assignment on the dimensions of difficulty, effort, and time to complete.

In terms of performance, results indicated that participants completed more total DCPM on the NRPT-I assignment compared to the RPT-NI and RPT-I assignments; however, participants did not complete significantly more total problems on the NRPT-I assignment compared to the NRPT-NI assignment.

Finally, results indicated that participants completed more target DCPM on the NRPT-I assignment compared to the RPT-NI and RPT-I assignments; however, participants did not complete significantly more target problems on the NRPT-I assignment compared to the NRPT-NI assignment.

Expanding Previous Related Research

The current study expands the current research on additive interspersal by analyzing preference for assignments on the dimensions of difficulty, effort required to complete, and time to complete both between the four assignment types overall, and between assignment types within each of the six different assignment pairs. Analysis of assignment preference between assignment pairs showed that there were significant differences in assignment preference on all three dimensions depending on what assignment pair the individual assignment.

The NRPT-NI assignment was significantly preferred on the dimensions of difficulty and time when paired with either the RPT-I or RPT-NI assignments, but not the NRPT-I assignment. The NRPT-I assignment was significantly preferred on the dimensions of difficulty, effort, and time when paired with the RPT-I and RPT-NI assignment, but not the NRPT-NI assignment. The RPT-NI assignment was preferred significantly more (though not the preferred assignment in the assignment pair) on the dimensions of difficulty, effort, and time when paired with the NRPT-NI assignment as

opposed to the NRPT-I assignment, but preferred significantly more (though not the preferred assignment in the assignment pair) when paired with the RPT-I assignment as opposed to both the NRPT-NI and NRPT-I assignments. The RPT-I assignment was significantly preferred on the dimensions of difficulty, effort, and time when paired with the RPT-NI assignment, but not the NRPT-NI or NRPT-I assignments.

A second way that the current study expands the current research on additive interspersal is to analyze discrete task completion by DCPM as opposed to correct problems. Results of the current study indicate that participants completed significantly more total and target DCPM on the NRPT-I assignment compared to both the higher-difficulty (regrouping) assignments (RPT-I and RPT-NI), but not compared to a similar lower-difficulty (no regrouping) assignment without added interspersed 1 x 1 problems (NRPT-NI). Participants also completed significantly more total DCPM on the RPT-I assignment compared to a similar higher-difficulty (regrouping) assignment without added interspersed 1 x 1 problems (RPT-NI). However, they did not complete significantly more target problems on the RPT-I assignment compared to the RPT-NI assignment.

The findings of the current study are partially supported by previous research examining the effects of additive interspersal. Previous research suggests that students prefer additive interspersal assignments over similar assignments without interspersal on various dimensions, including difficulty, effort to complete, and time to complete (Cates & Skinner, 2000; Billington, et al., 2004; Findings of the current study suggest that students prefer additive interspersal assignments over similar assignments without interspersal when the difficulty level of the target problems is higher (requires

regrouping) on the dimensions of difficulty, effort to complete, and time to complete. Those results correspond with previous research. However, with a lower difficulty level of target problems (that do not require regrouping), there is no significant difference in preference on the dimensions of difficulty, effort to complete, or time to complete.

Some previous research in the area has also suggested that the effects of additive interspersal may be powerful enough to result in participants preferring interspersal assignments with higher-level target problems over non-interspersal assignments with lower-level target problems. However, the findings in the current study imply just the opposite, as participants preferred the NRPT-NI assignment significantly more than the RPT-I assignment.

When examining task completion rates, previous research suggests that students complete more total and target problems on interspersal assignments than on similar non-interspersal assignments (Billington, et al.,, 2004; Meadows & Skinner, 2005; Cates & Skinner, 2000). This finding was supported by the current study, but only for higher-difficulty (regrouping) problem types. Some previous research in the area has also suggested that the effects of additive interspersal may be powerful enough to result in participants completing more total and target problems on interspersal assignments with higher-level target problems over non-interspersal assignments with lower-level target problems (Billington, Skinner, Hutchins, & Malone, 2004). However, the findings in the current study imply potentially the opposite, as participants completed significantly more total and target problems on the NRPT-NI assignment than on the RPT-I assignment.

Billington and Skinner (2006) suggested that there is a relationship between student preferences for interspersal assignments (such as on the dimensions of difficulty,

effort, and time) and task completion rates. According to these researchers, the reason why participants prefer interspersal assignments is because they are completing more problems. In the current study, participants only completed significantly more total DCPM on the NRPT-I assignment compared to the RPT-I and RPT-NI assignments, as well as the RPT-I assignment compared to the RPT-NI assignment. Significantly more participants preferred the NRPT-I assignment, supporting the previous findings that participants prefer interspersal assignments because they are completing more discrete tasks. However, participants significantly preferred the RPT-I assignment over the RPT-NI assignment only on the dimension of difficulty, even though participants completed significantly more total DCPM on the RPT-I assignment compared to the RPT-NI assignment (it is important to note, however, that the significance level of that finding was only at the .05 level). This may be because the conditioned reinforcer (completed discrete task) is weakened when analyzing DCPM.

Limitations

Although there are some significant findings in the current study, there are some limitations to acknowledge as well. First of all, preferences for assignment type were measured by students either choosing one assignment over the other. This may not present the most accurate preferences in such situations as when students do not prefer either assignment. For this reason, these dependent variables may be better measured by using a Likert-type scale. Additionally, the three preference dependent variables (difficulty, effort to complete, and time to complete) were not specifically defined in operational terms to the participants before they made their preference ratings.

Another limitation regarding the three preference dependent variables is that participant preference for assignment type was measured by a forced-choice decision as opposed to an actual choice. Research shows that there are differences between preference and choice, and that when students choose to complete an assignment, they are more likely to engage in it, which can increase the likelihood of learning occurring (Dunlap, DePerczel, Clarke, Wilson, Wright, White, & Gomez, 1994; Meadows & Skinner, 2005; Billington, et al, 2004). Therefore, choice may be a more powerful predictor of learning than preference.

The fact that participants were only allowed a set amount of time to complete each assignment may be another limitation of the current study. Limiting the amount of time may have prevented participants from completing as many problems (and therefore possibly more total and target DCPM), which may have in turn effected their preferences of assignments because they were not completing as many discrete tasks. However, setting the same specific time limit for all participants allows for a more efficient study, especially since a rate of completion was being calculated as opposed to a quantity.

Another limitation is that much of the data in the current study are in nominal form, which is the most primitive of data and can only be classified & counted, therefore limiting the types of statistical analyses which can be completed to those that are not as robust.

Additionally, all participants in the study were from the same school in the same school district in the southern United States, which may be a problem when trying to generalize results to other populations. A small sample size is another limitation of the

current study, as more participants may have yielded different or more significant findings.

Implications

The findings of the current study imply that the desirable effects of additive interspersal may not be as powerful as previous research utilizing within-subjects designs has suggested. Continued between-subjects analysis of these effects is necessary to better understand the effects of additive interspersal and how this technique can be applied.

According to the current study, additive interspersal may be effective at enhancing students' perceptions of more difficult assignments (in this case, regrouping multiplication problems). This finding may suggest that interspersal is more effective at enhancing students' perceptions when the students are at the acquisition phase for that specific target problem type, as opposed to possibly the fluency or generalization phase (Cates, 2005). However, research is very limited into the effects of interspersal at various stages of learning.

Areas for Future Research

Given the results of the current study and how they differ from the results of previous within-subject studies, it would be beneficial to expand the between-subjects analysis of the effects of interspersal in general. This will allow researchers and practitioners to better understand the implications and possible uses of the additive interspersal technique as a possible academic intervention. It would then also be beneficial to expand the between-subjects analysis of the effects of interspersal to assignments with different interspersal rates, as well as different areas of math and different academic areas.

The results of the current study suggest that differences in response effort between the target problems and added interspersed problems may impact participants' preferences. For example, the current results indicated that at least on the dimension of difficulty, there was a significant preference for the interspersal assignment between the two regrouping problem type assignments, but no significant preference between the two no regrouping problem type assignments. This may be due to the fact that the difference between the response effort required to complete the 1 x 1 interspersed problems and the 3 x 2 regrouping problems was greater than the difference between the response effort to complete the interspersed problems compared to the no regrouping problems. It may be beneficial to further examine the difference in response effort required between target problems and interspersed problems in order to maximize the potential effects of additive interspersal.

Whereas much of the previous research on additive interspersal has measured performance with correct problems, the current study did so using DCPM. This was chosen because it is a more sensitive measure compared to correct problems; however, there are potential issues with using DCPM while using an interspersal procedure. Additive interspersal is based on the theory that the completion of problems becomes conditioned reinforcers because they signal the completion of the overall assignment to come. But when measuring DCPM as opposed to correct problems, the DCPM may become a weaker conditioned reinforcer due to the process of chaining. Research into the differences between DCPM and correct problems is needed to better understand the implications of using one method over the other to measure performance. Once correct

problems per minute are calculated, data from the current study can be used to examine this difference.

Because of the implications of examining preference as opposed to choice, the results of this current study could be enhanced by having participants actually choose an assignment similar to one of the assignment types in the assignment pair after completing each assignment pair. This would allow researchers to further examine the between-subjects effects of additive interspersal in order to see if participants' rated preferences transfer into choice, which can be considered to be a more true measure of preference (Rhymer and Cates, 2006).

Further examining the use of interspersal at varying stages of the learning hierarchy, especially generalization, would allow researchers and practitioners to better understand the effective utilization of the additive interspersal technique (Cates, 2005). The results of the current study suggest that the stage of learning that a student is at may affect the usefulness of the additive interspersal technique, but more specific research into this needed to better understand. Related to this, it would also be beneficial to further examine the effects that errors have on student perceptions of additive interspersal assignments in order to better understand the relationship between performance and perception.

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Appendix A

Dear Parents or Legal Guardians,

We will be conducting a study examining a method that could possibly be used to improve your child's multiplication skills and even make difficult multiplication problems seem simpler and more desirable to practice. The risks of this study to your child are minimal, but could include your child being anxious about completing the measure. This activity, however, is similar to one a student would experience in the classroom, so the effects should be minimal. The results of this study could help researchers develop improved and effective methods of practicing mathematics skills that can possibly be applied by educators in the future. I am asking that your child participate in this study, which will take about forty minute's total (20 minutes each for two sessions taking place one week apart). The study will be conducted in your child's classroom and the children will be informed that they are not expected to be able to complete the whole thing in the time allotted for each assignment.

Consent to participate in this study is completely voluntary. If you do not want your child to participate in this study there will be no penalty. Your child may also choose to withdraw from the study at anytime without penalty. The results of the study may be published, but there will be no identifying information included in this publication. In other words, your child's name and the name of his or her school will not be used.

If you have any questions concerning this study, please feel free to contact me at lanash@eiu.edu or Dr. Kristin Johnson-Gros at kjohnsongros@eiu.edu or (217) 581-8511. If you have any questions about you or your child's rights as a subject/participant in this research or if you feel you or your child have been placed at risk, you can contact the Office of Research and Sponsored Programs at Eastern Illinois University at (217) 581-8453.

Sincerely,

Lindsay Nash
School Psychology Graduate Student

Please return bottom slip by **(DATE TO BE ENTERED)**

_____ I give consent for my child _____ to participate in the above study.

_____ I do not give consent for my child _____ to participate in the above study.

_____ _____

Signature Date

Appendix B

424 x 22	792 x 11	1 x 8	394 x 11	110 x 11		
5 x 6	915 x 11	223 x 22	1 x 3	122 x 33	324 x 22	4 x 2
202 x 31	321 x 21	5 x 2	925 x 11	311 x 31	3 x 9	141 x 11
132 x 33	2 x 1	788 x 11	112 x 20	2 x 3	212 x 21	412 x 12	8 x 2

STOP AND WAIT FOR INSTRUCTIONS!

Appendix C

2 x 2		565 x 55	752 x 85		3 x 4	838 x 73
353 x 71	8 x 7	158 x 85	681 x 36	4 x 7	387 x 37	737 x 45
1 x 5	174 x 37	552 x 42	1 x 2	953 x 95	477 x 81	3 x 6
910 x 59	383 x 92	2 x 2	362 x 28	857 x 71	2 x 5	477 x 21	125 x 62

STOP AND WAIT FOR INSTRUCTIONS!

Appendix D

324 x 21	132 x 13		412 x 22	
893 x 11	478 x 10	413 x 21	221 x 22	111 x 33
402 x 20		112 x 42	134 x 22	122 x 13	314 x 22
444 x 11	884 x 11	112 x 31	203 x 23	102 x 22	

STOP AND WAIT FOR INSTRUCTIONS!

Appendix E

193 x 52	555 x 85	428 x 63			
817 x 27	285 x 28	987 x 55		168 x 49	753 x 23
	744 x 98	349 x 51	858 x 76	527 x 88	337 x 15
	188 x 78	832 x 37	965 x 21	313 x 47	921 x 74

STOP AND WAIT FOR INSTRUCTIONS!

Appendix F

PLEASE CIRCLE ONE RESPONSE FOR EACH QUESTION

1. WHICH WORKSHEET IS **MOST DIFFICULT**?

Worksheet 1 Worksheet 2

2. WHICH WORKSHEET WOULD REQUIRE THE **MOST EFFORT** TO COMPLETE FROM START TO FINISH?

Worksheet 1 Worksheet 2

3. WHICH WORKSHEET WOULD REQUIRE THE **MOST TIME** TO COMPLETE FROM START TO FINISH?

Worksheet 1 Worksheet 2

Appendix G

PLEASE COMPLETE THE FOLLOWING INFORMATION

CIRCLE ONE:

I am a... BOY GIRL

How old are you? _____

Appendix H

DIRECTIONS

Today you are going to be asked to work on two different pairs of multiplication assignments. Try to finish as many problems as possible correctly. Work from left to right without skipping any problems. Stop when you reach the bottom of the page or when I tell you that you can stop. Try to do your best work. When you are done with each pair of assignments, you will be asked to answer a few questions about yourself and about the assignments that you are going to do. You can stop doing any of the assignments at any time if you want to. Are there any questions?

[Pass out packets]

When I say "Go", please flip to the next page in the packet. This is Worksheet 1. When you are done, do NOT turn the page again, just put your pencil down. Remember, work from left to right without skipping any problems. Stop when you reach the bottom of the page or when I tell you that you can stop. Go.

[Begin timing for 5 minutes]

[When time is up] Stop. Now when I say "Go" again, please flip to the next page in the packet. This is Worksheet 2. When you are done, do NOT turn the page again, just put your pencil down. Remember, work from left to right without skipping any problems. Stop when you reach the bottom of the page or when I tell you that you can stop. Go.

[Begin timing for 5 minutes]

[When time is up] Stop. Now you can turn the page and fill out the questions on the next page. Remember, the first worksheet in this pair was Worksheet 1 and the second worksheet was Worksheet 2. When you are finished, do not turn the page, just put your pencil down.

Now you are going to work on another pair of assignments. When I say "Go", please flip to the next page in the packet. This is Worksheet 1. When you are done, do NOT turn the page again, just put your pencil down. Remember, work from left to right without skipping any problems. Stop when you reach the bottom of the page or when I tell you that you can stop. Go.

[Begin timing for 5 minutes]

[When time is up] Stop. Now when I say "Go" again, please flip to the next page in the packet. This is Worksheet 2. When you are done, do NOT turn the page again, just put your pencil down. Remember, work from left to right without skipping any problems. Stop when you reach the bottom of the page or when I tell you that you can stop. Go.

[Begin timing for 5 minutes]

[When time is up] Stop. Now you can turn the page and fill out the questions on the next two pages. Remember, the first worksheet in this pair was Worksheet 1 and the second worksheet was Worksheet 2. When you are finished, please fill out the last page in the packet by circling whether you are a boy or a girl, and then by writing how old you are.

Thank you for helping me out today!

Table 1

All Possible Orders of Assignments

Assignment Pair 1		Assignment Pair 2	
Assignment 1	Assignment 2	Assignment 3	Assignment 4
NRPT-NI	NRPT-I	NRPT-NI	RPT-I
NRPT-NI	NRPT-I	NRPT-NI	RPT-NI
NRPT-NI	NRPT-I	NRPT-I	RPT-I
NRPT-NI	NRPT-I	NRPT-I	RPT-NI
NRPT-NI	NRPT-I	RPT-I	RPT-NI
NRPT-NI	RPT-I	NRPT-NI	RPT-NI
NRPT-NI	RPT-I	NRPT-I	RPT-I
NRPT-NI	RPT-I	NRPT-I	RPT-NI
NRPT-NI	RPT-I	RPT-I	RPT-NI
NRPT-NI	RPT-NI	NRPT-I	RPT-I
NRPT-NI	RPT-NI	NRPT-I	RPT-NI
NRPT-NI	RPT-NI	RPT-I	RPT-NI
NRPT-I	RPT-I	NRPT-I	RPT-NI
NRPT-I	RPT-I	RPT-I	RPT-NI
NRPT-I	RPT-NI	RPT-I	RPT-NI
NRPT-NI	RPT-I	NRPT-NI	NRPT-I
NRPT-NI	RPT-NI	NRPT-NI	NRPT-I
NRPT-I	RPT-I	NRPT-NI	NRPT-I
NRPT-I	RPT-NI	NRPT-NI	NRPT-I
RPT-I	RPT-NI	NRPT-NI	NRPT-I
NRPT-NI	RPT-NI	NRPT-NI	RPT-I
NRPT-I	RPT-I	NRPT-NI	RPT-I
NRPT-I	RPT-NI	NRPT-NI	RPT-I
RPT-I	RPT-NI	NRPT-NI	RPT-I
NRPT-I	RPT-I	NRPT-NI	RPT-NI
NRPT-I	RPT-NI	NRPT-NI	RPT-NI
RPT-I	RPT-NI	NRPT-NI	RPT-NI
NRPT-I	RPT-NI	NRPT-I	RPT-I
RPT-I	RPT-NI	NRPT-I	RPT-I
RPT-I	RPT-NI	NRPT-I	RPT-NI

Table 2

Results of the Pairwise Comparisons of Difficulty Using a Bonferroni Correction

Comparison	Chi-square	*p*	Cramer's *V*
NRPT-NI vs. RPT-NI	64.10*	<.001	.61
NRPT-I vs. RPT-I	38.36*	<.001	.48
RPT-NI vs. NRPT-I	75.94*	<.001	.66
NRPT-NI vs. RPT-I	29.26*	<.001	.42
NRPT-NI vs. NRPT-I	.51	.48	.07
RPT-NI vs. RPT-I	8.11*	.004	.23

*$p < .008$

Table 3

Results of the Pairwise Comparisons of Difficulty

Comparison	Assignment			
	NRPT-NI n (%)	NRPT-I n (%)	RPT-NI n (%)	RPT-I n (%)
RPT-NI vs. NRPT-NI	66 (85%)	-	12 (15%)	-
RPT-I vs. NRPT-I	-	71 (71%)	-	29 (29%)
RPT-NI vs. NRPT-I	-	71 (86%)	12 (14%)	-
RPT-I vs. NRPT-NI	66 (70%)	-	-	29 (30%)
RPT-I vs. RPT-NI	-	-	12 (29%)	29 (71%)

Table 4

Results of the Pairwise Comparisons of Effort Using a Bonferroni Correction

Comparison	Chi-square	*p*	Cramer's *V*
NRPT-NI vs. RPT-NI	12.95*	<.001	.28
NRPT-I vs. RPT-I	8.11*	.004	.23
RPT-NI vs. NRPT-I	11.90*	.001	.27
NRPT-NI vs. RPT-I	8.99*	.003	.24
NRPT-NI vs. NRPT-I	.000	1.00	.01
RPT-NI vs. RPT-I	.22	.64	.05

*$p < .008$

Table 5

Results of the Pairwise Comparisons of Effort

Comparison	Assignment			
	NRPT-NI n (%)	NRPT-I n (%)	RPT-NI n (%)	RPT-I n (%)
RPT-NI vs. NRPT-NI	56 (64%)	-	31 (36%)	-
RPT-I vs. NRPT-I	-	55 (61%)	-	35 (39%)
RPT-NI vs. NRPT-I	-	55 (64%)	31 (36%)	-
RPT-I vs. NRPT-NI	56 (62%)	-	-	35 (38%)

Table 6

Results of the Pairwise Comparisons of Time Using a Bonferroni Correction

Comparison	Chi-square	*p*	Cramer's *V*
NRPT-NI vs. RPT-NI	30.77*	<.001	.43
NRPT-I vs. RPT-I	21.60*	<.001	.36
RPT-NI vs. NRPT-I	27.56*	<.001	.41
NRPT-NI vs. RPT-I	24.50*	<.001	.38
NRPT-NI vs. NRPT-I	.03	.87	.02
RPT-NI vs. RPT-I	.24	.63	.05

*$p < .008$

Table 7

Results of the Pairwise Comparisons of Time

Comparison	Assignment			
	NRPT-NI n (%)	NRPT-I n (%)	RPT-NI n (%)	RPT-I n (%)
RPT-NI vs. NRPT-NI	63 (72%)	-	25 (28%)	-
RPT-I vs. NRPT-I	-	61 (68%)	-	29 (32%)
RPT-NI vs. NRPT-I	-	61 (71%)	25 (29%)	-
RPT-I vs. NRPT-NI	63 (69%)	-	-	29 (31%)

Table 8

Results of the Pairwise Comparisons of Difficulty Within Assignment Pairs Using a Bonferroni Correction

Comparison	Chi-square	*p*	Cramer's *V*
NRPT-NI and NRPT-I vs. NRPT-NI and RPT-I	46.72*	<.001	.62
NRPT-NI and NRPT-I vs. NRPT-NI and RPT-NI	46.18*	<.001	.63
NRPT-NI and NRPT-I vs. NRPT-I and RPT-I	38.74*	<.001	.57
NRPT-NI and NRPT-I vs. NRPT-I and RPT-NI	33.96*	<.001	.55
NRPT-NI and RPT-I vs. NRPT-NI and RPT-NI	15.06*	.001	.36
NRPT-NI and RPT-I vs. RPT-NI and RPT-I	95.63*	<.001	.89

NRPT-NI and RPT-I vs. NRPT-I and RPT-I	118.00*	<.001	1.00
NRPT-NI and RPT-NI vs. RPT-I and RPT-NI	98.19*	<.001	.91
NRPT-I and RPT-I vs. NRPT-I and RPT-NI	4.57	.03	.24
NRPT-I and RPT-I vs. RPT-NI and RPT-I	96.71*	<.001	.91
NRPT-I and RPT-NI vs. RPT-I and RPT-NI	120*	<.001	1.00

*$p < .003$

Table 9

Results of the Pairwise Comparisons of Difficulty Within Assignment Pairs

Comparison	Assignment Type			
	NRPT-NI n (%)	NRPT-I n (%)	RPT-NI n (%)	RPT-I n (%)
NRPT-NI/NRPT-I and NRPT-NI/RPT-I	28 (47%) 53 (88%)	-	-	-
NRPT-NI/NRPT-I and NRPT-NI/RPT-NI	28 (47%) 50 (86%)	-	-	-
NRPT-NI/RPT-I and NRPT-NI/RPT-NI	53 (88%) 50 (86%)	-	-	-
NRPT-I/NRPT-NI and NRPT-I/RPT-I	-	32 (53%) 52 (90%)	-	-
NRPT-I/RPT-NI and NRPT-I/NRPT-NI	-	60 (100%) 32 (53%)	-	-
RPT-I/RPT-NI and RPT-I/NRPT-NI	-	-	-	47 (78%) 7 (12%)
RPT-I/NRPT-I and RPT-I/RPT-NI	-	-	-	6 (10%) 47 (78%)
RPT-I/NRPT-NI and RPT-I/NRPT-I	-	-	-	7 (12%) 6 (10%)
RPT-NI/NRPT-NI and RPT-NI/NRPT-I	-	-	8 (14%) 0 (0%)	-
RPT-NI/NRPT-NI and RPT-NI/RPT-I	-	-	8 (14%) 13 (22%)	-
RPT-NI/NRPT-I and RPT-NI/RPT-I	-	-	0 (0%) 13 (22%)	-

Table 10

Results of the Pairwise Comparisons of Effort Within Assignment Pairs Using a Bonferroni Correction

Comparison	Chi-square	*p*	Cramer's *V*
NRPT-NI and NRPT-I vs. NRPT-NI and RPT-I	42.57*	<.001	.60
NRPT-NI and NRPT-I vs. NRPT-NI and RPT-NI	56.05*	<.001	.69
NRPT-NI and NRPT-I vs. NRPT-I and RPT-I	56.56*	<.001	.69
NRPT-NI and NRPT-I vs. NRPT-I and RPT-NI	47.20*	<.001	.63
NRPT-NI and RPT-I vs. NRPT-NI and RPT-NI	43.55*	<.001	.61
NRPT-NI and RPT-I vs. RPT-NI and RPT-I	86.08*	<.001	.85

NRPT-NI and RPT-I vs. NRPT-I and RPT-I	93.10*	<.001	.89
NRPT-NI and RPT-NI vs. RPT-I and RPT-NI	67.48*	<.001	.76
NRPT-I and RPT-I vs. NRPT-I and RPT-NI	35.74*	<.001	.55
NRPT-I and RPT-I vs. RPT-NI and RPT-I	59.75*	<.001	.71
RPT-NI and NRPT-NI vs. RPT-NI and NRPT-I	93.10*	<.001	.89
NRPT-I and RPT-NI vs. RPT-I and RPT-NI	96.26*	<.001	.90

*$p < .003$

Table 11

Results of the Pairwise Comparisons of Effort Within Assignment Pairs

Comparison	Assignment Type			
	NRPT-NI n (%)	NRPT-I n (%)	RPT-NI n (%)	RPT-I n (%)
NRPT-NI/NRPT-I and NRPT-NI/RPT-I	32 (53%) 49 (82%)	-	-	-
NRPT-NI/NRPT-I and NRPT-NI/RPT-NI	32 (53%) 30 (52%)	-	-	-
NRPT-NI/RPT-I and NRPT-NI/RPT-NI	49 (82%) 30 (52%)	-	-	-
NRPT-I/NRPT-NI and NRPT-I/RPT-I	-	28 (47%) 34 (59%)	-	-
NRPT-I/RPT-NI and NRPT-I/NRPT-NI	-	52 (87%) 28 (47%)	-	-
NRPT-I/RPT-I NRPT-I/RPT-NI	-	34 (59%) 52 (87%)	-	-
RPT-I/RPT-NI and RPT-I/NRPT-NI	-	-	-	37 (62%) 11 (18%)
RPT-I/NRPT-I and RPT-I/RPT-NI	-	-	-	24 (41%) 37 (62%)
RPT-I/NRPT-NI and RPT-I/NRPT-I	-	-	-	11 (18%) 24 (41%)
RPT-NI/NRPT-NI and RPT-NI/NRPT-I	-	-	28 (48%) 8 (13%)	-
RPT-NI/NRPT-NI and RPT-NI/RPT-I	-	-	28 (48%) 23 (38%)	-
RPT-NI/NRPT-I and RPT-NI/RPT-I	-	-	8 (13%) 23 (38%)	-

Table 12

Results of the Pairwise Comparisons of Time Within Assignment Pairs Using a Bonferroni Correction

Comparison	Chi-square	*p*	Cramer's *V*
NRPT-NI and NRPT-I vs. NRPT-NI and RPT-I	35.59*	<.001	.55
NRPT-NI and NRPT-I vs. NRPT-NI and RPT-NI	44.03*	<.001	.61
NRPT-NI and NRPT-I vs. NRPT-I and RPT-I	54.90*	<.001	.68
NRPT-NI and NRPT-I vs. NRPT-I and RPT-NI	53.54*	<.001	.67
NRPT-NI and RPT-I vs. NRPT-NI and RPT-NI	30.87*	<.001	.51
NRPT-NI and RPT-I vs. RPT-NI and RPT-I	90.75*	<.001	.87

NRPT-NI and RPT-I vs. NRPT-I and RPT-I	99.53*	<.001	.92
NRPT-NI and RPT-NI vs. RPT-I and RPT-NI	77.01*	<.001	.81
NRPT-I and RPT-I vs. NRPT-I and RPT-NI	18.61*	<.001	.40
NRPT-I and RPT-I vs. RPT-NI and RPT-I	81.29*	<.001	.83
RPT-NI and NRPT-NI vs. RPT-NI and NRPT-I	99.53*	<.001	.92
NRPT-I and RPT-NI vs. RPT-I and RPT-NI	101.33*	<.001	.92

*$p < .003$

Table 13

Results of the Pairwise Comparisons of Time Within Assignment Pairs

Comparison	Assignment Type			
	NRPT-NI n (%)	NRPT-I n (%)	RPT-NI n (%)	RPT-I n (%)
NRPT-NI/NRPT-I and NRPT-NI/RPT-I	36 (60%) 51 (85%)	-	-	-
NRPT-NI/NRPT-I and NRPT-NI/RPT-NI	36 (60%) 38 (66%)	-	-	-
NRPT-NI/RPT-I and NRPT-NI/RPT-NI	51 (85%) 38 (66%)	-	-	-
NRPT-I/NRPT-NI and NRPT-I/RPT-I	-	24 (40%) 46 (79%)	-	-
NRPT-I/RPT-NI and NRPT-I/NRPT-NI	-	54 (90%) 24 (40%)	-	-
NRPT-I/ RPT-I NRPT-I/RPT-NI	-	46 (79%) 54 (90%)	-	-
RPT-I/RPT-NI and RPT-I/NRPT-NI	-	-	-	39 (65%) 9 (15%)
RPT-I/NRPT-I and RPT-I/RPT-NI	-	-	-	12 (21%) 39 (65%)
RPT-I/NRPT-NI and RPT-I/NRPT-I	-	-	-	9 (15%) 12 (21%)
RPT-NI/NRPT-NI and RPT-NI/ NRPT-I	-	-	20 (35%) 6 (10%)	-
RPT-NI/NRPT-NI and RPT-NI/ RPT-I	-	-	20 (34.5%) 21 (35%)	-
RPT-NI/NRPT-I and RPT-NI/RPT-I	-	-	6 (10%) 21 (35%)	-

Table 14

Descriptive Statistics of Total and Target DCPM

Assignment Type	Total DCPM Mean	Total DCPM Standard Deviation	Target DCPM Mean	Target DCPM Standard Deviation
NRPT-NI	9.72	3.52	9.72	3.52
RPT-NI	4.29	2.07	4.29	2.07
NRPT-I	10.86	3.77	9.02	3.54
RPT-I	5.59	2.25	4.32	1.97

Table 15

MANOVA SUMMARY TABLE

Sources of Variance	*SS*	*df*	*MS*	*F*	*p*	*Parital Eta Squared*	*Power*
Main Effect of Assignment Type on Total DCPM	2686.62	3	895.54	99.56	<.001	.46	1.00
Main Effect of Assignment Type on Target DCPM	2306.60	3	768.87	92.90	<.001	.44	1.00
Residual (or Within Group) of Total DCPM	3166.39	352	9.00				
Residual (or Within Group) of Target DCPM	2913.24	352	8.28				