INCREASING HOMEWORK COMPLETION AND ACCURACY AMONG MATHEMATICS STUDENTS USING THE JARS GAME

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Project Certification Page

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CERTIFICATION OF PROJECT WORK
We, the undersigned, certify that this project entitled Increasing Homework Completion and Accuracy for Middle School Mathematics Students Using Mystery Motivators by Debra Zibreg Hargis, Candidate for the Degree of Master of Science in Education, Department of Curriculum & Instruction, is acceptable in form and content and demonstrates a satisfactory knowledge of the field covered by this project.

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Abstract

Homework is a teaching strategy used in mathematics to promote student mastery of new material through practice. In addition, homework completion and accuracy has a positive effect on academic achievement (Madaus, Kehle, Madaus, & Bray, 2003). Unfortunately, the literature also suggests that many students fail to complete homework and many others fail to do so at appropriate levels of success. As such, classroom teachers are in need of effective, efficient, and socially acceptable interventions that can improve the homework-related performance of all their students. The present study examined the effects of the jars intervention, a combination of interdependent and dependent group contingencies with randomized behaviors, criteria, and rewards, on the homework completion and accuracy of an 8th grade math class. The jars game produced immediately and educationally important improvements in all students' completion and accuracy rates and replicated these effects across subsequent experimental phases. Teachers and pupils rated intervention goals, procedures, and outcomes quite favorably. Implications for future research and practice are discussed.

Consistent and accurate homework completion has shown to be important for effective student learning; in addition, homework completion and accuracy has a positive overall impact on academic achievement (Cooper, Robinson, & Patall, 2006; Little, Akin-Little, & Newman-Fig, 2010; Madaus et al., 2003; Olympia, Sheridan, Jenson, & Andrews, 1994; Paschal, Weinstein, Walberg, 1984; and Trautwein, 2007). The academic benefits associated with homework include improving the retention and understanding of content material (Gajria & Salend, 1995), promoting the mastery of new material through practice, and demonstrating the students' mastery of content material (Epstein & Van Voorhis, 2001). Alternatively, not completing homework and completing homework with errors does not promote effective student learning of content material (Olympia et al., 1994). Since homework has academic benefits, researchers have studied many interventions to increase homework completion and accuracy.

Applied behavior researchers identified group contingencies as a potentially powerful intervention for improving the performance of *groups* of students by applying the same reinforcement criteria across all group members. Reinforcement was given based on participants meeting a certain criteria (Kelshaw-Levering, Sterling-Turner, Henry, & Skinner, 2000). Group contingency interventions were originally defined by Litow and Pumroy (1975) as independent, interdependent, or dependent. Litow and Pumroy conceptualized the independent group contingency as each individual student having the opportunity to receive reinforcement if he or she met the criteria set forth for all students in the classroom (1975). An example of an independent group contingencies used in a classroom is student grades; every student in the classroom has the same expectations for a specific grade and each student is responsible for their own performance. The interdependent group contingency was defined by Litow and Pumroy as a strategy where students earned rewards if *every* student in the group or specified groups of

students attained certain performance levels; each student was *interdependent* on others to gain reinforcers. The dependent group contingency, on the other hand, was in effect when the performance of one or a few group members determined access to rewards for the entire group (Litow & Pumroy, 1975). All three group contingencies have been shown to: (a) reduce inappropriate classroom behavior and (b) increase academic achievement (McKissick, Hawkins, Lentz, Hailly, & McGuire, 2010; Skinner, Skinner, & Burton, 2009; Theodore, Bray, & Kehle, 2004).

The present study investigated the effects of an interdependent and dependent group contingency intervention (i.e., jars game) on the homework completion and accuracy rates for an 8th grade math class. The jars intervention also randomized three specific components of the group contingencies: (a) target behaviors (completion versus accuracy), (b) criteria (80% to 100% completion and accuracy), and (c) rewards. Previous research suggested that successfully and consistently completing homework has helped students with disabilities increase their academic achievement (Salend & Gajria, 1995) and interdependent and dependent group contingencies had positive effects on numerous elementary classrooms (e.g., Lynch, Theodore, Bray, & Kehle, 2009; Reinhardt, Theodore, Bray, & Kehle, 2009; and Theodore et al., 2009). This research was a partial replication of Reinhardt et al. (2009) and Theodore et al. (2009). The primary research question is: What effects will the jars intervention, a combination of dependent and interdependent group contingencies with randomized components, have on the homework completion and accuracy of students in a rural 8th grade math classroom?

Literature Review

Positive, proactive, evidence-based practices are critical to teacher success in 21st Century inclusive classrooms (Simonsen, Fairbanks, Briesch, Myers, & Sugai, 2008). Teachers

must provide safe, encouraging, and productive learning environments in which all children can maximize their academic and behavioral potential. One common and long-standing practice in our public schools is the use of homework. Although the topic has generated must debate and heat over the years, it has not always yielded sufficient "light" or new knowledge about its utility and impact on pupil learning. We do know, however, that consistent homework completion and accuracy correlates positively with improved academic achievement (Simonsen et al., 2008). We also know, however, that many pupils do not complete homework and when they do, their performance is not very accurate (Olympia et al., 1994; Salend & Gajria, 1995). As such, teachers need evidence-based practices that improve their students' homework completion and accuracy rates and hopefully their overall academic achievement (Sharp & Skinner, 2004; Theodore et al., 2009). Researchers have successfully identified many different strategies that have a positive effect on homework completion and accuracy; however, many of these are not efficient and easy for teachers to implement (Olympia et al., 1994).

Homework

Homework is used as a pedagogical tool to promote learning across most, if not, all grade levels (Olympia et al., 1994). Consistent and accurate homework completion and accuracy has been associated with improved academic and interpersonal skills (Salend & Gajria, 1995)), more time on task (Epstein & Van Voorhis, 2001), and improved test scores and student mastery (Epstein & Van Voorhis, 2001; Gajria & Salend, 1995; Salend & Gajria, 1995). Specifically, the academic benefits of homework include increased student understanding and retention of class material (Gajria & Salend, 1995).

Researchers have studied many classroom interventions to increase students' academic achievement (Skinner, Williams, & Neddenriep, 2004). Homework interventions identified to

improve academic achievement include: (a) school-based programs (e.g. after-school programs, during school programs, parent-teacher communications, cooperative homework teams, and parent volunteers), and (b) home-based programs (e.g. parental involvement programs, parent training, and family-school improvement programs). The school-based and home-based programs have distinct disadvantages that include high costs, increased amounts of teacher time, and difficulty of implementation in classroom environments (Hill & Tyson 2009; Trautwein & Lüdtke, 2006). Teachers acceptability and student satisfaction are necessary factors for classroom teachers to choose to implement an intervention (Skinner, Cashwell, & Dunn, 1996). Teachers and students have reported group contingency interventions as highly favorable and highly acceptable for use in the classroom (Skinner et al., 1996; Skinner, Skinner, Skinner, & Cashwell, 1999).

Given that homework improves content acquisition when newly learned skills are involved (Hill & Tyson, 2009; Hughes, Ruhl, Schumaker, & Deshles, 2002; Madaus et al., 2003), it is essential that mathematics teachers have practical and effective methods to improve and promote homework completion and accuracy for all students. Trautwein and Lüdtke (2006) demonstrated that students' conscientiousness consistently predicted their homework motivation and behavior. As students' conscientiousness increased there was a positive effect on their homework effort (Trautwein, 2007). Student conscientiousness was also positively related to homework completion and accuracy (Thorne & Kamps, 2008; Trautwein, 2007). In addition, students' cognitive abilities were not predictive of homework motivation or behavior. Thus student conscientiousness was an important factor to consider in designing homework completion interventions (Trautwein & Lüdtke, 2006).

Improving homework completion and accuracy was one area studied by researchers to increase academic performance (Skinner et al., 2004). Effective classroom management strategies were important to improve appropriate student behaviors, promote positive student interactions, and increase instructional time (Campbell & Skinner, 2004; McKissick et al., 2010). One group of effective classroom interventions was group contingencies; which were reported to be preferable to individual interventions because of their efficiency and generalized effects on classrooms of students (Heering & Wilder, 2006).

Group Contingency

Group contingency interventions have been successful in classroom environments because they are inexpensive, time efficient, easy to implement, and generally well-liked by teachers and students (Heering & Wilder, 2006; Skinner et al., 2009). The applied behavioral definition for a classroom group contingency intervention involves the application of operant techniques to the behavioral management of a group of students in a classroom by applying the same criteria for reinforcement across all group members. Research in the field of applied behavior analysis indicates that all group contingency programs (i.e., independent, dependent, and interdependent) have been effective in both increasing academic and behavior success in both special and general education classrooms (e. g., Alric, Bray, Kehle, Chafouleas, & Theodore, 2007; Baer & Richards, 1980; Bennett, 2007; Cooper et al., 2006; Hansen & Lignugaris-Kraft, 2005; Hulac & Benson, 2010; Little et al., 2010; Lynch et al., 2009; Skinner, Pappas, & Davis, 2005; Theodore, Bray, & Kehle, 2004; Thorne & Kamps, 2008; Skinner et al., 2009). However, each of the three types of group contingencies had advantages and disadvantages based on the intended setting and target behavior modification (Baer & Richards, 1980).

Skinner et al. (1996) identified the parts of a group contingency as target behavior, criteria, and reinforcement. Independent group contingencies require the same criteria for reinforcement for all students; however, the reinforcement is given individually based on the *independent* performance of each student in meeting criteria. Research showed, however, that independent group contingencies were not efficient, time-saving interventions for routine classroom management (Skinner et. al., 1996). In addition, some negative side effects were associated with the use of independent group contingencies such as (a) legal and ethical issues, (b) lying or stealing to get a reinforcer, (c) diminished performance in other academic domains, (d) variable reward strength among pupils and (e) the creation of a *class system* (i.e., winners and losers) in the classroom (Skinner et al., 1996). Given the potential negative side-effects of independent group contingencies, many researchers have recommended the use of interdependent and dependent group contingencies to improve students' academic, social, and classroom behaviors (Skinner et al., 1996).

Dependent Group Contingency

Dependent group contingencies (DGC) are similar to interdependent group contingencies. DGC are interventions in which all members in the group are reinforced if a specific individual or small group of individuals meets a criterion (Litow & Pumroy, 1975). It is the performance of the *randomly-selected* targeted student(s) that determines whether the class as a whole receives the reinforcement (Heering & Wilder, 2006; Theodore, Bray, Kehle, DioGuardi, 2003). Since student's peers are involved in the intervention as part of the process for behavioral change, student socialization and cooperation are improved as a result of this form of intervention (Theodore et al., 2003).

Dependent group contingency interventions have practical advantages for classroom teachers as well. Since all-or-none of the students receive access to reinforcement, this should reduce interpersonal student conflicts (Campbell & Skinner, 2004). Research has shown the use of dependent group contingency can also increase on-task behavior in general and special education classrooms (Hansen & Lignugaris-Kraft, 2005; Tankersley, 1995). The literature also indicated that dependent group contingency interventions were successful with homework completion and academic achievement (Kelshaw-Levering et al., 2000; Theodore, Bray, Kehle, & Jenson, 2001). However, the comparison of group contingencies to improve homework completion and accuracy for students with disabilities concluded the three group contingencies were equally effective in promoting academic and social behavior (Lynch, et al., 2009).

Interdependent Group Contingency

Interdependent group contingencies are those in which all members in the group are reinforced if an individual or small group of individuals meets a criterion (Litow & Pumroy, 1975). It was the performance of the randomly selected targeted student that determined whether the class as a whole received the reinforcement (Theodore et al., 2003). Since student's peers were involved in the intervention as part of the process for behavioral change, student socialization and cooperation were improved as a result of this intervention (Theodore et al., 2003).

Randomization.

Randomization was a technique initially used by applied behavior researchers to keep the students' attentive and engaged in the intervention (Kehle, Madaus, Baratta, & Bray, 1998). Researchers have increased the effect of the interdependent group contingency with the randomization of criteria for reinforcement (Kelshaw-Levering et al., 2000; Little et al., 2010;

Sharp & Skinner, 2004; Theodore et al., 2004; Theodore et al., 2001; Theodore et al., 2009). The criteria for the target behavior were randomly selected from a jar that held slips of papers specifying different criterion values. The Kelshaw-Levering et al study showed that the randomization of criteria can decrease inappropriate classroom behavior. Researchers concluded the students were motivated to change their behavior because they did not know what reward criterion would be selected (Skinner et al., 1996).

Randomization of reinforcers was apparent in an intervention called Mystery Motivators (Jenson, Rhode, & Reavis, 1994). The reinforcer was a reward that remained a mystery until it was randomly selected. Randomized reinforcers were used to motivate when randomly selected from a jar that held paper slips specifying rewards (Kelshaw-Levering et al., 2000). Since the reward was a mystery, students were less likely to become disappointed for not earning the most desirable reward (Skinner et al., 1996).

When randomized criteria and reinforcers were studied using a dependent group contingency intervention, results showed substantial reductions in disruptive behaviors (Kelshaw-Levering et al., 2000; Theodore et al., 2001). When randomized criteria and randomized reinforcers were incorporated with an interdependent group contingency intervention immediate and substantial reductions in disruptive behaviors were noted as well (Theodore et al., 2003). Theodore (2003) stated, however, that the interdependent intervention was more successful overall than the dependent group contingency.

Kelshaw-Levering et al., (2000) suggested further that randomizing multiple components as well as simply randomizing reinforcers within interdependent group contingencies (i.e., access to reinforcement contingent on the behavior of the group) produced desired behavior changes compared to baseline data. In this study, the teacher provided feedback to students halfway

through the day for students to modify their behavior as necessary (Kelshaw-Levering et al., 2000).

Homework & Group Contingencies.

Group contingencies used student-managed individual and group contingencies to improve homework completion and accuracy (Olympia et al., 1994). This research used two parallel conditions replicated across sixteen 6th grade general education students. All students were identified as having math difficulties in general and homework completion problems in particular. The use of the group contingencies increased all students' homework completion rates, however accuracy levels varied significantly among students.

Lynch and her colleagues (2009) examined whether group contingencies and randomized reinforcers would increase the rate of students' homework completion and accuracy. In addition, they compared the differential effects of randomized independent, interdependent, and dependent group contingencies. The study examined the homework performance of students in a self-contained, suburban, elementary classroom. All students were diagnosed with either learning disabilities or Speech or Language Impairments. Homework completion was defined as the math assignment turned in to the classroom teacher first thing in the morning with all problems completed; homework accuracy was defined as the percentage of correct answers on each assignment (Lynch et al., 2009).

Collectively, the literature shows that interdependent and dependent group contingency interventions with randomized criterion and reinforcers can improve homework completion and accuracy (Lynch et al., 2009). Moreover, teachers and students rate these types of interventions quite favorably. Degree of teacher satisfaction is important to sustained intervention use. The

most successful intervention will not be effective if they are too complicated, time-consuming, and/or expensive to use.

Social validity

The social value of interventions may be just as important as their effectiveness. Witt and Martens (1985) suggested, for example, that interventions should not only be effective in changing behavior, but that they should be *socially acceptable* or liked as well. Witt and Martens (1983) developed and analyzed the *Intervention Rating Profile* (IRP) as a tool to assess the acceptability of classroom interventions. This instrument was developed to measure the appropriateness of interventions, the amount of time needed to implement them, and any potential adverse risks or effects on students (Witt & Martens, 1983). Chafouleas, Briesch, Riley-Tillman and McCoach (2009) developed a self-reporting measure of an intervention's usage called the *Usage Rating Profile-Intervention* (USP-I). Their research found that teachers were more likely to use interventions they found to be acceptable and effective. Similar findings were reported on the use of the USP-I.

The specific question now is how the use of an interdependent and dependent group contingencies with randomized components (i.e., target behaviors, criteria, and rewards) will affect the homework completion and accuracy rates of an 8th grade, math inclusion class in a rural school district. They have been used successfully in general education classrooms (Little et al., 2010; Lynch et al., 2009; Skinner, Skinner, & Burton, 2009; Theodore et al., 2009) and were reported to be preferable to individual interventions because of the efficiency and generalized effects (Heering & Wilder, 2006). The primary research question is, What effects will the jars intervention, an interdependent group contingency with randomized components, have on the homework completion and accuracy rates of an entire 8th grade classroom, as well as two

specific target students (i.e., one average and one low performer)? Relatedly, how socially acceptable will pupils and their teachers rate the jars intervention?

Method

Participants and Setting

Seventeen students attending a Western New York rural public school district participated in this study. Just over half (51%) of the district's student population was eligible for free and/or reduced-price lunches. The racial/ethnical composition of the district population was: (a) 96% Caucasian, (b) 2% Hispanic, and (c) 2% African-American or other. District-wide achievement results on the New York State Grade 6 Mathematics Assessment were slightly higher than total scores for the state as a whole.

One 8th grade middle school mathematics inclusion class was selected for participation based upon their poor homework performance. The class had a total of 17 students (10M, 7F) between the ages of 13 and 14 years old. Ten students had Individual Education Plans (IEPs) for various learning disabilities, although specific learning challenges were not shared the investigator. It was revealed, however, that the majority of pupils did not regularly complete math homework and when they did their performance was below expectations. Students were enrolled in an 8th grade class taught by a mathematics general education teacher and a consultant teacher (i.e., special education) who had 15 and 25 years of teaching experience respectively. The consultant teacher was assigned full-time to this classroom to support students with special needs. The classroom and consulting teacher were responsible for daily math instruction and assisted with study implementation. The investigator, a female with 3 years of teaching experience, was primarily responsible for the development of study-related materials, student and teacher training, and data collection and analysis. The study was conducted during pupils'

regularly-scheduled, 55-minute math periods. The class was arranged physically into a series of five rows of individual pupil desks that were all facing the front of the classroom. The math educator was primarily responsible for lesson development and implementation, while the consultant teacher provided individualized assistance to students with special needs on an as needed basis. Homework assignments were typically assigned four days per week and consisted of five to 10 math problems. Math topics covered over the course of the study included: (a) proportional reasoning evaluating percentage problems, (b) multiplication and division of polynomials, and (c) transformational geometry (reflections, rotations, translations, and dilations. The teacher walked around the classroom to check the homework of every student and completion accuracy scores were recorded. While the teacher was checking the homework the students were working individually on review problems.

Dependent Variables

There were four dependent variables in the present study: (a) percentage of homework assignments completed, (b) percentage correct on completed math assignments, as well as (c) pupil and teacher satisfaction ratings. Homework completion was defined as the successful completion and submission of all assigned math problems upon arrival to class (i.e., before the bell rang). For an item to be considered "completed", students must make an overt written response to each item; irrelevant written responses were not counted. For each item a pupil failed to provide a written response was marked as "not complete". The investigator then calculated the percentage written responses completed for each pupil. The investigator calculated the number of students who completed assignments by dividing the number of completed assignments by the number of students in the classroom times 100%.

Homework accuracy was defined as the percentage of problems solved correctly on daily homework assignments. The classroom teacher checked each homework item and deemed it either correct or incorrect. No partial credit was provided for individual items. Percentage correct was calculated as the number of items correct divided by the number correct and incorrect times 100%. Homework completion and accuracy percentages were aggregated at the classroom level and plotted on simple line graphs. In addition, individual data charts were created for the highest and lowest performing students during initial baseline assessments.

The third and fourth dependent measures were pupil and teacher social validity assessments. The pupils' consumer satisfaction surveys included 19-item, 5-point, Likert-type item based on Bray and Kehle's (1996) index. Pupils were asked to rate the two jars intervention in terms of the: (a) importance of intervention *goals* (e.g., how important is it to do well in math class and to complete homework), (b) acceptability of intervention *procedures* (e.g., using the jars to set criteria, determine whose performance was evaluated, and earn mystery rewards), and (c) satisfaction with intervention *outcomes* (e.g., improved grades in math, helped learn content better, and help complete more work). Survey items were scored on a 5-point scale where 1 = not important at all, not acceptable at all, and not satisfied at all and 5 = very important goal, liked it a lot, and very satisfied. Higher mean ratings (approaching 5.0) reflected more positive perceptions of intervention goals, procedures, and outcomes. In addition, students were asked to indicate the extent to which the intervention: (a) was fair, (b) should be done in other classes, and (b) could be harmful to other students.

A teacher satisfaction survey was constructed using acceptability items from previous research with group contingencies and rewards (Chafouleas et al., 2009; Witt &Martens, 1983). This particular scale included 28 items clustered around three headings: (a) *Acceptability*, (b)

Understanding, and (c) *Feasibility* (see Appendix B). The classroom and consulting teachers were asked to rate the extent to which they agreed or disagreed with each item using a 5-point, Likert-type scale (i.e., 1 = strongly disagree and 5 = strongly agree). In this instance, higher scores (approaching 5.0) were indicative of higher levels of teacher agreement. The first section included 14 questions that addressed the following issues (a) fairness, (b) effectiveness, (c) ease to implementation, and (d) probability the teacher would use this intervention again. The second section included seven questions regarding teacher understanding of the intervention's: (a) procedures, (b) theoretical framework, and (c) directions. The third section included seven questions that addressed intervention feasibility included assessments of record keeping and time requirements as well as the level of intrusiveness for students. Teachers completed survey items independently and anonymously and their responses were described qualitatively.

Independent Variable

The intervention package included three primary components: (a) interdependent and dependent group contingencies, (b) randomized target behaviors and criteria and (c) randomized and unknown rewards in the form of mystery motivators. The intervention was made operational in the form of the Two Jars Game. Interdependent group contingencies were established by telling the entire class that their access to "mystery" rewards was dependent on either the *collective* performance of the group (e.g., class average). That is, if the class average student's completion or accuracy scores met or exceeded the daily criterion, then the whole group would be rewarded. If the criterion was not met, students were simply told that they could not earn a reward that day, but that they should try harder the next day.

The second intervention component was randomized target behaviors and criteria. After examining class performance during initial baseline sessions, criteria were established for two

target behaviors: (a) percentage completed or (b) percentage correct. Target behaviors and criteria were then written on 10 separate paper slips and placed in Jar #1 labeled "mystery goals". Two pieces of paper had "80% and 90% student completion" written on them respectively, while a fifth paper slip had the words "100% student completion" printed on it. Five additional paper slips containing minimum *accuracy* levels were placed in the first jar as well. These slips included the following: (a) 70% with 100% accuracy score, (b) 70% with 95% accuracy score or higher, (c) 70% with 75% accuracy score or higher, (d) 70% with 80% accuracy score or higher. The paper slip selected randomly each day determined whose homework performance would be evaluated against the criteria. For example, if 90% student completion was picked, then at least 90% of the students present that day must have turned in completed math homework (i.e., interdependent group contingency). If, 70% with an accuracy score of 80% was selected, then at least 70% of the students present that day must have a homework grade of at least 80%, If 70% of the students' grades were 80% or higher then the entire class was rewarded. If at least 70% of the students did not have a score of at least 80%, then the class was told that they did not earn a reward today (i.e., interdependent group contingency). The teacher never revealed student names if the criterion was not met.

The third intervention component consisted of randomized and unknown rewards. The names of possible rewards were written on small paper slips and placed into highly decorated envelopes, sealed and placed into the second jar labeled "mystery motivators". Potential rewards were selected based upon teacher and pupil suggestions given prior to formal data collection. Mystery Motivators included: (a) treat day (i.e. string cheese, gum, and/or cookies), (b) school supplies (e.g., pencils, erasers, and/or pencil grips), (c) free time coupons, and (d) small toys (e.g., flying gliders, puzzle balls, and maze puzzles).

To ensure that the two jars intervention was implemented accurately, a 10-item, fidelity of implementation checklist was developed (see Appendix C). The fidelity protocol listed the 10 primary steps required to use the two jars intervention as intended and designated spaces to indicate the presence or absence of each procedural step. Specific procedural items included: (a) grading homework assignments for percentage completed and percentage accurate, (b) recording scores on the homework data sheet, (c) drawing paper slips from the "Mystery Goals" jar, (d) announcing if class met the criterion, and (e) if students selected an envelope from the "Mystery Motivator" jar. During 25% of the intervention session, a teaching assistant observed two jars being used and recorded the presence or absence of each procedural component. Fidelity of implementation was calculated by dividing the number of items present by the number present and absent and multiplying by 100%. For example, if 9 of 10 intervention steps were used, then fidelity of implementation would be .90. Fidelity observations indicated that 100% of intervention components were present during each observation.

Experimental Design and Procedures

An A-B-A-B withdrawal of treatment design was used to assess the effects of the two jars intervention on pupils' homework completion and accuracy rates. This particular experimental design is capable of establishing a functional relationship between intervention and outcomes by showing that pupil performance changes, when and only when, the intervention is presented and/or withdrawn (Kennedy, 2005). In the present study, pupils' homework performance was examined first under typical or normal teaching conditions (i.e., baseline I).

Baseline I.

During initial baseline sessions, math homework was assessed by the teacher at the beginning of class while students completed warm-up, review problems. The teacher recorded

percentage scores for both completion and accuracy for all students and forwarded them to the investigator. After homework was graded, the teacher reviewed specific troublesome homework problems, demonstrated how to solve challenging problems, and then proceeded with a new lesson for the day. During baseline sessions, students worked under independent group contingencies (i.e., access to rewards was contingent solely on their own performance) and pupils were expected to monitor their own homework completion and accuracy rates.

After the class' performance stabilized, a brief (i.e., 20-minute) training session was used with students. The teachers announced that the class would be playing the Two Jars Game for the next few weeks in math class. She described how the game was played and drew sample paper slips from each jar and explained how homework would be evaluated on those days. Formal data collection on the effects of the two jars intervention began the next day (intervention I). A typical two jar intervention session worked as follows. First, the teacher graded pupil homework while they worked on review activities. Next, she emphasized to the class that everyone must work as a team if they are going to earn mystery rewards. The teacher then selected a paper slip from Jar #1 to determine which outcome (completion versus accuracy) and criterion (e.g., 90% completion or 70% with accuracy score of 85% or above) was in effect that day. She then compared the target behavior and criterion to pupil performance to determine if the criterion was met and the class earned a mystery reward. After reviewing the homework and morning seatwork with the class, the teacher announced whether the criterion was reached and if so, when the reward would be delivered (i.e., most immediate and reasonable time). The teacher continued to lead instruction based on pupils' homework performance and assigned independent seatwork. After intervention data stabilized, the two jars intervention was removed for five days (baseline II). Once again, the teachers graded and reviewed daily homework, modeled new

problem solutions, and assigned independent work. Independent group contingencies and pupil self-monitoring of progress was back in effect. Following the second baseline period, the two jars intervention was re-introduced (intervention II). Immediately after the final intervention session, pupils completed the social validity survey independently and anonymously. The teacher also completed the acceptability and feasibility assessment at this time.

Results

The effects of the two jars intervention on the entire class' homework completion rates can be seen in Figure 1. As seen, during initial baseline conditions, about 60% of the entire class turned in completed math assignments each day. There were two or three students who didn't complete any items and about one-third of the class who routinely completed all assignments. When the jars intervention was implemented, the percentage of students turning in completed homework assignments increased immediately and noticeably to 94% (range = 80 to 98 Eight students had perfect completion rates, seven completed at least 80% of their assignments (i.e., minimal reward criteria), and two students who failed to meet the criterion one day each. There were no overlapping data points with the initial baseline phase. When the intervention was removed, homework, completion rates dropped to an average of 69% (range = 64% to 76%) which was slightly higher than initial baseline levels but noticeably lower than the adjacent intervention phase. Six students failed to complete homework on at least one day during the second baseline phase. Again, there were no overlapping data points with the adjacent intervention phase. Reintroduction of the jars intervention increased homework completed to an average of 95% (range 86% to 100%) and all pupils turned in completed assignments on the final intervention day. During the final intervention phase, 10 students had perfect completion rates,

four students consistently completed at least 80%, while three others failed to meet the minimum 80% completion criteria on two days.

Data related to the entire class' homework accuracy are depicted in Figure 2. As seen, the class' overall performance on daily math homework was below grade expectations. On a typical baseline day, the class average percentage correct was 51% with a range of 46% to 65%. There was considerable variability in class performance with an average standard deviation of 24. When the jars intervention was introduced, there was an immediate and noticeable increase in the class' math accuracy to a mean of 86% (range = 65% to 93%). This represented a 35% increase in the class average or the equivalent of almost four letter grades (F to B+). Again, much of this improvement was due to more students turning in more completed assignments.

During the first intervention phase, seven students maintained homework accuracy scores about 80% (minimum accuracy criterion), and only two students failed to complete their homework on one day each. When the intervention was removed, the mean homework accuracy rate decreased immediately and noticeably to 66% (range = 58% to 76%). Again, second baseline means were higher than initial baseline levels but were still below expectations. When the jars intervention was re-introduced, homework accuracy levels increased once again to a mean of 90% with a range of 86% - 95%. During the second intervention phase, two students maintained 100% accuracy rates, while 10 others' grades exceeded the minimum accuracy criterion of 80%.

One problem with class means is that they can cloud intervention effects on individual students. As such, Table 1 was constructed to show the impact of the jars intervention on all students' performance across all phases of the investigation. As depicted, all but one pupil's data patterns (#9) showed a functional relationship between the intervention and homework

performance. (That one exception was mostly likely a function of a ceiling effect). Pupils always had higher completion and accuracy rates under intervention rather than baseline conditions.

Individual data were also collected on an average pupil and his lowest performing classmate. Homework completion data for Grady (average performing) are shown in Figure 3. As seen, Grady completed an average of 54% of his homework assignments during initial baseline sessions (range = 30% to 80%). When the intervention was implemented, however, he immediately completed every homework assignment (M = 100%). His completion rates dropped somewhat to a mean of 78% with a range from 50% to 100%. When the jars intervention was re-implemented, his completion rate increased immediately and noticeably to 94% (range = 80% to 100%). Grady's homework accuracy scores showed very similar patterns (see Figure 4). As seen, Grady had a homework average of 50% correct during initial baseline (range = 20% to 80%). His average improved to a perfect 100% during the first intervention phase, but fell again to 74% during second baseline (range = 50% to 80%). Finally, when the jars intervention was re-introduced, Grady's homework average increased once again to 94% (range = 80% to 100%).

Similar data patterns emerged for Esther, the lowest performing student during initial baseline sessions (see Figure 5). As depicted, Esther only completed about 20% of her assigned math homework during initial baseline. On two days, she turned in assignments that were half completed and failed to turn in any math homework on the other three days (M completion rate = 20%). When the jars intervention was put into effect, Esther's mean completion rate increased immediately and noticeably to 70%. She successfully completed at least 80% of her homework assignments (i.e., minimum reward criterion) but failed to turn in assignment at all during one intervention session. When the jars intervention was removed, Esther's completion rates fell to

an average of 46% (range = 0 to 80%), but improved substantially to a mean of 74% during the second intervention phase. Once again, Esther met the minimum reward criterion during four of five intervention sessions. Similar data patterns were seen in the accuracy of Esther's homework assignments. Her respective averages across each experimental phase were: (a) 20%, (b) 70%, (c) 36%, and (d) 74%. It is significant to note as well, that Esther maintained a passing average only during the two intervention phases.

Student consumer satisfaction ratings provided some interesting reactions to the jars intervention (see Table 2). As seen in Table 2, students rated the intervention goals of improving their own and their peers homework completion and accuracy as very important. Most students also reported varying levels of enjoyment across intervention components. They provided the highest acceptability ratings for "picking mystery motivators" (M = 4.4) and the lowest rating for "not knowing what level of performance was selected" (M = 3.5). Finally, students reported varying levels of satisfaction with intervention outcomes. On the positive side, most students felt that the jars intervention helped them to complete math assignments and to get better grades overall. Moreover, most pupils felt that others thought they were smarter after playing the jars game. In contrast, a comparable number of pupils reported that the jars game might be harmful to other students and overall they reported that the jars game was not very fair.

Social validity results for the math and consultant teacher were very positive. In general, the teachers' thought that the intervention was effective, feasible to implement, and fair to students overall. Both teachers indicated that they would be willing to use this or a similar intervention again in their classrooms.

Discussion

The present results indicate that the jars intervention produced immediate and noticeable improvements in the math homework completion and accuracy rates for all 17 8th grade students. During initial baseline sessions, the entire class was only completing about 60% of their math assignments and with an overall accuracy rate of only 51% correct. The jars game immediately increased the class' completion and accuracy rates to 94% and 86% respectively. Students were completing more math homework and most of their responses were correct. As a result, the class' mean accuracy levels improved by almost four letter grades (F to B+) when the jars intervention was in effect. Completion and accuracy rates dropped substantially when the game was removed but improved noticeably once again when the jars were reintroduced.

These findings suggest a *functional* relationship between the use of the jars intervention and pupils' homework completion and accuracy rates. When the intervention was in effect, students completed over 90% of assigned work with high degrees of accuracy; when the game was removed pupil performance on both outcomes decreases substantially. The educational importance of these findings cannot be under-estimated. All 17 students did better in math when they were playing the jar game! When told that they could earn rewards contingent on meeting minimum but randomly selected criteria, students responded positively by completing more work at higher accuracy levels. Identifying class-wide interventions that are effective for all, feasible to implement, and socially acceptable is very important in the era of evidence-based practice.

The present findings are highly consistent with a robust research line that shows that interdependent and dependent group contingencies can: (a) improve academic performance (Lynch, et al., 2009; Popkin & Skinner, 2003; Reinhart et al., 2009; Sharp & Skinner, 2004; Theodore et al., 2009), (b) reduce disruptive behavior (e.g., Christ, & Christ, 2006; Kelshaw-

Levering et al., 2000; McKissick et al., 2010; Theodore et al., 2001; Theodore et al., 2004; Theodore, Bray, Kehle, & Jenson, 2001), and (c) facilitate room-to-room transitions (Campbell & Skinner, 2004). As such, the jars game might serve as a useful intervention for teachers who have numerous students who struggle to complete homework accurately. The intervention might be equally applicable to the completion of "in class" work.

Present findings also extend the literature on the use of group contingencies to improve homework completion and accuracy to a new student population and geographic location, another math content assignment, and adapted intervention procedures (i.e., randomized behaviors, criteria, and rewards combined with the use of mystery motivators). The improvements for targeted average and low performing students were particularly noteworthy. One *average* performing student raised his math homework average from 64% to 97% when the game was in effect and his lower performing classmate raised her average from 28% to 72%. The former instance, Grady, appears to reflect a *performance deficit*. That is, he had the knowledge and skills to accurately complete his math homework, but he just failed to do so. When sufficient incentives were in place, however, he demonstrated his math competence more accurately and consistently. Esther, on the other hand, appears to have a math *skill deficit*. That is, although the incentives motivated her to complete more items accurately, her knowledge and skill levels were not developed enough to demonstrate mastery of content at this time. The data do suggest, however, that continued exposure to the jars game would be highly beneficial to both target students.

The jars intervention also appeared to be feasible and socially acceptable to both teachers and pupils. As such, it is consistent with previous research that shows positive consumer satisfaction evaluations for jars-related studies (Skinner et al., 2009). The classroom and

consultant teachers felt that the intervention was fair, took very little time and effort to implement and evaluate, and produced important improvements in pupils' math performance. Students appeared to be equally positive about intervention goals, procedures, and outcomes. One surprising outcome, however, was that students reported that the jars intervention was quite unfair. This is different from previous outcomes and suggests that more attention should be focused on the perceived fairness of interdependent group contingencies; particularly since these types of concerns were voiced before (e.g., Litow & Pomroy, 1975; Skinner et al., 2009). The pupils' ratings also appeared to be somewhat inconsistent with other survey responses (e.g., enjoyed intervention components and satisfied with outcomes) and reported excitement in class when the intervention was in effect. In any event, the fairness issue related the use of randomized interdependent group contingencies is an important domain for future inquiry.

Although current findings are quite promising, there are a number of important study limitations that may reduce the utility of the present findings. First, the study was conducted with only one class of students (N =17), in one geographical location, and in only one narrow facet of the academic curriculum (i.e., math homework completion and accuracy). Generalizations to other grade levels, geographic settings, and subject areas are not warranted at this time. Second, the study was conducted for a relatively short duration (5 to 6 weeks) and no generalization and maintenance data were collected. It is not appropriate to conclude, therefore, that the same effects would be obtained over a longer time period and/or that benefits would generalize to other areas of math performance (e.g., in class work completion, quiz performance, and active participation in class) and/or be sustained in the absence of the intervention. As such, future research should include longer intervention durations and explicit generalization measures for examining potential "spillover effects". Current findings are limited as well because the

investigator also served as primary data collector and evaluator. Although procedures were used to monitor fidelity of implementation (i.e., fidelity assessments), one cannot rule out potential experimenter bias effects at this time. Future research should utilize independently trained data collectors to the maximum extent possible. Finally, present findings are limited by the absence of direct observations of pupils' academic and interpersonal behavior during baseline and intervention phases. It is quite likely that one can learn much more about the effects of interventions by observing the looks on their faces and/or the tone of their voices when intervention procedures are implemented and/or taken away. Are they excited, dismayed, or some other affect? Are there any observable referents to the lack of fairness issue raised on satisfaction surveys? Future researchers should consider, therefore, the use of more direct observational measures of the intervention's impact.

Conclusion

This study was designed to examine the effects of an interdependent group contingency with randomized components on homework completion and accuracy rates of an 8th grade math class in a rural New York school district. This was a partial replication of research conducted by Reinhardt et al. (2009) and Theodore et al. (2009). Present findings indicated that the jars intervention was a very powerful and efficient strategy for getting all students in an 8th grade math class to complete more homework items and at higher accuracy rates. It did so with a minimum of teacher time and effort and with generally high levels of pupil satisfaction. The only concern raised was the generally negative rating regarding the fairness of the jars intervention. While the rating was not reflected in any other areas of pupil performance, its report should be examined in greater depth by future researchers. In the interim, there is a need for additional replications of the group contingency interventions. In an era of evidence-based

practice, classroom teachers must have access and support to use such interventions to improve other important pupil outcomes.

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Table 1. Pupil average completion and accuracy rates across experimental conditions.

	Baseline I		Intervention I		Baseline II		Intervention II	
Students	**Comp.**	**Accuracy**	**Comp.**	**Accuracy**	**Comp.**	**Accuracy**	**Comp.**	**Accuracy**
1	73	73	100	98	95	85	100	95
2	53	48	100	80	78	73	95	90
3	78	70	93	75	15	15	95	88
4	50	50	95	84	100	90	100	95
5	28	20	85	75	45	40	95	88
6	53	28	100	83	45	45	100	95
7	38	33	98	98	45	50	75	75
8	25	25	70	66	45	45	73	73
9	95	95	100	98	100	90	100	100
10	85	70	100	98	90	90	100	90
11	83	83	100	94	90	85	100	95
12	73	45	85	85	58	58	95	85
13	83	83	100	95	90	78	100	100
14	73	53	98	85	85	85	100	95
15	80	48	100	93	78	78	100	90
16	45	38	98	84	78	73	100	90
17	28	28	80	65	45	45	73	73
Mean	**61**	**52**	**94**	**85**	**69**	**66**	**94**	**89**

Table 2. Mean consumer satisfaction ratings by 6th grade pupils.

Items	Mean	Standard Deviation
1. How important is it for you to do well in 8th grade Math class?	4.9	0.2
2. **How important is it for other students in your class to do well in Math class?**	4.2	1.0
3. **How important is it for students to complete homework assignments in Math class?**	4.9	0.3
4. **How did you feel about not knowing what level of performance would be selected for evaluation? (i.e., 100 % completed their homework, 85% completed their homework)?**	3.5	0.9
5. **How much did you like completing accurate homework assignments each day?**	4.1	0.9
6. **How much did you like using the Jars to determine the homework completion goal for the classroom for each day?**	4.0	0.9
7. **How much did you like using Jars to find out what rewards the class earned that day?**	3.9	1.1
8. **How much did you enjoy playing the Jars game?**	3.8	1.1
9. **How much did you like picking the mystery motivators?**	4.4	1.1
10. **How satisfied are you with your performance when using Jars?**	4.2	0.8
11. **How much did the Jars Game help you learn Math content better?**	3.8	1.1
12. **How much did Jars help you to complete homework assignments?**	3.8	1.1
13. **Does Jars seem like something that should be done in other classes?**	3.8	1.2
14. **Could Jars be harmful to other students?**	3.8	1.3
15. **How fair was Jars to everyone in class?**	1.8	0.7
16. **Did other students think that you were smarter after using Jars?**	3.2	1.3
17. **How do you feel about the overall effect of the intervention on your homework behavior?**	2.9	1.2
18. **How did you feel about not knowing which reward you would get?**	3.7	1.1

Appendix A

Student Social Validity Questionnaire

Directions: Please read each item aloud to your students and ask them to circle the number that best represents their feelings about that particular item. Emphasize the importance of completing the rating individually and privately.

Importance of Instructional Goals

1. How important is it for you to do well in **8th grade Math (Math)** class?

   1 2 3 4 5
   not at all somewhat important very important

1. How important is it for **other students** in your class to do well in Math class?

   1 2 3 4 5
   not at all somewhat important very important

2. How important is it for students to **complete homework assignments** in Math class?

   1 2 3 4 5
   not at all somewhat important very important

3. How did you feel about not knowing what level of performance would be selected for evaluation? (i.e., 100 % completed their homework, 85% completed their homework)?

   1 2 3 4 5
   not at all some did everyone did

Acceptability of Instructional Procedures

4. How much did you like completing accurate homework assignments each day?

   1 2 3 4 5
   not at all ok liked it a lot

5. How much did you like using the Jars to determine the homework completion goal for the classroom for each day?

   1 2 3 4 5
   not at all ok liked it a lot

6. How much did you like using Jars to find out what rewards the class earned that day?

   1 2 3 4 5
   not at all ok liked it a lot

7. How much did you enjoy **playing the Jars game**?

   1 2 3 4 5
   not at all somewhat liked it a lot

8. How much did you like picking the mystery motivators?

   1 2 3 4 5
   not at all some liked it a lot

9. How satisfied are you with **your overall performance** in Math class?

1	2	3	4	5
not at all		somewhat satisfied		very satisfied

10. How satisfied are you with your performance when using **Jars**?

1	2	3	4	5
not at all		somewhat satisfied		very satisfied

11. How much did the Jars Game **help you learn** Math content better?

1	2	3	4	5
not at all		some		a lot

12. How much did Jars **help you to complete** homework assignments?

1	2	3	4	5
not at all		some		a lot

13. Does Jars seem like something that **should be done** in other classes?

1	2	3	4	5
not at all		maybe		definitely should

14. Could Jars **be harmful** to other students?

1	2	3	4	5
not at all		maybe		definitely could

15. How **fair** was Jars to everyone in class?

1	2	3	4	5
not fair at all		somewhat fair		very fair

16. Did other students think that **you were smarter** after using Jars?

1	2	3	4	5
not at all		some did		everyone did

17. How do you feel about the overall effect of the intervention on your homework behavior?

1	2	3	4	5
not at all		some did		everyone did

18. How did you feel about not knowing which reward you world get?

1	2	3	4	5
Not at all		some did		everyone did

Additional Comments/Suggestions: _____

_____

Appendix B

Teacher Social Validity Questionnaire

Directions: Please complete the following survey regarding the use of the Mystery Motivator intervention that was just completed in your classroom. Each question has a scale after it that indicated your level of agreement with that item. The scale is 1 to 5 with "1" meaning "strongly disagree" and "5" meaning "strongly agree".

Acceptability

1. I was excited to use this intervention. **1 2 3 4 5**
2. I liked the procedures used in this intervention.
   1 2 3 4 5
3. This intervention is a good way to handle classroom management involving mathematics homework. **1 2 3 4 5**
4. I would not be interested in implementing this intervention again.
   1 2 3 4 5
5. I would be resistant to use this intervention again. **1 2 3 4 5**
6. This is an acceptable intervention strategy to improve homework completion and accuracy in mathematics. **1 2 3 4 5**
7. I had positive attitudes about implementing this intervention.
   1 2 3 4 5
8. Overall, the intervention was beneficial for the students.
   1 2 3 4 5
9. I was motivated to try this intervention. **1 2 3 4 5**
10. This intervention was reasonable for the problem of homework completion and accuracy.
    1 2 3 4 5
11. This intervention would be an effective choice for addressing a variety of classroom management problems. **1 2 3 4 5**
12. I would implement this intervention again with a good deal of enthusiasm.
    1 2 3 4 5
13. The intervention was a fair way to improve homework completion and accuracy behaviors in my classroom. **1 2 3 4 5**

14. Use of this intervention would save time spent on classroom management.
1 2 3 4 5

Understanding

15. I understood how to use this intervention. **1 2 3 4 5**

16. I was knowledgeable about the intervention procedures. **1 2 3 4 5**

17. I knew what to do when I was asked to implement this intervention.
1 2 3 4 5

18. The directions for using this intervention were clear to me. **1 2 3 4 5**

19. I understood the procedures of this intervention. **1 2 3 4 5**

20. I had the skills needed to implement this intervention. **1 2 3 4 5**

21. The requirements for implementing this intervention are unclear.
1 2 3 4 5

Feasibility

22. The amount of time required for record keeping with this intervention was reasonable.
1 2 3 4 5

23. The intervention was implemented for the duration of time as prescribed.
1 2 3 4 5

24. The intervention was implemented with the intensity as prescribed.
1 2 3 4 5

25. The amount of time required to use this intervention was reasonable.
1 2 3 4 5

26. This intervention was implemented as frequently as described.
1 2 3 4 5

27. This intervention was not disruptive to other students.
1 2 3 4 5

28. All pieces of this intervention were implemented precisely.
1 2 3 4 5

Appendix C

Fidelity of Treatment Record

Classroom Teacher: Karen Schrader Investigator: Debra Zibreg Date: _____

Directions: Use the scoring code below to note the presence and/or absence of each component of the procedure for the intervention.

Scoring Code: + Goal demonstrated -- Goal not demonstrated **NA** Not applicable

General Implementation:

_____ 1. Classroom teacher selects the homework completion and accuracy goal and the classroom teacher announces the goal for students to earn reinforcement. The classroom teacher selects the student(s) who need to meet the goal; the student(s) names remain anonymous to the class. The reward is selected if the student(s) meet the goal.

_____ 2. Possible reinforcers were identified by seeking pupil input (e.g., asking them, watching them, having them complete reinforcement menus, and/or using suggestions from anonymous box). (You may need to ask classroom teacher how reinforcers were identified).

_____ 3. Classroom rules are posted and reviewed by the classroom teacher**.**

_____ 4. Three labeled jars are visible in classroom; Jar #1 is homework completion and homework accuracy goals, Jar #2 is student(s) and Jar #3 labeled "Reinforcers".

_____ 5. At the beginning of the class period when the students are getting out their homework assignments, classroom teacher selects a piece of paper from Jar #1 to identify target homework goal (i.e., 100% homework completed and 80% accurate, 90% homework completed and 75% accurate).

_____ 6. Classroom teacher then selects a slip of paper from Jar #2; (pieces of paper with the words “whole class” or a specific student printed on them).

_____ 7. Classroom teacher then evaluates pupil performance on basis of first two jar selections; if pupils meet pre-established criteria, then classroom teacher congratulates students and randomly selects one pupil to pick a reinforcer from Jar #3.

_____ 8. If individual or group fails to reach criteria, then classroom teacher announces that they did not meet the criteria and encourages them to work hard the following day.

_____ 9. Teacher does not mention name of individuals when criteria is not reached.

_____ 10. Following session, classroom teacher makes a smooth transition to the next instructional activity.

Total _____/ 10 (Please record the number of components plus the number of NA)
_____ % Procedural fidelity

Anecdotal comments