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The Differential Effects of Performance-Contingent, Completion-Contingent, and No
Reward Conditions on Math Performance, Voluntary Task Participation, and
Self-Reported Interest in Math

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Dedication

This work is dedicated to my family. First, I thank my parents for impressing upon me the value of an education and for giving me their unconditional love and support. To my sisters, Elizabeth and Rebecca, thank you for your friendship and for keeping me laughing. I also dedicate this dissertation to James who continues to encourage me and to give me confidence.

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Abstract

Researchers have repeatedly found that performance-contingent and task-contingent rewards can be used to increase both math accuracy and completion rates. However, researchers have not directly compared the differential effects of these two types of reward contingencies. Although researchers have examined the differential effects of performance-contingent and task-contingent rewards on intrinsic motivation to perform an activity, this research has consistently focused on the dependent measures of self-reported interest and free-choice participation. To this point, researchers have not thoroughly investigated the differential effects of performance- and task completion-contingent rewards on academic accuracy when these contingencies are in place and after teachers remove them. Researchers also have failed to examine the differential effects of meeting or failing to meet a reward contingency on academic accuracy.

To address the gaps in the past research on performance-contingent and task-contingent rewards, this study investigated the effects of different types of reward contingencies on both academic performance and interest in math. Specifically, the study attempted to answer the following questions: What are the differential effects of performance-contingent, completion-contingent, and no reward conditions on math performance when the experimental conditions are in place, in a mandatory follow-up phase, and in a choice follow-up phase? What are the differential effects of earning a reward versus failing to earn a reward on subsequent academic performance within the framework of a completion or performance contingency? What are the differential effects of receiving a reward versus no reward for high academic performance on subsequent performance under a choice follow-up condition?

Students from three 4th grade classrooms and four 5th grade classrooms served as participants. Over the course of three school days, all students were exposed to three experimental conditions including performance-contingent reward, completion-contingent reward, and no reward. The order of the presentation of conditions was counterbalanced and randomly assigned to the seven participating classrooms. In each of the three experimental conditions, students were given feedback regarding the accuracy of their responding.

The day before experimental procedures began, students completed a pretest of math performance (i.e., an assignment of math problems) and of self-reported interest in math (i.e., a short Likert-scale questionnaire). On each of the three experimental days, the primary researcher distributed math assignments to students in each class and informed them of the presence or absence of reward contingencies in place that day. Assignments were comprised of problems appropriate for the grade level. The fourth grade classrooms were presented with 30 two-digit by two-digit subtraction problems, each involving borrowing. The fifth grade classrooms were presented with 50 two-digit by one-digit multiplication problems.

The researcher told students under the performance-contingent condition that they would earn 10 bonus points towards their math grade for answering 75% or more of the problems correctly (22 or more problems for 4th graders and 37 or more problems for 5th graders), five bonus points for answering between 50-74% of the problems correctly (15-21 problems for 4th graders and 25-36 problems for 5th graders), and zero bonus points for answering less than 50% of the problems correctly (0-14 problems for 4th graders and 0-24 problems for 5th graders). The researcher told students under the completion-

contingent condition that they could earn 10 bonus points towards their math grade for answering 75% or more of the problems, five bonus points for answering between 50-74% of the problems, and zero bonus points for answering less than 50% of the problems. The researcher informed students under the control condition that no rewards were available for their math performance.

After permitting students to work on the assignments for 10 minutes, the researcher collected the assignments, took five minutes to score them with the help of the classroom teacher and a graduate student, and handed students back their assignments with feedback and the number of points earned written on the assignment according to the contingency in place for the class that day. Before collecting the corrected assignments, the researcher asked students to write either yes or no on the bottom of their assignment in response to the question, “Were you successful at this activity?”

The researcher then assigned students another 10-minute assignment similar to the one they had just completed, explaining that no rewards were available for doing the assignment. Finally, the researcher presented students with a continuous choice two-page assignment. One page contained math problems similar to the problems completed on previous assignments. The other page contained a word search. Students were instructed to place the two assignments side by side on their desk. They were told to work on whatever part of the assignments they would like for ten minutes. On the first day of experimental procedures only, students again completed the Likert-scale questionnaire assessing interest in math as a posttest measure.

Results showed that both performance-contingent and completion-contingent rewards led to higher accuracy and completion rates than the no reward control condition.

However, the two contingency conditions did not differ in their effects on math performance. Once these contingencies were removed, there were no significant differences between conditions with respect to student performance on the mandatory follow-up assignment. The reward contingencies did appear to differentially affect performance on the choice follow-up assignment, particularly for high-achieving students. More participants chose to engage in the choice assignment and had higher accuracy and completion rates on the choice assignment following the control condition than either of the reward contingency conditions.

In addition, students who earned the maximum amount of bonus points under the reward contingencies and students who would have earned the maximum amount of bonus points on the control day, had a contingency been in place, both had significantly higher accuracy and completion rates on the choice assignment than participants who earned or would have earned a smaller number of points under the contingency and control conditions. Also, the choice follow-up performance of the high performers after the contingency conditions was directly compared with that of the high performers after the control condition. High performers did significantly better on choice follow-up performance following the control condition than they did following the contingency conditions, with the former almost doubling the performance of the latter on both accuracy and completion in the choice follow-up phase.

Discussion focuses on the implications of these findings, limitations of the study, and ideas for future research. Particular emphasis is given to the implications of the findings regarding the overjustification effect. In general, the pattern of results suggested an overjustification effect for the reward contingencies.

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Chapter I

Literature Review

Researchers have explored the use of reward contingencies to improve math performance in students. Drew, Evans, Bostow, Geiger, and Drash (1982) applied a contingency for both math completion and accuracy in order to improve the performance of third-grade students. Parents rewarded students with home based privileges if they completed their daily math assignments and accurately answered at least 76% of the problems. Positive, immediate, and significant changes in both the completion and accuracy of the students' resulted. Although the study clearly suggests that reinforcing complete and accurate responding can improve academic performance, it is unknown whether both parts of the contingency (i.e., completion and accuracy) were necessary for improvement to occur.

Similar to the work of Drew et al. (1982), Pavchinski, Evans, and Bostow (1989) used token rewards exchangeable for home-based privileges to improve the math and reading performance of a 12-year-old student. However, unlike Drew et al. (1982), Pavchinski et al. (1989) did not explicitly include task completion as part of the reward contingency. During in-class experimental sessions using flash cards of reading sight words and math facts, the student earned tokens based on correct responses. Applying a changing-criterion experimental design, researchers initially awarded the student 20 tokens for each correct response. Researchers then implemented a 50% criterion phase in which the student was required to correctly respond to at least 50% of the items in order to earn 20 tokens for each correct response. Increments of 10% were used to adjust the criteria, with the final goal being 90% accurate responding. At the conclusion of the

study, the final goal was met and the student achieved 90% mastery of the targeted items.

In a study applying a completion contingency, McGinnis, Friman, & Carlyon (1999) rewarded two middle school students for time spent on math and the number of math assignment pages completed. Although accuracy was not included as part of the reward contingency, both students' accuracy and completion of math assignments increased and were maintained during fading and withdrawal. However, at follow-up, the time spent working on math and the number of pages completed fell below baseline for one of the students. The results suggest accuracy does not need to be an explicit part of a reward contingency for improvements in accuracy to occur. However, it is unknown if even greater improvements in accuracy would have resulted had accuracy been included in the reward contingency.

Weiner, Sheridan, and Jenson (1998) also used a completion-contingent reward system in order to improve the math homework completion of five junior high students. Through the process of conjoint behavioral consultation, parents, teachers, and a school psychologist developed a home-based intervention. Each night students earned a reinforcer (i.e., candy, food, privileges), if they completed 100% of their math homework assignment and spent at least 20 minutes working on the assignment. Although the nightly reward was not contingent on accuracy, a long-term reinforcer (i.e., shoes, drum lessons) available at the end of the intervention phase was contingent upon the students' achieving an average accuracy of 70% on the homework assignments.

Four of the five students who participated in the Weiner et al. (1998) study improved both their accuracy and completion of math homework assignments during the intervention phase. The home-based intervention procedures were believed to lack

treatment integrity for the student whose performance did not improve. Once again, this study suggests that rewards can be used to improve academic performance.

Unfortunately, it is unclear which aspect of the reward contingency may have had the strongest impact on performance: the nightly rewards for completion or the long-term reward for accuracy. It is possible that either one of these reward contingencies may have had the same effect regardless of the presence or absence of the other.

The results of the Drew et al. (1982), Pavchinski et al. (1989), McGinnis et al. (1999), and Weiner et al. (1998) studies suggest that rewards for complete and accurate academic responding are powerful motivators for school learning. Both Drew et al. (1982) and Pavchinski et al. (1989) required accurate responding in order for students to earn reinforcement. Although the Weiner et al. (1998) intervention appeared to rely more heavily on a completion-contingent reinforcement system, an additional reward was contingent upon accurate responding. McGinnis et al. (1999) found students demonstrated greater accuracy and completion on math assignments when presented with a reward contingency for completion alone. With or without an explicit completion-contingent reward, completion is often subsumed under contingencies for accuracy inasmuch as a task or problem needs to be completed in order for it to be accurate.

Contingencies based on accuracy often can result in low-achieving students consistently failing to earn rewards. As a result, these students may become unmotivated to engage in academics, with their performance continuing to worsen. Reward contingencies for assignment or task completion may provide low-achieving students the opportunity to experience a degree of academic success. This success or access to reinforcement may increase the likelihood that low-achieving students engage in

academic work and potentially strengthen their academic performance. More research is needed that isolates the effects of rewards contingent upon task completion and compares the effects of these rewards with rewards contingent upon accurate responding.

Rewards and Intrinsic Motivation

Studies comparing the effects of performance-contingent and task-contingent rewards on intrinsic motivation mainly have focused on time spent voluntarily participating in the activity in a posttreatment phase and self-report measures of interest (Cameron, Banko, & Pierce, 2001; Deci, Koestner, & Ryan, 2001). The term task-contingent has referred both to rewards given for simply engaging in an activity and rewards given for completing an activity. Performance-contingent rewards are rewards given for the quality of performance on an activity. In two separate meta-analyses, Cameron et al. (2001) and Deci et al. (2001) explored the differential effects of task-contingent and performance-contingent rewards on free-choice behavior and self-reports of task interest. These two analyses reported both consistent and conflicting conclusions regarding the effects of task-contingent and performance-contingent rewards on intrinsic motivation (Table 1).

Cameron et al. (2001) found that expected tangible rewards applied during an experimental phase had no effect on time engaged in the target activity in a no reward free-choice period when these rewards were task-noncontingent, contingent upon the participant finishing a task, or contingent upon the participant attaining or surpassing a score (criterion-referenced). Task-noncontingent rewards were those offered for simply agreeing to participate in the study, irrespective of whether participants actually engaged in the task. Cameron et al. found that rewards offered for engaging in a task, performing

Table 1

The Effects of Extrinsic Rewards on Free-choice Intrinsic Motivation and Self-reported Interest as Reported by Cameron et al. (2001) and Deci et al. (2001)

Reward Contingency	Cameron et al. (2001)		Deci. et al (2001)	
	Free-choice	Self-report	Free-choice	Self-report
Task noncontingent	0	0		
Completion-Contingent	0	+	-	-
For engaging in a task	-	-	-	-
Performance-Contingent			-	0
For attaining or surpassing a score	0	+		
For performing well	-	+		
For meeting or exceeding the performance of others	+	+		
For each unit or problem solved	-	+		
No feedback control/all receive maximum reward			-	
No feedback control/all did not receive maximum reward			-	
Positive feedback control/no reward			-	
Negative feedback control/no reward			0	

Note. 0 indicates no effect, - indicates a negative effect, and + indicates a positive effect on intrinsic interest. Blank cells indicate dimension was not included in meta-analysis.

well at a task (with no specification as to what well means), and for solving units or problems resulted in participants spending less time on the target activity in a free-choice period. In contrast, Cameron et al. found that rewards have positive effects on free-choice behavior when offered for meeting or exceeding the performance level of others (norm-referenced). With respect to the effects of different reward contingencies on self-report measures of interest, Cameron et al. (2001) found that task-noncontingent rewards had no effect on interest. Cameron et al. reported small negative effects on task interest for rewards contingent upon doing a target activity. Finally, they concluded that rewards contingent upon solving problems, doing well, surpassing a score, finishing the activity, and meeting or exceeding the performance level of others resulted in significantly higher self-reported interest.

Cameron et al.'s (2001) results revealed some inconsistencies between the results from the free-choice measure and the self-interest measure. Rewards contingent upon finishing an activity and for attaining or passing a score had no effect on free-choice behavior but they had a positive effect on self-reports of interest. Rewards contingent upon performing well and for solving problems had negative effects on free-choice behavior but positive effects on self-report measures of interest. Only rewards given for agreeing to participate in an activity, for actually engaging in an activity, and for meeting or exceeding the performance of others had the same positive effect on both free-choice and self-report measures of intrinsic interest.

In contrast to several findings reported by Cameron et al. (2001), Deci et al. (2001) found that engagement-contingent, completion-contingent, and performance-contingent rewards had negative effects on free-choice of the target task. Although

Cameron et al. (2001) did report that engagement-contingent rewards had negative effects on free-choice behavior, they reported that completion-contingent rewards had no effect on free-choice participation in target activities.

Regarding the effects of different reward contingencies on self-reported task interest, both Deci et al. and Cameron et al. reported that engagement-contingent rewards reduced interest in the target task. However, while Deci et al. reported that completion-contingent rewards also had negative effects on self-reported interest, Cameron et al. found that completion-contingent rewards increased self-reported interest in the target activity. In addition, while Cameron et al. did not report the combined effects of different types of performance-contingent rewards, Deci et al. reported that performance-contingent rewards had no effect on self-reported interest.

In their meta-analysis, Deci et al. (2001) found that the effects of performance-contingent rewards were not homogeneous. Rather than simply removing outliers, they examined four categories of performance-contingent rewards based on the different types of control groups and different levels of performance included in the studies. The four categories included treatment effects involving no feedback control groups and experimental groups in which everyone received the maximum reward, effects involving no feedback control groups and experimental groups in which all participants did not earn the maximum reward, effects with feedback control groups and experimental groups in which all participants received positive feedback, and effects with comparable feedback control groups and experimental groups in which all participants received negative feedback.

Significant negative effects on free-choice behavior were found for studies that

compared no feedback control groups to participants receiving the maximum amount of reward and to participants who did not all receive the maximum amount of reward. Negative effects on free-choice behavior also were found for studies with feedback control groups in which every participant received positive feedback. No significant effect was found for studies with feedback control groups in which participants received negative feedback. Deci et al. pointed out that the condition in which at least some participants received less than the maximum possible rewards and the control condition in which participants received no feedback had the largest negative effect on free-choice behavior. Deci et al. suggested that this performance-contingent reward scenario, in which not all participants earned access to the maximum amount of reward, approximates what people would find in the real world where rewards are a direct function of performance.

While Cameron et al. (2001) reported instances when tangible, expected rewards for high-interest tasks had positive effects on free-choice behavior and self-reported interest, Deci et al. (2001) reported the consistent negative effects of rewards on these same measures. One major difference in the analyses of Deci et al. and Cameron et al. is in the way the two classified and compared studies. Cameron et al. (2001) evaluated the effects of different types of performance-contingent rewards by dividing the studies into those offering rewards for each unit solved, for doing well, for meeting or surpassing a score, and for exceeding the performance of others. Deci et al. (2001) initially classified all of these contingencies as performance-contingent rewards. When homogeneity in the effects of the rewards did not result, they divided performance-contingent reward studies into different comparison groups. However, unlike Cameron et al. who divided

performance-contingent reward studies based on the specifics of the contingency, Deci et al. divided these studies based on the different types of control groups and levels of performance seen in the studies. In addition, while Cameron et al. found their specific performance-contingent reward groups to have positive effects on self-reported interest, Deci et al. did not compare the effects of their four performance-contingent sub-groups on this dependent measure.

Although measures of free-choice behavior and self-reported interest commonly are used to assess intrinsic motivation, these two measures are different and often result in inconsistent findings. Based on the meta-analyses of Deci et al. (2001) and Cameron et al. (2001), the use of free-choice behavior as a dependent variable more often reveals that tangible rewards have negative effects on intrinsic motivation than does the use of self-report measures. Self-reports more often suggest that tangible rewards have no effect or positive effects on self-reported interest. However, self-report measures are subjective and susceptible to social desirability. Because it is an objective measure, free-choice behavior may be a better indicator of intrinsic interest.

Researchers, including Cameron et al. (2001) and Deci et al. (2001), have not assessed the effects of different reward contingencies on task performance after the contingencies are removed. In addition, the results from research on the differential effects of performance-contingent and task-contingent rewards on measures of intrinsic motivation are mixed. While some studies (e.g., Boggiano & Ruble, 1979) support the notion that performance-contingent rewards can maintain or increase intrinsic motivation, other studies (e.g., Harackiewicz, 1979) suggest that both performance-contingent and task-contingent rewards significantly undermine intrinsic motivation.

The Competency and Control Hypotheses

In explaining the differing results regarding the undermining effects of performance-contingent and task-contingent rewards on intrinsic motivation, researchers have proposed two hypotheses: the competency hypothesis and the control hypothesis. The competency hypothesis suggests that task-contingent rewards should have more negative effects on intrinsic motivation than performance-contingent rewards because task contingencies do not provide information concerning ability at a task. Performance-contingent rewards, by their nature, convey information to recipients about their competency at a given task. Karniol and Ross (1977) have suggested that performance-contingent rewards provide tangible evidence of personal success at a task and should therefore maintain or increase intrinsic interest.

Consistent with ideas of Karniol and Ross (1977), Cameron et al. (2001) reported that tangible rewards result in positive effects on intrinsic motivation when the rewards are closely tied to performance and success. However, tangible rewards have negative effects when rewards signify failure or are only loosely connected to the target behavior. In order to ensure that group differences are truly due to the tangible reward contingency and not the knowledge of success or failure, the effects of feedback per se must be isolated.

In contrast to the competency hypothesis, the control hypothesis has been emphasized by other researchers (e.g., Deci, 1975). According to the latter hypothesis, performance-contingent rewards should produce greater decrements to intrinsic motivation than do task-contingent rewards, because performance contingencies are perceived as more controlling. Both Deci (1975) and Karniol and Ross (1977)

acknowledged that rewards have both controlling and informational features. However, while Karniol and Ross (1977) asserted that the informational aspect of the reward is more salient, Deci (1975) claimed that the controlling aspect of the reward is more salient and more likely to undermine intrinsic motivation.

Posttreatment Performance

Regardless of whether they support the control or the competency hypothesis, few researchers have examined the posttreatment performance of the students after they were exposed to either performance-contingent or task-contingent rewards. Schunk (1983) did investigate the posttreatment performance of students after they received either a performance-contingent or task-contingent reward, concluding that performance-contingent rewards led to higher division skill and self-efficacy. However, unlike the majority of researchers investigating the differential effects of performance-contingent and task-contingent rewards, Schunk rewarded the students in the performance-contingent group with five points for each problem completed, regardless of accuracy. At the end of the experimental session, the participants exchanged their points for such prizes as markers and stickers. Also exchangeable for prizes, points were given to children in the task-contingent group simply for participating in the study.

Although Schunk (1983) described the rewards given to students for completing math problems as performance-contingent, these rewards could more accurately be described as completion-contingent because the students were rewarded regardless of accuracy of responding. In addition, Schunk also failed to take into account the role of feedback. While the application of the reward contingency in the performance-contingent reward group conveyed to students the number of problems they completed,

no such feedback was given to students in the task-contingent reward group. Therefore, it is unclear whether the feedback or the reward contingency led to Schunk's findings.

Feedback

In a study comparing the effects of performance-contingent and task-contingent rewards on intrinsic motivation, Boggiano and Ruble (1979) provided performance feedback to all participants in an attempt to make fairer group comparisons. Participants consisted of students from both a preschool and from 3rd through 5th grade elementary school classrooms. After establishing that a hidden picture game was intrinsically interesting to children during pilot testing, researchers collected data on the amount of time participants engaged in the hidden picture game during a baseline control condition. Participants were then individually exposed to one of three conditions including performance-contingent reward, task-contingent reward, and a control (no reward) condition. Researchers told participants in the performance-contingent reward group that they would earn two pieces of candy for finding at least three of eight hidden pictures. Researchers told participants in the task-contingent reward group that they would earn two pieces of candy for simply participating in the hidden picture activity. In addition to informing the children of the contingency for engaging in a hidden picture game, researchers also provided the children with social-comparison information after they had completed the activity.

One third of the children in the performance-contingent and task-contingent reward groups were shown a scoreboard indicating that most other children had found seven out of the eight hidden pictures and some had found six or eight. Another third of the children in these two contingency groups were shown a scoreboard indicating that

most other children had found one out of the eight pictures and some had found zero or two. A final third of the participants in the performance-contingent and task-contingent reward groups, as well as all of the participants in the control group, did not receive any information about their performance relative to their peers. While not all children received the same social comparison information, all children were asked to mark on a scoreboard the number of hidden figures they found and were shown where the rest of the hidden pictures were located. In addition, the scoreboard had stars over numbers three through eight, indicating that scoring three or better reflected success at the task.

Although there were no significant differences among the performance levels of the groups during the experimental sessions, significant differences between groups were found for time children spent playing with the hidden-figure puzzles in a follow-up free-choice period. These differences varied according to social comparison condition, reward condition, and age group (i.e., younger preschool children vs. older elementary school children). For younger children, task-contingent rewards produced less follow-up participation in the task than did performance-contingent rewards. Only task-contingent rewards resulted in less participation in the activity during the follow-up phase than during the baseline control condition for preschool aged children. In addition, social comparison information had no effect on the younger children's time engaged in the activity in the free-choice period.

For the older children, children who were given social comparison information that suggested they did an excellent job at the task were more interested in the task later than children who believed they performed worse than other children or who were not given social comparison information. Compared to the control condition, task-contingent

rewards led to less interest in the activity, but only when no social comparison information was provided. Intrinsic interest was maintained only when participants were given social comparison information that they performed better than others or when they met an absolute standard of competency (e.g., finding at least three hidden pictures) when no social comparison information was given.

The results of the Boggiano and Ruble (1979) study provided evidence that performance-contingent rewards do not undermine intrinsic interest. This evidence supports the competency explanation for the effects of performance-contingent rewards. The competency hypothesis suggests that performance-contingent rewards provide more competency information than do task-contingent rewards and control conditions of no reward. Therefore, performance-contingent rewards should maintain or increase intrinsic interest in the activity.

In addition, the results of the Boggiano and Ruble (1979) study indicated that the mediating effects of competency information on intrinsic interest vary by developmental level. The results revealed that, for older children, direct information about competency had a more powerful effect on intrinsic interest than did the reward contingency. For these children, the information they received was more salient than the rewards. For preschool aged children, social comparison information was not salient enough to maintain interest in the task. However, competency information in the form of absolute performance standards maintained younger children's interest in the task.

Unfortunately, Boggiano and Ruble (1979) did not explore how the different reward contingency groups and types of competency information affected performance in a posttreatment phase. In addition, researchers deemed the hidden figure game an

intrinsically interesting game based on practice sessions. Therefore, no information can be gleaned from this study regarding the usefulness of these different types of reward contingencies and competency information on fostering interest when a task is not initially intrinsically motivating. Finally, despite receiving social comparison information that may have indicated incompetence, all participants earned access to the reward in the performance-contingent and task-contingent reward conditions. The results might have been different had students failing to meet the reward contingencies also failed to receive the reinforcer.

Harackiewicz (1979) also presented research on high school students that controlled for the role of feedback, but her results failed to support the competency hypothesis. She established six contingency groups including no reward without feedback, no reward with feedback, task-contingent reward without feedback, task-contingent reward with feedback, performance-contingent reward with feedback with the norms of performance given before the task, and performance-contingent with feedback with the norms of performance given after the task was completed. Harackiewicz (1979) devised the two performance-contingent groups based on the work of Karniol and Ross (1977), who predicted that rewards providing additional rather than redundant information about ability should increase intrinsic motivation.

Karniol and Ross (1977) suggested that, if the performance standard is outlined at the start of a task, participants will know how well they did as soon as they have finished, with the receipt of the actual reward simply repeating what they already know from their understanding of the directions. Harackiewicz (1979) tested this hypothesis by providing the performance standard to one of the performance-contingent reward groups before the

task and providing this same performance standard information to the other performance-contingent reward group only after they had completed the task. By creating task-contingent and no reward groups both with and without positive feedback, Harackiewicz also was able to isolate the effects of feedback versus reward.

Overall, Harackiewicz (1979) found that intrinsic motivation was enhanced by positive feedback but undermined by rewards. Based on the results from five outcome measures of intrinsic motivation including self-reported experimental enjoyment, the amount of time the participant spent looking at extra puzzles in a free-choice period, willingness to volunteer to do more puzzles, the number of extra puzzles requested by the participant, and self-reported posttest enjoyment, Harackiewicz found that both performance-contingent and task-contingent rewards, including those with and without additional positive feedback, reduced intrinsic motivation more than control conditions. In addition, examining only the task-contingent reward and no reward conditions, she found that positive feedback increased interest relative to no feedback. Effect-size data suggested that the positive feedback effect was stronger than the overjustification effect. Task-contingent rewards reduced intrinsic motivation with an effect size of $-.38$, whereas positive feedback increased interest with an effect size of $.59$.

Examining the groups that received positive feedback, including the two performance-contingent groups, the task-contingent group with feedback, and the no reward with feedback group, Harackiewicz (1979) found that performance-contingent and task-contingent rewards reduced interest more than the control condition. In addition, the two performance-contingencies taken together were significantly more undermining than the task-contingency with feedback. The mean scores on the dependent

measures of interest were not significantly different between the task-contingent reward with feedback group and the performance-contingent reward with performance norms provided at the start of the task. However, the performance-contingent reward group not given the performance norms until completion of the activity scored significantly lower on measures of interest than both the task-contingent reward group with positive feedback and the performance-contingent reward group given the norms ahead of time.

The results of the Harackiewicz (1979) study failed to support the competency hypothesis, as students in the more informational performance-contingent reward group given the performance norms at the end of the activity displayed less interest than the task-contingent reward group receiving positive feedback and the performance-contingent reward group receiving the norms at the start of the activity. However, the results did support the control hypothesis. Harackiewicz suggested that participants in the performance-contingent reward group who were only given norms after they completed the task may have felt that they had to perform as well as possible as long as they were engaged in the activity. The reward may have been perceived as more controlling for students in this group. On the other hand, students in the performance-contingent reward group that received norm information at the start of the task were not as controlled by the reward. These participants may have experienced less pressure, as they knew they only had to find four of the hidden names in the picture to perform at the normal level of success.

Harackiewicz (1979) did not explore the effects of the different task-contingent and performance-contingent rewards on performance once the contingencies were removed. In addition, the task employed in the study was intrinsically interesting to

participants, as measured by a task-enjoyment questionnaire. It is unclear what effect the different reward contingencies may have on a participant with little or no intrinsic interest in the activity. Finally, all participants in feedback conditions received positive feedback. Therefore, it remains unclear what effect the contingencies may have when combined with negative rather than positive feedback information.

Both Boggiano and Ruble (1979) and Harackiewicz (1979) found some evidence that positive feedback can potentially negate the negative effects of rewards on intrinsic interest. Boggiano and Ruble concluded that competency information, in the form of either absolute or relative performance standards, maintained or increased interest in the target activity. When comparing the four groups that received a task-contingent reward or no reward crossed with positive feedback or no feedback, Harackiewicz found that positive feedback had a stronger positive effect on interest than task-contingent rewards had a negative effect on interest.

However, comparing the four groups in the study that received positive feedback, Harackiewicz (1979) concluded that performance-contingent and task-contingent rewards significantly reduced intrinsic interest in the activity. At the start of the study, the performance-contingent reward contingency that entailed no information about the norms until completion of the activity was hypothesized to be more informational and therefore have less negative effects on interest than performance-contingent reward conditions in which participants were told the performance norms at the start of the activity and task-contingent reward conditions. This hypothesis was not supported. The performance-contingent reward group that was not informed of the performance norms until completion of the activity demonstrated significantly less interest than the performance-

contingent reward group that received the norms at the start of the activity and the task-contingent reward group receiving positive feedback. Harackiewicz's (1979) finding that the performance-contingent reward with norms given at the conclusion of the activity group reduced interest contradicts the Boggiano and Ruble (1979) findings, suggesting that despite competency information performance-contingent rewards may still decrease intrinsic interest. While Boggiano and Ruble hypothesized that competency information was more salient and thus maintained interest, Harackiewicz (1979) hypothesized that the more informational performance-contingent reward condition was more controlling, thus reducing interest in the activity.

Failure to Meet a Reward Contingency

Studies investigating the effects of different reward contingencies on intrinsic motivation often arrange circumstances so that all participants gain access to the reinforcement. In one of the few studies in which some participants did not gain access to any part of the reward, students who lost in a competitive activity expressed self-derogating feelings (Ames & Ames, 1978). In this study, pairs of students competed in a puzzle tracing activity. The winner chose a tangible prize such as crayons as his/her reward. However, researchers did not explore the effects of failing to earn a reward on future performance of the activity.

Other studies have explored the effects of tangible rewards offered for each problem or unit solved. Although these studies were not designed to assess the effects of failing to meet a reward contingency, participants often were given information that they received less than the maximum amount of reward available, which may have been interpreted as failure feedback. In their meta-analysis on the effects of extrinsic rewards

on intrinsic motivation, Deci et al. (2001) examined the very specific effects of performance contingencies based on the type of control group used and the different amounts of reward participants earned. They found that the group in which at least some participants received less than the maximum amount of reward and the control group that received no feedback evidenced the largest undermining effect on intrinsic motivation. Again, however, the researchers did not explore the effects on future performance.

The Current Experiment

To this point, researchers have not investigated the differential effects of performance-contingent and task completion-contingent rewards on academic performance when these contingencies are in place and after teachers remove them. Researchers also have failed to examine thoroughly the potential positive effects these reward contingencies may have on behaviors not initially intrinsically reinforcing. In addition, researchers have negligibly investigated the differential effects of meeting or failing to meet a reward contingency on subsequent academic accuracy.

Based on the competency hypothesis for explaining the differential effects of various reward contingencies, performance-contingent and task-contingent rewards, as well as no reward conditions, should have the same effect on measures of interest, performance, and free-choice behavior, if each is accompanied with the same competency information. However, despite the equitable competency information across groups, performance-contingent rewards may result in increased performance levels if they convey to the participants the saliency of the task. Suggesting that the task is not only worth completing, as in the task-completion contingency, but also worth completing accurately, performance-contingent rewards may lead participants to try harder and

increase accuracy.

According to control-hypothesis explanations of the differential effects of task-contingent and performance-contingent rewards, the latter rewards should result in greater decrements in interest and free-choice behavior as they exert more control over behavior. Requiring participants to meet a certain standard of performance in order to receive a reward, performance-contingent rewards place more specific demands on behavior than do task-contingent and no reward conditions. While the control hypothesis offers an explanation for the effects of task-contingent and performance-contingent rewards on interest and free-choice behavior, it does not explain how these contingencies may affect subsequent task performance.

Thus, this study investigated the effects of meeting or failing to meet different types of reward contingencies on the academic performance of students. Specifically, the study attempted to answer the following questions: What are the differential effects of performance-contingent, completion-contingent, and no reward conditions on math performance when the experimental conditions are in place, in a mandatory follow-up phase, and in a choice follow-up phase? What are the differential effects of earning a reward versus failing to earn a reward within the framework of a completion or performance contingency on subsequent academic performance? What are the differential effects of earning bonus points versus receiving no bonus points for high academic performance on subsequent academic performance under a choice arrangement?

Chapter II

Method

Participants

Participants included 74 students from three 4th grade classrooms ($n = 29$) and four 5th grade classrooms ($n = 45$) in an elementary school in the southeastern United States. Forty-two of the participants were female (56.76%) and 32 of the participants were male (43.24%). The elementary school primarily serves students from low-income neighborhoods and is ethnically and racially diverse. Thirty-eight of the participants were African-American, 31 were white, and five were Hispanic-American.

Materials

Participants were asked to complete assignments of math problems based on their current curriculum. Assignments were designed so that some students could successfully complete all the problems in the allotted 10-minute time, but others could not. Although all problems were on the instructional level of students, the assignments were long, making them difficult to complete in a 10-minute period. Ten parallel math problem assignments were prepared for each participating grade level (i.e., fourth and fifth grade). These assignments were randomly assigned to the appropriate grade-level classes for experimental conditions and phases of the study. In addition, for the continuous choice follow-up assignment including a word search, three word searches were selected from a popular word search magazine. The word searches included age and grade appropriate vocabulary.

Participants in fourth grade classes were presented with assignments consisting of 30, two-digit by two-digit subtraction problems. Each problem required borrowing and

all answers were positive numbers. The numbers 21-98, excluding multiples of ten, were used as the larger numbers in the problems and the numbers 12-89, also excluding multiples of ten were used as the smaller numbers in the problems. There were 56 possible answers to the problems included on the assignments.

To create the 10 assignments used in the study, numbers were randomly combined to create problems. A running record was kept of which numbers and problems were used on the assignments. No two-digit number either included as part of a problem or as a correct answer was repeated on the same assignment. In addition, there were no problems that were repeated across assignments. However, 36 of the possible correct responses were used five times and 20 of the possible correct responses were used six times.

Participants in fifth grade classes were presented with assignments consisting of 50, two-digit by one-digit multiplication problems. The digits 0-2 were not included in the problems because they are typically more easily mastered by students and would make counterbalancing problem order and difficulty more laborious. Using the digits three through nine, a list of all the possible 2-digit combinations was compiled, resulting in a list of 49 numbers. Combined with the seven 1-digit possibilities, this list was used to create a pool of 343 two-digit by one-digit multiplication problems to be included on the 10 experimental assignments. Because 10 assignments of 50 problems each were needed for the study, 157 problems from the pool of 343 had to be repeated on a second assignment. Thirteen problems on each assignment were repeat problems from another assignment but a single problem never repeated on the same assignment.

The pretest assignment was made by randomly combining two-digit and one-digit

numbers to create problems. A record was kept to ensure that all but one of the possible two-digit combinations was used only once and that each of the seven single digit options was used equally except for a randomly selected digit that had to be used an 8th time. The assignments for the experimental days were created by first making an assignment for one phase of the study (i.e., experimental, mandatory, or choice follow-up). Two-digit and one-digit numbers were randomly combined to create problems. A running record was kept of which numbers were used on the pretest and all the experimental assignments. Once an assignment was created, second and third assignments for that phase of the study were created by rotating the three digits included in each problem. This process was repeated to create assignments for the other two phases of the study.

Pretest

Before implementing experimental procedures, the researcher administered a pretest measure of math interest to students. Students completed a short Likert-scale questionnaire asking questions about willingness to engage voluntarily in math activities, preference for math as compared to other school subjects, and enjoyment of math (see Appendix A for 5th grade questionnaire).

The primary researcher also administered a pretest measure of math performance. At the start of the activity, the researcher informed students that they would have 10 minutes to complete a math assignment containing problems similar to the ones included on the experimental assignments. Students were told to try their best and that the assignment was a required classroom assignment. Both pretests (i.e., math interest and performance) were taken the day before experimental procedures began.

General Procedures

Sessions were held during the classroom time typically reserved for math on three school days. The primary researcher distributed math assignments to students. The researcher then read scripted directions (see Appendix B for example of scripted instructions) explaining the instructions for the assignment, the 10-minute time limit for working on the assignment, and the reward contingencies in place for that day. The researcher wrote the criteria for bonus points on the board and showed the class three sample assignments to clarify the contingency in place that day. All classrooms had a clock on the wall and the researcher wrote the start and stop times for assignments on the board. After ten minutes, the researcher collected the assignments for scoring. The primary researcher, a second graduate student, and the teacher scored the assignments within five minutes and redistributed them to students. While the assignments were being scored, students were told to read silently at their desks. Scorers wrote the number of bonus points the student earned under each reward contingency on the top of the page and put correct answers for problems solved incorrectly on the assignment.

After giving students one minute to look over their returned assignments, the researcher asked students to write either yes or no on the bottom of the page in response to the question, “Were you successful at this activity?” The teacher collected the assignments again and distributed another assignment to all students, similar to the one they just completed. The researcher explained that there were no reward contingencies in effect and the assignment was a required assignment. Again, students were told that they would have 10 minutes to work on the assignment. After collecting this assignment, the researcher gave students two more assignments. One assignment contained math

problems similar to the ones worked on during the earlier phases of the study. The second assignment contained a word search. Students were instructed to place the two assignments side by side on their desk and that they could complete any part of the assignments that they chose. The implication was that students would work on one or both of the assignments. Students were given the last ten minutes of the math period to work on the assignments.

Experimental Phase

Over the course of three days, the researcher implemented a performance-contingent reward condition, a completion-contingent reward condition, and a no reward condition during experimental sessions. Each of the seven classrooms was exposed to each of the three conditions. The order of the presentation of the conditions was counterbalanced and randomly assigned to the classrooms. All students were given 10 minutes to complete assignments of math problems. Table 2 provides a flow chart of different experimental phases. Table 3 shows the sequence of the three conditions across the seven classes.

Performance-contingent reward. During the performance-contingent reward condition, participants were given a copy of an assignment of math problems appropriate for their grade and curriculum. The researcher told students in the performance-contingent group that they would earn 10 bonus points towards their math grade for answering 75% or more of the problems correctly (22 or more problems for 4th graders and 37 or more problems for 5th graders), five bonus points for answering between 50-74% of the problems correctly (15-21 problems for 4th graders and 25-36 problems for 5th graders), and zero bonus points for answering less than 50% of the problems correctly (0-

Table 2

Flow Chart of the Phases within Conditions

Pretest Phase		Experimental Phase		Follow-up Phases	
Condition					
Math performance and self-reported interest	1. Performance-contingent reward	Mandatory math assignment			Continuous choice assignments
	or				
	2. Completion-contingent reward				
	or				
	3. Control				

Table 3

Order of the Presentation of Experimental Conditions for the Seven Participating Classes

		Day		
Classroom	Grade	1	2	3
1	4	A ₁ A ₂ A ₃	B ₁ B ₂ B ₃	C ₁ C ₂ C ₃
2	4	B ₁ B ₂ B ₃	C ₁ C ₂ C ₃	A ₁ A ₂ A ₃
3	4	C ₁ C ₂ C ₃	A ₁ A ₂ A ₃	B ₁ B ₂ B ₃
4	5	C ₁ C ₂ C ₃	B ₁ B ₂ B ₃	A ₁ A ₂ A ₃
5	5	B ₁ B ₂ B ₃	A ₁ A ₂ A ₃	C ₁ C ₂ C ₃
6	5	A ₁ A ₂ A ₃	C ₁ C ₂ C ₃	B ₁ B ₂ B ₃
7	5	A ₁ A ₂ A ₃	C ₁ C ₂ C ₃	B ₁ B ₂ B ₃

Note. A = Performance-contingent reward condition, B = Task-completion reward condition, C = Control condition, Subscript 1 = Experimental assignment, Subscript 2 = Mandatory follow-up assignment, Subscript 3 = Continuous choice follow-up assignment.

14 problems for 4th graders and 0-24 problems for 5th graders). The researcher also told students that they would have 10 minutes to work on the assignment. After 10 minutes, the researcher collected the assignments and scored them in five minutes with the help of the teacher and another graduate student (providing the correct answers to problems that the student answered incorrectly). The scorers wrote the number of bonus points each student earned under the reward contingency on students' assignments. The researcher allowed students to look over their corrected assignments for one minute. Before collecting the corrected assignments, the researcher asked students to write either yes or no on the bottom of their assignment in response to the question, "Were you successful at this activity?"

Completion-contingent reward. During the completion-contingent reward condition, the researcher gave participants an assignment of math problems and informed them that they would have ten minutes to work on the assignment. The researcher told students that they would earn 10 bonus points towards their math grade for answering 75% or more of the problems (22 or more problems for 4th graders and 37 or more problems for 5th graders), five bonus points for answering between 50-74% of the problems (15-21 problems for 4th graders and 25-36 problems for 5th graders), and zero bonus points for answering less than 50% of the problems (0-14 problems for 4th graders and 0-24 problems for 5th graders). After 10 minutes, the researcher collected the assignments and scored them within five minutes with the help of the teacher and another graduate student (providing the correct answers to problems that the student answered incorrectly). The scorers informed students how many bonus points they earned by writing the amount on the top of the assignment. In addition, the researcher gave

students their assignments back for one minute in order for them to review the problems that they answered incorrectly. Students were asked to write yes or no on the bottom of their assignment in response to the question, “Were you successful at this activity?”

No reward. During the no reward condition, the researcher gave participants an assignment of math problems. The researcher told the students that they would have 10 minutes to work on the assignment and that no bonus points were to be awarded. After 10 minutes, the researcher collected the assignments and scored them in five minutes with the help of the teacher and a second graduate student (providing the correct answers to problems that the student answered incorrectly). The researcher gave the students back their corrected assignments to look over for one minute. The researcher asked students to write yes or no on the bottom of their assignment in response to the question, “Were you successful at this activity?”

Follow-up Phases

Mandatory follow-up. After looking over their corrected assignments, students received another assignment. The researcher explained that there were no rewards available and that the assignment was a mandatory classroom assignment. After 10 minutes, the researcher collected the assignments.

Continuous choice follow-up. In the last phase of the study, the researcher gave students a third assignment. The assignment included two assignments, one of math problems and the other of a word search. The researcher explained to students that they could work on whatever part of the two assignments that they chose for the remainder of the class session (i.e., 10 minutes). The implication was that students would work on one or both of the assignments. At the end of the research period on the first day of

experimental procedures only, the researcher administered a posttest measure of math interest to students identical to the one students completed during the pretest phase of the study.

Interrater Reliability

A second rater scored thirty percent of the assignments for completion and accuracy. Two undergraduate students served as the secondary raters. Because scorers already marked the assignments used in the experimental phase of the study in order to provide immediate feedback to participants on the experimental days, they were not used for interrater reliability. However, pretest, mandatory follow-up, and choice follow-up assignments were included for reliability assessment. The primary researcher first recorded the accuracy and completion rates from the assignments without making any marks on the actual assignments. The assignments were then placed in folders with blank accuracy and completion rate scoring forms. The folders were given to the second raters to independently score and were later returned to the primary researcher. The interrater reliability for accuracy was .98, $p < .01$, and for completion was .96, $p < .01$.

Procedural Integrity

To evaluate whether the experimental methods were implemented as designed, a procedural integrity checklist was developed (Appendix C). The checklist included a series of statements reflecting the important procedural aspects of the experiment. The graduate students who were present in the classrooms to assist with the scoring of the experimental assignments completed the checklist. They placed a checkmark by each task that was completed by the researcher and did not place a checkmark if the researcher had failed to complete the task. A procedural integrity checklist was completed for each

class on each of the experimental days. Procedural integrity was 100%. In each of the seven classrooms included in the study and on each of the experimental days, the experimental methods were implemented as they were designed.

Dependent Measures

The dependent variables assessed in the study included students' math accuracy rates (percentage of problems answered correctly in 10-minute work periods), problem completion rates (percentage of problems answered in 10-minute work periods), and pre and post self-reported interest in math. In addition, students' self-assessments of how well they had done on the experimental assignments were correlated with their actual performance on the assignments.

Chapter III

Results

The results of the study indicated that both performance- and completion-contingent rewards led to greater problem accuracy and completion rates than a no reward control condition. However, once the rewards were removed for the mandatory follow-up phase of the study, the accuracy and completion rates in the performance- and completion-contingent reward conditions significantly decreased. Although the accuracy rates for the control condition also significantly decreased during the mandatory follow-up phase, completion rates under the control condition were the same for both the experimental and the mandatory follow-up assignments. There were no significant differences in accuracy or completion on the mandatory follow-up assignment based on condition.

Comparisons between performance on the pretest and on the mandatory follow-up on the first day of experimental procedures showed that student accuracy and completion rates both declined from the pretest to mandatory follow-up for participants who were exposed to the reward contingencies but performance remained the same across the pretest and mandatory follow-up for the control participants. In addition, although not significant at the $p < .05$ level, after the control condition, students had higher problem accuracy and completion rates on the choice math assignment than they did after the performance- and completion-contingent conditions.

The performance differential between the control and contingency conditions on the choice assignment was significant for high-achieving students. Students who earned the maximum amount of bonus points under the reward contingencies and who would

have earned the maximum amount of bonus points on the control day, had a contingency been in effect, had significantly higher completion and accuracy rates on the choice assignment following the control condition than participants who had performed at an average or low level. In addition, following the control condition, the high performers did significantly better on choice follow-up performance than did the high performers following the contingency conditions, with the former almost doubling the performance of the latter on both completion and accuracy.

Preliminary Analyses

Although all identifiable factors that might have influenced student performance on the math assignments initially were included in the model for the statistical analysis of the results, the factors of grade level (i.e., 4th or 5th grade) and order (i.e., sequence in which the conditions were applied to each classroom) were examined first. If these two independent variables did not differentially affect student performance, they could be removed as variables to simplify further analysis.

Grade level. An independent samples *t* test was used to examine accuracy rates on the pretest math assignment for the two grade levels. There was no significant difference between the pretest accuracy rate of the 4th grade students ($M = 54.25$, $SD = 36.66$) and the 5th grade students ($M = 54.13$, $SD = 29.10$), $t(72) = .02$, $p = .99$. The overall pretest accuracy mean was 54.18%, $SD = 21.03$.

An independent samples *t* test also was used to examine completion rates on the pretest math assignment for the two grade levels. There was no significant difference between the pretest completion rate of the 4th grade students ($M = 72.76$, $SD = 29.09$) and

the 5th grade students ($M = 66.80$, $SD = 23.84$), $t(72) = .96$, $p = .34$. The overall pretest completion mean was 69.14%, $SD = 25.99$.

A mixed-design ANOVA with the phase (experimental, mandatory, and choice follow-up) and condition (performance-contingent, completion-contingent, and control) serving as the within variables and grade level (4th and 5th) serving as the between variable was used to determine if grade level affected students' math accuracy rates during the study. The main effect of grade level on accuracy rate was not significant, $F(1, 72) = 2.00$, $p = .16$. In addition, the interaction effects of grade x condition and grade x phase were not significant, $F(2, 144) = .96$, $p = .39$, and $F(2, 144) = 1.07$, $p = .35$, respectively.

A mixed-design ANOVA with the phase (experimental, mandatory, and choice follow-up) and condition (performance-contingent, completion-contingent, and control) serving as the within variables and grade level (4th and 5th) serving as the between variable also was used to determine if grade level affected students' math completion rates during the study. The main effect of grade level on completion rate was not significant, $F(1, 72) = 3.39$, $p = .17$. In addition, the interaction effects of grade x condition and grade x phase were not significant, $F(2, 144) = .82$, $p = .44$, and $F(2, 144) = .99$, $p = .38$, respectively. Because grade level had neither a significant effect on accuracy or completion rates during the study nor on the pretest accuracy and completion rates, grade level was not included as a between-subjects variable in further data analyses.

Order. A univariate ANOVA with order of condition presentation serving as the between-subjects variable was completed to determine if pretest accuracy rates were

equivalent across the six condition orders applied in the study. The main effect of order on pretest accuracy was not significant, $F(5, 68) = 1.47, p = .21$. A univariate ANOVA also found that pretest completion rates were equivalent across the different orders of condition presentations, $F(5, 68) = 2.23, p = .06$.

A mixed-design ANOVA with the phase (experimental, mandatory, and continuous choice follow-up) and condition (performance-contingent, completion-contingent, and control) serving as the within variables and order of condition presentation as the between variable was used to determine if order had a significant effect on response accuracy during the study. The main effect of order was not significant, $F(5, 68) = .87, p = .51$. In addition, the interaction effects of order x phase and order x condition were not significant, $F(10, 136) = 1.46, p = .16$, and $F(10, 136) = .93, p = .32$, respectively.

A mixed-design ANOVA with the phase (experimental, mandatory, and continuous choice follow-up) and condition (performance-contingent, completion-contingent, and control) serving as the within variables and order of condition presentation as the between variable was used to determine if order had a significant effect on problem completion during the experimental phases. The main effect of order was not significant, $F(5, 68) = 1.13, p = .35$. In addition, the interaction effects of condition x order and order x phase were not significant, $F(10, 136) = .32, p = .72$, and $F(10, 136) = .62, p = .87$, respectively. Because the order of condition presentation had neither a significant effect on accuracy or completion rates during the study nor on the pretest accuracy and completion rates, order was not included as a between-subjects variable in further data analyses.

Performance as a Function of Condition and Phase

Accuracy rate. To examine the accuracy of math performance, a repeated measures ANOVA with the phase (experimental, mandatory, and continuous choice follow-up) and condition (performance-contingent, completion-contingent, and control) serving as the within variables was used. The accuracy means as a function of phase and condition are displayed in Table 4. The main effect of condition was not significant, $F(2, 146) = .57, p = .57$, although there was a significant main effect for phase, $F(2, 146) = 201.04, p < .05$, and a significant interaction effect between condition and phase, $F(4, 292) = 8.50, p < .05$.

Using Tukey's Honestly Significant Difference (HSD) test, post hoc analyses were conducted to clarify both the main effect of phase and the phase x condition interaction effect. Regarding the main effect of phase, comparisons revealed student accuracy rates declined as students progressed through the experimental phases of the study. Students achieved significantly greater accuracy rates in the experimental phase than in the mandatory and choice follow-up phases for all experimental conditions, $p < .05$. Students also accurately answered a significantly greater percentage of problems in the mandatory follow-up phase than in the choice phase, $p < .05$.

Regarding the phase x condition interaction effect, post hoc comparisons indicated condition had a significant effect on accuracy during the experimental phase but not during the mandatory and choice follow-up phases. Students in the performance-contingent and completion-contingent conditions accurately responded to a greater percentage of problems on the experimental assignment than students in the control condition, $p < .05$ (see the top half of Table 4). Comparisons between the control and

Table 4

Math Performance as a Function of Experimental Condition and Phase (N = 74)

Condition	Experimental		Mandatory		Choice
Accuracy					
Performance-contingent	72.50 _a	>	51.90	>	8.76
Completion-contingent	72.99 _a	>	53.80	>	8.94
Control	60.97 _b	>	55.53	>	14.01
Completion					
Performance-contingent	84.60 _c	>	63.30	>	9.21
Completion-contingent	84.41 _c	>	65.16	>	9.44
Control	73.49 _d	=	67.54	>	14.41

Note. The values represent mean percentages of correct or complete math problems.

Means in the same column that do not share subscripts differ at $p < .05$. Means in the same row that are not equal differ at $p < .05$

completion-contingent condition and the control and performance-contingent condition yielded effect sizes of .35 and .34, respectively. The performance and completion contingencies improved accuracy on the experimental assignment to the same degree.

Although not significant at the $p < .05$ level, condition did affect accuracy on the choice follow-up at the $p = .07$ level of significance. The variability of performance on the choice follow-up assignment resulted in standard deviations ranging from 26.86 to 32.29 across conditions, likely contributing to the lack of statistical significance at the $p < .05$ level. On the continuous choice follow-up assignment, students accurately answered a greater percentage of problems following the control condition than following the completion-contingent condition, $p = .05$, and the performance-contingent condition, $p = .06$ (refer to Table 4). Comparisons between accuracy on the choice assignment following the performance contingency and the control and following the completion contingency and the control both led to effect sizes of .16. Table 5 shows that this difference in accuracy on the continuous choice follow-up assignment was fairly consistent across the six orders of condition presentation used in the study.

Unlike Table 4, which displays the accuracy means for the continuous choice follow-up assignment including the performance of all participants, Table 6 displays the accuracy means by condition on the continuous choice follow-up assignment only for students who chose to complete one or more of the problems. A univariate ANOVA indicated the main effect of condition was not significant on the choice follow-up, $F(2, 32) = .46, p = .63$. The large standard deviations reported in Table 6 indicate considerable within-group variability among student performances on the choice follow-up assignment. This high degree of variability among student performances and the

Table 5

Math Performance on Math Portion of the Continuous Choice Follow-up as a Function of Experimental Condition and Order of Condition Presentation

Condition	Order of Condition Presentation					
	1 (<i>n</i> = 11)	2 (<i>n</i> = 9)	3 (<i>n</i> = 9)	4 (<i>n</i> = 10)	5 (<i>n</i> = 13)	6 (<i>n</i> = 22)
Accuracy						
Performance-contingent	17.27	.00	18.89	.00	.92	12.55
Completion-contingent	14.55	.00	9.26	.00	14.92	10.18
Control	28.79	.37	21.85	.00	18.77	12.55
Completion						
Performance-contingent	18.18	.00	19.26	.00	1.23	13.27
Completion-contingent	15.15	.00	11.11	.00	15.38	10.55
Control	29.39	.37	22.22	.00	20.00	12.82

Note. The values represent mean percentages of correct or complete math problems.

Table 6

Math Performance of Students who Chose to Work on the Math Portion of the Continuous Choice Follow-up by Condition

Condition	Mean	SD
Accuracy		
Performance-contingent ($n = 11$)	58.91	44.90
Completion-contingent ($n = 10$)	66.13	41.10
Control ($n = 14$)	74.05	32.69
Completion		
Performance-contingent ($n = 11$)	61.94	46.60
Completion-contingent ($n = 10$)	69.87	42.23
Control ($n = 14$)	76.33	33.39

Note. The values represent mean percentages of correct or complete math problems.

small number of students who chose to engage in the assignment likely contributed to the failure to find statistical significance at the $p < .05$ level. Comparisons between choice accuracy of students who engaged in the assignment following the performance contingency and the control and following the completion contingency and the control led to effect sizes of .46 and .24, respectively. More students chose to engage in the choice follow-up assignment and had higher accuracy rates on the assignment following the control condition than following either of the contingency conditions. It also should be noted that not only was the mean after the control condition greater than the means after the contingency conditions but also the standard deviation after the control condition was less than those after the contingency conditions.

Completion rate. A repeated measures ANOVA with the phase (experimental, mandatory, and continuous choice follow-up) and condition (performance-contingent, completion-contingent, and control) serving as the within variables was used to examine math completion rates. The bottom half of Table 4 displays the completion means as a function of phase and condition. The main effect of condition was not significant, $F(2, 146) = .24, p = .79$. There was a significant main effect for phase, $F(2, 146) = 293.75, p < .05$, and a significant interaction effect between condition and phase, $F(4, 292) = 6.92, p < .05$.

Tukey's HSD test was used to complete post hoc analyses of the main effect of phase and the interaction effect of condition x phase. Regarding the main effect of phase, post hoc comparisons revealed completion rates decreased across experimental phases, $p < .05$. Post hoc comparisons exploring the role of phase in the phase x condition interaction effect indicated this decrease in completion across phases was evident for both

the performance- and completion-contingent conditions.

Under the contingency conditions, students achieved significantly greater completion rates in the experimental phase than in the mandatory and choice follow-up phases, $p < .05$ (refer to the bottom half of Table 4). Following these two contingency conditions, students also answered a significantly greater percentage of problems in the mandatory follow-up phase than in the choice phase, $p < .05$. In the control condition, however, there was no significant difference between the percent of problems students completed on the experimental and mandatory follow-up assignments. Also in the control condition, students completed significantly more problems during the experimental and mandatory follow-up phases than they did in the choice phase, $p < .05$ (see Table 4).

Post hoc comparisons to clarify the role of condition in the phase x condition interaction effect on completion rates revealed that condition led to significantly different completion rates on the experimental assignment but not on the mandatory and choice follow-up assignments (see bottom half of Table 4). Students in the performance-contingent and completion-contingent conditions completed a greater percentage of problems than students in the control condition on the experimental assignment. Comparisons between the control and completion-contingent condition and the control and performance-contingent condition both yielded an effect size of .16. The performance and completion contingencies increased completion to an equal degree.

Although not significant at the $p < .05$ level, condition did affect completion rates on the choice follow-up assignment at the $p = .09$ level of significance. Again, lack of significance at the $p < .05$ level was probably due to the large within-group variability in

completion rates on the choice assignment. It also should be noted that on the choice follow-up assignment, comparisons indicated students in the control condition completed a greater percentage of problems than students in the completion-contingent condition, $p = .06$, and the performance-contingent condition, $p = .07$ (see bottom half of Table 4). Comparisons between completion on the choice assignment following the control versus the completion-contingent condition and following the control versus the performance-contingent condition both yielded an effect size of .16. This pattern mirrors that seen in student accuracy rates. Table 5 shows that this difference in completion on the optional follow-up assignment was fairly consistent across the six orders of condition presentation used in the study.

Looking only at the performance of students who chose to complete at least one of the problems on the choice follow-up assignments, a univariate ANOVA showed the main effect of condition on completion was not significant, $F(2, 32) = .39$, $p = .68$ (Table 6). The large variability in completion rates on the choice assignment and the small sample sizes likely contributed to the lack of statistical significance. However, the completion rate condition difference on the choice follow-up assignment is notable. The comparison between completion on the choice assignment following the control versus following the completion contingency yielded an effect size of .19 and the comparison between completion on the choice assignment following the control versus following the performance contingency resulted in an effect size of .43. Students who chose to engage in the choice assignment completed a greater percentage of problems following the control condition than following either of the contingency conditions (Table 6). Again, as was the case for accuracy rates, the standard deviation on the choice follow-up

assignment was considerably less following the control condition than the contingency conditions.

Students' Self-perceptions of Success

After students received feedback on their performance in the experimental phase of each condition, they were asked to respond to the question, "Were you successful at this activity?" by writing yes or no at the bottom of their assignment. Student responses to this question were correlated with their actual performance on the assignment to see if students' criteria for success were related to the performance criteria established by the researcher in the reward contingency conditions. In addition, students under the control condition were not told what was considered a good performance on the assignment, while students under the contingency conditions were given this information through the contingencies. An understanding of the relationship between student perceptions of success and actual performance was needed to ensure that the lack of information regarding what was considered a strong performance did not influence performance in the control condition.

Point-biserial correlations (a) between accuracy and perceived success and (b) between completion and perceived success were computed for each of the three conditions. Under the performance-contingent reward condition, there was a $.77, p < .01$, correlation between accuracy and perceived success and a $.71, p < .01$, correlation between completion and perceived success. Under the completion-contingent condition, students' accuracy correlated $.72, p < .01$, with perceived success and students' completion correlated $.78, p < .01$ with perceived success. Student perceptions of success and accuracy correlated $.75, p < .01$, under the control condition. Also under the control

condition, students' perceived success correlated with completion $.77, p < .01$. The relationship between perceived success and actual performance did not differ based on condition. Despite not receiving information regarding what was considered quality performance on the assignments, students under the control condition had the same understanding of what was a successful performance as did students under the contingency conditions.

Effects of Bonus Points under Performance-contingent Reward Condition

Accuracy rate. Analyses were conducted to examine the effects of earning or failing to earn bonus points during the performance-contingent condition on math accuracy in the subsequent phases of the study. A mixed-design ANOVA with the phase (experimental, mandatory, and continuous choice follow-up) serving as the within variable and number of bonus points earned (0, 5, or 10) serving as the between variable was used. The main effects of phase and bonus points were significant, $F(2, 142) = 101.56, p < .05$, and $F(2, 71) = 40.58, p < .05$, respectively. In addition, the interaction effect between phase and bonus points was significant $F(4, 142) = 9.79, p < .05$. Table 7 displays the accuracy means under the performance-contingent condition relative to the number of bonus points earned.

Post hoc comparisons using Tukey's HSD test were used to clarify the main and interaction effects related to phase. Examination of the main effect of phase indicated students demonstrated decreases in accuracy as they progressed through experimental phases of the study, $p < .05$. Regarding the role of phase in the phase x bonus points interaction effect, students who earned bonus points demonstrated significant declines in accuracy across phases of the study, $p < .05$. However, the accuracy rate for students

Table 7

Math Performance under Performance-contingent Reward Condition Relative to Bonus Points Earned on Experimental Assignment

Bonus points	Experimental		Mandatory		Choice
Accuracy					
0 ($n = 13$)	21.79 _a	=	20.26 _d	>	.00 _f
5 ($n = 18$)	62.70 _b	>	34.04 _d	>	.33 _f
10 ($n = 43$)	89.95 _c	>	67.38 _e	>	14.59 _g
Completion					
0 ($n = 13$)	63.48 _i	=	61.79 _m	>	.00 _p
5 ($n = 18$)	72.52 _i	>	37.48 _o	>	.33 _p
10 ($n = 43$)	93.86 _k	>	72.94 _m	>	15.35 _r

Note. The values represent mean percentages of correct or complete math problems.

Means in the same column that do not share subscripts differ at $p < .05$. Means in the same row that are not equal differ at $p < .05$.

who did not earn bonus points did not significantly decline from the experimental to the mandatory follow-up phase, although it did significantly decrease in the choice follow-up phase, $p < .05$ (see Table 7).

Post hoc comparisons exploring the main effect of bonus points showed accuracy increased as number of bonus points earned increased. Regarding the role of bonus points in the bonus points x phase interaction effect, post hoc comparisons suggested accuracy rates differed according to number of bonus points earned both on the experimental assignment and the mandatory follow-up assignment, with significant increases in accuracy paralleling increases in the number of bonus points earned, $p < .05$. However, on the choice follow-up assignment, students who did not earn bonus points were indistinguishable from students who earned five bonus points, although both groups demonstrated accuracy rates significantly lower than students who earned 10 bonus points, $p < .05$ (as shown in the top half of Table 7).

Although no bonus points were awarded during the control condition, analyses were used to determine if the accuracy rate trends seen under and following the performance contingency were primarily a function of bonus points or skill level. Based on accuracy rates on the experimental assignment, students in the control condition were divided into three groups based on the number of bonus points they would have earned under the performance contingency. A mixed-design ANOVA with phase (experimental, mandatory, and choice follow-up) as the within-subjects variable and number of bonus points students would have earned as the between-subjects variable was computed. The main effects of phase and bonus points were significant, $F(2, 142) = 99.85, p < .05$, and $F(2, 71) = 73.08, p < .05$, respectively. In addition, the interaction effect of phase x

bonus points was significant, $F(4, 142) = 8.37, p < .05$. Table 8 displays student accuracy rates across phases of the study under the control condition based on bonus-point groupings.

Post hoc comparisons using Tukey's HSD test showed that the accuracy trends across phases and bonus-point groupings were almost identical to the accuracy rates of students actually receiving or not receiving bonus points under the performance-contingent reward condition. However, one difference was apparent in the accuracy of high-performing students (students who earned or would have earned 10 bonus points) on the choice follow-up assignment. Although the accuracy rates declined for students at all performance levels from the mandatory follow-up to the choice follow-up assignment, Table 9 shows that the accuracy rates for high-achieving students on the choice follow-up assignment were significantly greater following the control condition than following the performance-contingent condition, $t(74) = 1.60, p < .05$.

Completion rate. To explore the effects of bonus points on completion for the performance-contingent condition, a mixed-design ANOVA with the phase (experimental, mandatory, and continuous choice follow-up) serving as the within variable and number of bonus points earned (0, 5, or 10) serving as the between variable was used. Both the main effects of phase and bonus points were significant, $F(2, 142) = 153.14, p < .05$, and $F(2, 71) = 16.89, p < .05$, respectively. The interaction effect between phase and bonus points also was significant, $F(4, 142) = 2.93, p < .05$. The bottom half of Table 7 displays the completion means on the performance-contingent experimental day relative to the number of bonus points earned.

Using Tukey's HSD test, post hoc analyses were used to clarify the main effect of

Table 8

Control Condition Performance Based on Bonus-Point Groupings Had Participants Been Under the Performance Contingency

Bonus points	Experimental		Mandatory		Choice
Accuracy					
0 ($n = 29$)	24.02 _a	=	28.60 _d	>	.07 _g
5 ($n = 12$)	60.61 _b	=	47.56 _e	>	6.67 _g
10 ($n = 33$)	93.57 _c	>	82.10 _f	>	28.93 _h
Completion					
0 ($n = 29$)	49.54 _i	=	52.64 _m	>	.07 _p
5 ($n = 12$)	66.55 _k	=	51.28 _m	>	6.67 _p
10 ($n = 33$)	97.05 _l	>	86.55 _o	>	29.90 _r

Note. The values represent mean percentages of correct or complete math problems.

Means in the same column that do not share subscripts differ at $p < .05$. Means in the same row that are not equal differ at $p < .05$.

Table 9

Math Performance of High-performing Students on Choice Follow-up after Contingency Conditions versus Control Condition

Contingency Condition	Contingency		Control
Accuracy			
Performance-contingent	14.93 ($n = 43$)	<	28.93 ($n = 33$)
Completion-contingent	11.52 ($n = 56$)	<	23.28 ($n = 41$)
Completion			
Performance-contingent	15.71 ($n = 43$)	<	29.90 ($n = 33$)
Completion-contingent	12.12 ($n = 56$)	<	24.07 ($n = 41$)

Note. The values represent mean percentages of correct or complete math problems.

Unequal means in the same row differed at $p < .05$.

phase and the role of phase in the phase x bonus points interaction effect. Regarding the main effect of phase, comparisons indicated completion rates significantly declined across experimental phases of the study, $p < .05$. Comparisons regarding the role of phase in the phase x bonus points interaction effect indicated the completion rates for students who earned bonus points significantly declined across phases, $p < .05$.

However, identical to the accuracy performance patterns, the completion rate for students who did not earn bonus points did not significantly decline from the experimental to the mandatory follow-up phase, although it did significantly decrease in the choice follow-up phase, $p < .05$ (refer to the bottom half of Table 7).

Post hoc comparisons used to more fully explicate the main effect of bonus points showed that increases in completion paralleled increases in the number of bonus points earned by students. Regarding the role of bonus points in the phase x bonus points interaction effect, comparisons revealed that, in the experimental phase, the completion rates of students who earned 10 bonus points for accuracy under the performance contingency were significantly higher than the completion rates of students who earned zero or five bonus points, $p < .05$. On the mandatory follow-up assignment, students who did not earn bonus points were indistinguishable from students who earned 10 bonus points, although both of these groups' completion rates were significantly greater than the completion rate of students who earned five bonus points, $p < .05$. In the choice follow-up phase, students who earned the maximum bonus credit for accuracy had a significantly higher completion rate than students who earned zero or five bonus points, $p < .05$ (see bottom half of Table 7).

Although no bonus points were awarded during the control condition, analyses

similar to those used to examine the effects of bonus points during the performance-contingency condition were used to determine if the completion rate trends seen under the performance contingency were primarily a function of bonus points or skill level. Based on accuracy rates on the experimental assignment, students in the control condition were divided into three groups based on the number of bonus points they would have earned had the performance contingency been in effect. A mixed-design ANOVA with phase as the within-subjects variable and bonus points as the between-subjects variable revealed the main effect of phase, $F(2, 142) = 117.09, p < .05$, bonus points, $F(2, 71) = 35.42, p < .05$, and the interaction effect of phase x bonus points, $F(4, 142) = 12.60$, were significant, $p < .05$.

The bottom half of Table 8 shows the completion rates across phases of control students based on the number of points they would have earned under the performance contingency. Post hoc comparisons using Tukey's HSD showed these completion rate trends were almost identical to those of students actually receiving or not receiving bonus points under the performance-contingent reward condition. However, although the completion rate declined for students at all performance levels from the mandatory follow-up to the choice follow-up assignment, Table 9 shows that the completion rates for high-achieving students on the choice follow-up assignment were significantly greater after the control condition than after the performance-contingent condition, $t(74) = 1.57, p < .05$.

Effects of Bonus Points under the Completion-contingent Reward Condition

Accuracy rate. A mixed-design ANOVA with the phase (experimental, mandatory, and continuous choice follow-up) serving as the within variable and number

of bonus points earned (0, 5, or 10) serving as the between variable was used to examine the effects of bonus points on subsequent accuracy in the completion-contingent condition. The main effect of phase, $F(2, 142) = 58.78$, bonus points, $F(2, 71) = 14.68$, and the interaction effect between phase and bonus points, $F(4, 142) = 5.04$, were significant, $p < .05$. Accuracy means under the completion contingency based on bonus points and phases of the study are displayed in Table 10.

Using Tukey's HSD test, post hoc analyses were used to clarify the main effect of phase and the role of phase in the phase x bonus points interaction effect. Regarding the main effect of phase, comparisons once again revealed that accuracy rates decreased as students progressed through the phases of the study, $p < .05$. Further comparisons relevant to the phase x bonus points interaction effect showed the accuracy rates for students who earned bonus points significantly declined across phases, $p < .05$. However, the accuracy rate for students who did not earn bonus points did not significantly decline from the experimental to the mandatory follow-up phase, although it did significantly decrease in the choice follow-up phase, $p < .05$ (as shown in the top half of Table 10).

Comparisons to clarify the main effect of bonus points showed that student accuracy increased as the number of bonus points earned by students increased. Regarding the role of bonus points in the phase x bonus points interaction effect, post hoc analyses indicated accuracy rates significantly increased as number of bonus points earned under the completion contingency increased in the experimental phase, $p < .05$. On the mandatory follow-up assignment, students who did not earn bonus points performed at the same level as students who earned five bonus points, although both

Table 10

Math Performance under Completion-contingent Reward Condition Relative to Bonus Points Earned on Experimental Assignment

Bonus points	Experimental		Mandatory		Choice
Accuracy					
0 ($n = 9$)	29.96 _a	=	17.18 _d	>	.00
5 ($n = 9$)	57.56 _b	>	37.56 _d	>	1.78
10 ($n = 56$)	82.87 _c	>	62.30 _e	>	11.50
Completion					
0 ($n = 9$)	38.44 _f	>	24.07 _i	>	.00
5 ($n = 9$)	61.33 _g	>	41.11 _i	>	2.22
10 ($n = 56$)	95.51 _h	>	75.63 _k	>	12.12

Note. The values represent mean percentages of correct or complete math problems.

Means in the same column that do not share subscripts differ at $p < .05$. Means in the same row that are not equal differ at $p < .05$.

groups demonstrated accuracy rates significantly lower than students who earned 10 bonus points, $p < .05$. Although not significant at the $p < .05$ level, in the choice follow-up phase, accuracy increased as number of bonus points earned increased (see top half of Table 10). The variability among the accuracy rates of students on the choice follow-up assignment likely led to the non-significant finding. Comparisons between choice follow-up accuracy of students who earned 10 versus five bonus points and between students who earned 10 versus zero bonus points yielded effect sizes of .32 and .38, respectively.

Although no bonus points were awarded during the control condition, analyses similar to those used to examine the effects of bonus points during the completion contingency were used to determine if the accuracy rate trends seen under the completion contingency were due more to bonus points or skill level. Based on completion rates on the experimental assignment, students in the control condition were divided into three groups based on the number of bonus points they would have earned had the completion contingency been in effect. A mixed-design ANOVA with phase as the within-subjects variable and bonus points as the between-subjects variable found a significant phase main effect, $F(2, 142) = 77.15, p < .05$, bonus-points main effect, $F(2, 71) = 18.05, p < .05$, and phase x bonus points interaction effect, $F(4, 142) = 3.38, p < .05$.

Post hoc comparisons using Tukey's HSD were computed to clarify the main effect of phase and the role of phase in the phase x bonus points interaction effect under the control condition. The top half of Table 11 shows that accuracy trends across phases of the study based on the number of points students would have earned under the completion contingency were almost identical to the performance of students actually

Table 11

Control Condition Performance Based on Bonus-Point Groupings Had Participants Been Under the Completion Contingency

Bonus points	Experimental		Mandatory		Choice
Accuracy					
0 ($n = 19$)	26.63 _a	=	31.09 _d	>	.11 _f
5 ($n = 14$)	51.19 _b	=	49.71 _d	>	5.71 _f
10 ($n = 41$)	80.22 _c	>	68.85 _e	>	23.28 _g
Completion					
0 ($n = 19$)	33.86 _h	<	44.04 _i	>	.11 _p
5 ($n = 14$)	62.48 _i	=	61.81 _i	>	5.71 _p
10 ($n = 41$)	95.61 _k	>	80.39 _m	>	24.07 _r

Note. The values represent mean percentages of correct or complete math problems.

Means in the same column that do not share subscripts differ at $p < .05$. Means in the same row that are not equal differ at $p < .05$.

receiving or not receiving bonus points under the completion-contingent reward condition. However, as shown in Table 9, the accuracy of high-performing students (students who earned or would have earned 10 bonus points) on the choice follow-up assignment was significantly greater after the control condition than it was after the completion-contingent condition, $t(95) = 1.66, p < .05$.

Completion rate. A mixed-design ANOVA with the phase (experimental, mandatory, and continuous choice follow-up) serving as the within variable and number of bonus points earned (0, 5, or 10) serving as the between variable was used to examine the effects of bonus points on subsequent completion in the completion-contingent condition. The main effect of phase, $F(2, 142) = 84.97$, bonus points, $F(2, 71) = 32.79$, and the interaction effect between phase and bonus points, $F(4, 142) = 6.60$, were significant, $p < .05$. The bottom half of Table 10 displays the completion means under the completion-contingent condition relative to the number of bonus points earned.

Using Tukey's HSD test, post hoc analyses were conducted to delineate the main effect of phase. Follow-up comparisons of the main effect of phase showed completion rates declined progressively across phases of the study, $p < .05$. An examination of the main effect of bonus points revealed that student completion rates increased proportionately to the number of bonus points students earned.

Regarding the role of bonus points in the phase x bonus points interaction effect, post hoc comparisons revealed that completion rates significantly increased as number of bonus points earned under the completion contingency increased on the experimental assignment, $p < .05$. On the mandatory follow-up assignment, students who did not earn bonus points were indistinguishable from students who earned five bonus points,

although both groups demonstrated significantly lower completion rates than students who earned 10 bonus points, $p < .05$. In the choice follow-up phase, there were no significant differences between the groups. Although students who earned the maximum bonus points reward did demonstrate a higher completion rate in the choice follow-up phase, the variability among student performances likely led to the non-significance of this finding (see bottom half of Table 10). The comparison between choice follow-up completion of students who earned 10 bonus points versus zero bonus points resulted in an effect size of .38, and the comparison between students who earned 10 bonus points versus five bonus points yielded an effect size of .31.

In order to separate the effects of skill level from the effects of bonus points on completion rates under the completion-contingent reward condition, analyses similar to those used to examine the effects of bonus points during the completion contingency were used for the control condition. Based on completion rates on the experimental assignment, students in the control condition were divided into three groups based on the number of bonus points they would have earned had the completion contingency been in effect. Using a mixed-design ANOVA with phase as the within variable and bonus points as the between variable, a significant main effect of phase, $F(2, 142) = 117.17, p < .05$, bonus points, $F(2, 71) = 35.39, p < .05$, and a significant interaction effect between phase and bonus points, $F(4, 142) = 5.08, p < .05$, were found.

Tukey's HSD test was used to make post hoc comparisons. The bottom half of Table 11 shows the completion trends across phases of the study for the control condition based on the bonus-point groupings. These completion rate trends for the control condition were almost identical to the trends seen for students actually under the

completion contingency. However, as was the case under the performance-contingent condition, the completion rate of high-performing students (students who earned or would have earned 10 bonus points) on the choice follow-up assignment was significantly greater after the control condition than it was after the completion-contingent condition, $t(95) = 1.62, p < .05$ (as shown in Table 9).

Performance during Experimental Phases on First Day versus Pretest Performance

Accuracy rate. Because a pretest measure of accuracy was only collected once, before any experimental conditions were introduced, comparisons between accuracy rates across experimental phases and the pretest could only be made for the first day of experimental procedures. A mixed-design ANOVA with phase (pretest, experimental, mandatory follow-up, and choice follow-up) serving as the within variable and condition (performance-contingent, completion-contingent, and control) serving as the between variable was computed. The main effect of phase and the interaction effect of condition x phase were significant, $F(3, 213) = 91.44, p < .05$, and $F(6, 213) = 2.92, p < .05$, respectively. The main effect of condition was not significant, $F(2, 71) = .48, p = .62$. Table 12 displays the accuracy means across phases of the study by condition for the first day of condition presentation.

Post hoc comparisons using Tukey's HSD test were used to explore the main effect of phase and the phase x condition interaction effect. These comparisons showed the accuracy rate trends during the experimental phases of the study (experimental, mandatory, and choice follow-up) were generally similar to those seen in the composite analysis of accuracy across phases. However, on the first experimental day, the accuracy rates in the control condition did not decline from the experimental to mandatory follow-

Table 12

Math Performance as a Function of Experimental Condition and Phase on First Experimental Day

Condition	Pretest		Experimental		Mandatory		Choice
Accuracy							
Performance-contingent	53.58 ₁	<	72.73 _a	>	43.66 ₂	>	14.12
Completion-contingent	60.58	<	79.76 _a	>	50.64	>	8.82
Control	47.82	=	54.04 _b	=	54.74	>	10.35
Completion							
Performance-contingent	64.38 ₃	<	80.99 _c	>	54.22 ₄	>	14.91
Completion-Contingent	72.73	<	88.24 _c	>	58.46	>	9.09
Control	73.23	=	72.35 _d	=	73.09	>	10.53

Note. The values represent mean percentages of correct or complete math problems.

Means in the same column that do not share alphabetic subscripts differ at $p < .05$. In addition to the significant differences graphically identified within the table, means in the same row that do not share numerical subscripts also differ at $p < .05$.

up assignment (see top half of Table 12). This finding contrasts with the overall analysis finding that accuracy rates declined from experimental to mandatory follow-up.

By including the pretest accuracy means in this analysis, an additional comparison between pretest and mandatory follow-up accuracy rate was made. The requirements and instructions for the mandatory follow-up assignment were identical to those for the pretest. For pretest and mandatory follow-up assignments, students were not given a choice to participate and were not presented with a reward contingency. For the control condition, accuracy rates remained stable from the pretest through the mandatory follow-up phase. However, for the contingency conditions, student accuracy rates declined on the mandatory follow-up assignment compared to both the experimental phase and the pretest. Although this decrease in accuracy on the mandatory follow-up compared to the pretest was not significant at the $p < .05$ level following the completion contingency, it was significant for the performance contingency, $p < .05$ (refer to Table 12). The comparison between accuracy on the pretest and on the mandatory follow-up assignment following the completion contingency resulted in an effect size of .32.

In examining the role of condition in the condition x phase interaction effect, post hoc comparisons revealed no significant differences among student accuracy rates on the pretest, mandatory follow-up, and choice follow-up assignments based on condition. However, consistent with results reported earlier in this chapter for the composite data, student accuracy rates were significantly lower on the experimental assignment under the control condition than they were under the contingency conditions, $p < .05$ (refer to the top half of Table 12). In addition, comparisons of accuracy on the mandatory follow-up after the control versus performance-contingency conditions and following the control

versus completion-contingency conditions resulted in effect sizes of .30 and .11, respectively.

Completion rate. Fair comparisons between completion rates across experimental phases of the study and pretest completion rates could only be made for the first day of condition presentation because pretest completion data were only collected once before conditions were introduced to participants. A mixed-design ANOVA with phase (pretest, experimental, mandatory, and choice follow-up) serving as the within-subjects variable and condition (performance-contingent, completion-contingent, and control) serving as the between-subjects variable was completed. The bottom half of Table 12 shows the completion means across phases of the study on the first day of experimental procedures. The main effect of phase and the phase x condition interaction effect were significant, $F(3, 213) = 131.72, p < .05$, and $F(6, 213) = 2.63, p < .05$, respectively. The main effect of condition was not significant, $F(2, 71) = .23, p = .80$

Using Tukey's HSD test, post hoc comparisons indicated the completion rate trends during the experimental phases (experimental, mandatory, and choice follow-up) on the first day of experimental procedures were very similar to the trends in the overall analysis of completion across phases. However, comparisons between pretest and mandatory follow-up completion rates revealed that completion rates declined not only from the levels seen on the experimental assignment but also from pretest levels following the contingency conditions. The completion rate on the mandatory follow-up assignment after the performance contingency was significantly lower than the pretest completion rate, $p < .05$. The lower completion rate on the mandatory follow-up assignment following the completion-contingent condition compared to the pretest was

not significant for the completion contingency but the difference in completion rates on these two assignments yielded an effect size of .60. Mandatory follow-up completion rates following the control condition were statistically equal to those seen on the pretest (as shown in the bottom half of Table 12).

Post hoc comparisons related to the role of condition in the phase x condition interaction effect showed no significant differences between conditions with respect to completion rates during the pretest, mandatory follow-up, and choice follow-up phases. However, students did have significantly higher completion rates on the experimental assignment under the contingency conditions than under the control condition, $p < .05$ (refer to Table 12). In addition, comparisons between mandatory follow-up completion after the control versus performance contingency and after the control versus completion contingency resulted in effect sizes of .62 and .48, respectively.

Self-reported Interest

A mixed-design ANOVA with the interest questionnaire (pre and post measures) serving as the within variable and condition on the first day of experimental procedures serving as the between variable was used to determine the effects of the various conditions on self-reported interest in math. The main effect of pre to post administration of the interest questionnaire and the main effect of condition were not significant, $F(1, 69) = .06, p = .81$, and $F(2, 69) = .87, p = .42$, respectively. The interaction effect between self-reported interest and condition also was non-significant, $F(2, 69) = 2.86, p = .06$.

Chapter IV

Discussion

This chapter outlines the significant findings of the study including the direct and indirect effects of reward contingencies on math performance and interest. Particular emphasis is given to the implications of the findings regarding the overjustification effect. In addition, the results are discussed in terms of the competency and control hypotheses for explaining the differential effects of reward contingencies on intrinsic motivation. Limitations of the study and directions for future research also are addressed.

Direct Effects of Performance versus Completion Contingencies

Consistent with previous research on the use of reward contingencies to improve math performance (e.g., Drew et al., 1982; Pavchinski et al., 1989), both the performance and completion contingencies applied in this study resulted in higher math accuracy and completion rates than a no reward condition. The promise of the reward contingency led students to perform with greater accuracy and completion than they did under the no reward condition, suggesting that bonus points would be reinforcing to students. In addition, based on the finding that the accuracy and completion rates under the contingency conditions ranged from 10 to 12 percentage points higher than under the control condition, it can be argued that bonus points were moderately valued by the students. This performance differential between the contingency and control conditions would typically be equivalent to a whole letter grade in most classrooms. However, repeated delivery of bonus points across work sessions would be needed to confirm the reinforcing effect of bonus points.

Although the contingencies each focused on a different aspect of math

performance (i.e., accuracy or completion), both contingencies seemingly affected student math performance in the same way. It is reasonable that completion rates would increase when the performance-contingent reward condition was in place, given that accurately responding to problems requires completing the problems. However, under the completion-contingent reward condition, students could have provided mainly incorrect responses and still gained access to the reward. Surprisingly, student accuracy rates were statistically equivalent under both of the reward contingencies.

One possible explanation as to why student performance was so similar under the distinctive performance-contingent and completion-contingent reward conditions may relate to reinforcement history. Reinforcement history refers to the behavior patterns that persist despite a change in contingency conditions (Skinner, 1958; Skinner, 1977). Research has found that current behavior is influenced by past reinforcement contingencies (Epstein, & Price, 1970; Martens, Bradley, & Eckert, 1997; Martens et al., 2003; Schuett, & Leibowitz, 1986). Although all of the teachers involved in the study informally reported that they sometimes graded assignments under a completion contingency, the majority of the students' academic assignments were graded under a performance contingency. This history of being reinforced for accuracy and completion, rather than just completion, may have affected student performance during experimental procedures.

If reinforcement history did mediate the effects of the reward conditions, this may suggest that teachers who use performance contingencies to grade the majority of student work can occasionally grade student assignments using a completion contingency without fear that students will automatically disregard the need for accuracy. Grading

assignments simply for completion offers practical benefits to teachers as it allows them to spend less time grading and more time teaching. On the other hand, if reinforcement history did not affect student responses to the reward contingencies, an even stronger argument can be made that teachers can evaluate student performance using completion contingencies. If both contingencies result in similar student performance, it is unnecessary for teachers to grade all assignments using the more labor-intensive performance contingency.

Performance after Termination of Reward Contingencies

The positive effects of the reward contingencies on student math performance did not persist. Once these contingencies were removed, student performance on the mandatory follow-up assignment generally did not differ according to condition. Students' accuracy and completion rates significantly declined from the experimental assignment to the mandatory follow-up assignment after the reward contingencies, but students maintained the same completion rates on the experimental and mandatory follow-up assignments under the no reward control condition. In addition, on the first day of experimental procedures, student performance on the mandatory follow-up assignment after the reward contingency conditions fell below the performance levels seen on the baseline pretest. However, students' accuracy and completion rates remained the same on the mandatory follow-up assignment as they were on the pretest following the control condition.

The consistent decreases in student accuracy rates from the experimental assignment to the mandatory follow-up assignment across all three conditions could possibly be due to fatigue. However, the findings that student completion rates did not

decline following the control condition and that student accuracy and completion rates dropped to levels below pretest performance only following the contingency conditions offer some support for the idea that extrinsic rewards can undermine intrinsic motivation to engage in an activity. The rewards used under the performance- and completion-contingent conditions may have led to a decrease in students' intrinsic motivation to engage in the math assignments, otherwise known as the overjustification effect (Deci, 1971; Lepper, Greene, & Nisbett, 1973).

Indirect Effects of Reward Contingencies on Voluntary Participation

In the choice follow-up phase of the study, there were no significant differences between conditions for either student accuracy or completion rates at the $p < .05$ level. However, during the choice phase, students' accuracy rates following the control condition were higher than following the contingency conditions at the $p < .10$ level. On the choice follow-up assignment, students' completion rates following the control condition were also higher than those following the contingency conditions. These higher accuracy and completion rates were fairly consistent across classrooms and the six orders of condition presentation. In addition, although not statistically significant, more students chose to engage in the choice assignment and had higher accuracy and completion rates after the control condition than after either of the reward contingency conditions. These findings once again seem to suggest an overjustification effect. When students were not presented with a reward contingency for math performance, they were more likely to choose to engage in the choice follow-up assignment and perform with greater accuracy and completion rates than when they had experienced either of the reward contingencies.

Perhaps the most interesting finding related to the effects of bonus points was seen in the performance of high-performing students (students who earned 10 bonus points under the reward contingencies or who would have earned 10 points if one of the reward contingencies had been in effect on the control day). Although the accuracy and completion rates of high-performing students significantly declined from mandatory follow-up to choice follow-up performance across all conditions, the actual accuracy and completion rates on the choice follow-up assignment were significantly higher for high performers following the control condition than following either of the reward contingencies. Students who earned the maximum amount of bonus points under the reward conditions chose to complete significantly less problems and with significantly less accuracy on the choice follow-up assignment than high-performing students following the control condition. The accuracy and completion rates of these high-performing students were nearly twice as high after the control condition as they were after the reward contingency conditions.

Overjustification Effect

The promise of receiving bonus points towards their math grade led students to perform with higher accuracy and completion rates than they did under the no reward condition. Students demonstrated accuracy and completion levels 10 to 12 percentage points higher under the contingency conditions than they did under the control condition, a difference typically equivalent to a letter grade. This finding indicates that bonus points were potentially reinforcing to the student participants. However, once the opportunities to earn bonus points were removed, student performance on the mandatory and choice follow-up assignments reflected decreased intrinsic interest in math or an

overjustification effect. The bonus points offered in the reward contingency conditions may have lowered students' motivation to engage in the activity without a reward incentive, viewing the task as something only worth doing for a reward (Deci, 1971; Lepper et al., 1973).

Three findings in particular point to the possibility of an overjustification effect: (a) only following the control condition did completion rates remain at the same level on the mandatory follow-up assignment as during the experimental phase and the pre-test; (b) more students chose to engage in and had higher accuracy and completion rates on the choice follow-up after the control condition than after the contingency conditions; and (c) high-performing students under the control condition subsequently performed at approximately twice the level on the choice follow-up as high-performing students under the contingency conditions. With respect to the latter finding, receipt of bonus credit for high performance apparently diminished the follow-up math engagement of high performers.

More evidence for the overjustification effect was found through examination of the accuracy and completion rates of average-performing students (students who earned five points under the reward contingencies and students who would have earned five points had a reward contingency been in place on the control day). Following the control condition, average-performing students maintained the same levels of completion and accuracy on the mandatory follow-up assignment as they did on the experimental assignment. However, after earning five bonus points, students exhibited significantly lower accuracy and completion rates on the mandatory follow-up assignment than on the experimental assignment. Although not statistically significant, after earning five points

in the experimental phase, students had lower accuracy and completion rates on the choice follow-up assignment than after performing at an average level under the control condition. The bonus points earned by these students potentially undermined their intrinsic motivation to try their best on the mandatory follow-up assignment and to engage in the choice follow-up assignment.

The failure to earn bonus points apparently did not have a negative effect on the performance of low-achieving students. In fact, low-achieving students (students who did not earn bonus points under the reward contingencies and students who would not have earned bonus points had a reward contingency been in place on the control day) performed very similarly under the reward contingencies and under the no reward control condition across the phases of the study. The accuracy rates of low-performing students were the same on the experimental and mandatory follow-up assignments. The completion rates also remained the same after the performance-contingent condition but significantly decreased after the completion-contingent condition from the experimental to the mandatory follow-up assignment.

While the bonus points earned by average- and high-performing students appeared to have negative effects on intrinsic motivation, the failure to earn bonus points did not affect the follow-up performance of low-achieving students either positively or negatively. If extrinsic rewards undermine the intrinsic motivation of students who access them and fail to motivate low-achieving students to try harder, educators must carefully consider their use with groups of students demonstrating heterogeneous levels of intrinsic interest.

Control versus Competency Hypotheses

Although the math performance of low-achieving students was not negatively impacted by extrinsic rewards, this finding does not refute the overjustification effect. It is more than likely that these low-achieving students were not initially intrinsically motivated to do math work. If the students had little or no intrinsic motivation to accurately complete math problems, it is unlikely that extrinsic rewards could have an undermining effect. The competency hypothesis for explaining the differential effects of reward contingencies on intrinsic motivation suggests that intrinsic motivation for a task is affected by the information individuals receive regarding their competency at the task (Karniol & Ross, 1977). The low-achieving students who participated in the study probably received little positive competency information regarding their ability to do math problems. This lack of competency information would contribute to low intrinsic motivation according to the competency hypothesis.

Although the performance of low-performing students in this study can be understood through the competency hypothesis, the majority of the results of this study support the control hypothesis for explaining the differential effects of various reward contingencies on intrinsic motivation. According to the control hypothesis, the more the reward contingencies exert control over behavior the greater the decrements in interest and free-choice behavior (Deci, 1975). Of the three conditions included in the study, the performance-contingent reward condition should have exerted the most control over behavior; requiring students both to complete math problems and complete them accurately. The completion-contingent reward condition was less controlling, as it simply required students to complete the problems, and the control condition exerted the

least amount of control with no reward possibilities. Contrary to what would be expected based on the control hypothesis, the performance and completion contingencies applied in this study did not differentially affect student math performance or interest. As suggested earlier in this chapter, students' reinforcement histories may have led to this finding.

There were no significant differences between pre and post responses on the interest questionnaire. However, student performance on the continuous-choice follow-up assignment varied according to condition in a way consistent with the control hypothesis. Overall, although not significant at the $p < .05$ level, more students chose to engage in the assignment, complete more problems, and complete more problems accurately following the control condition than following either of the reward contingency conditions. In addition, high-performing and average-performing students demonstrated lower completion and accuracy rates on the continuous choice follow-up assignment after the contingency conditions than after the control condition.

Limitations and Future Research

Perhaps the greatest limitation of the study was the limited experimental time. Each classroom was exposed to each condition only once. Although this design allowed for within-subjects comparisons, the experimental phase may not have been long enough to significantly change intrinsic interest in math. The lack of significant differences between the pre and post interest questionnaire responses supports this possibility. Carton (1996) suggested that evaluating postreward performance over a longer term provides a better representation of the effects of rewards. Future studies should include an extended experimental period. In addition, an extended research period would allow

for examination of voluntary participation in the activity at a time further removed from the experimental phase and over a longer term.

In this study, the three conditions were applied on three consecutive days. Although statistical analyses indicated the order of condition presentation did not affect performance, longer spacing between the presentations of conditions arguably would minimize carryover effects. A longer break between condition presentations also would provide time to establish baseline performance and interest levels before each condition.

In this study, baseline data of math accuracy and completion rates as well as self-reported interest were only collected once before any conditions were introduced, rather than before the presentation of each condition separately. Although it is likely that student performance and self-reported interest would not have been significantly different from the overall pretest means had baseline performance and interest levels been established each day, this type of data collection would have provided a point of comparison for each condition. The pretest data collected in this study could only be used as a fair point of comparison for the first day of experimental procedures. Establishing baseline before each condition would allow for cleaner direct comparisons of performance and interest. In addition, a pretest or baseline measure of choice behavior was never established.

Another major limitation to drawing definite conclusions based on this study is the series of results just above the $p < .05$ level of significance used as evidence of the overjustification effect. The large within-group variation in performance on the assignments, particularly on the choice follow-up assignment, likely contributed to nonsignificant results. Not surprisingly, applying the conditions on a classwide basis

resulted in large variations in performance levels. The students in the classes that participated in the study were not grouped according to math skill level. Although the heterogeneity of skill in the classes likely led to nonsignificant findings, the classes' compositions were a realistic representation of general education classrooms. Notwithstanding a series of borderline results, the pure number and consistency of results suggesting the overjustification effect should not be ignored. Replications of this study using a larger sample size and/or applying the conditions to groups of students with more homogeneous skill levels may lead to more conclusive findings.

Students' understanding of the way the reward contingencies worked may have been another limitation of the study. Despite the examples shown to students to clarify the contingencies, it is possible that some students may not have differentiated between the performance and completion contingencies. Students only had one opportunity to earn bonus points under each of the two contingencies. It is possible that only after earning or failing to earn bonus points did some students truly understand the contingency in place. In a study with an extended experimental phase, there might be a change in student performance on the second experimental day after students have seen how the reward contingency works first hand. For example, on the second day under a completion contingency, students might hurry through an assignment writing down incorrect responses because they know that they will earn bonus points despite low accuracy.

Another potential limitation of this study lies in the evaluation of self-reported interest in math. No significant differences were found between pre and post measures of self-reported interest across all conditions. Although this finding is inconsistent with

students' choice follow-up behavior that reflected decreases in intrinsic interest, it is consistent with previous research on the effects of extrinsic rewards on self-report measures of interest (Cameron et al., 2001; Deci et al., 2001). Dependent measures of self-reported interest more often reveal that rewards have no effect or positive effects on intrinsic interest than dependent measures of free-choice behavior. On the other hand, the use of free-choice behavior as a dependent measure more often reveals rewards have negative effects on interest than does the use of self-report measures. Despite these findings, it is certainly possible that the interest questionnaire designed for this study was not sensitive enough to detect changes in intrinsic interest.

Like other research studies measuring intrinsic motivation by free-choice behavior, this study offered students a limited number of task options in the choice follow-up phase. Students could choose to work either on the math assignment or the word search. However, they were expected to work on one or the other or both of the assignments. All findings on the intrinsic interest of the math assignments are relative to the intrinsic interest of the word search. Although this is a potential limitation of this study and other studies investigating the effects of reward contingencies on voluntary participation in a target activity, it is also a realistic representation of the choices presented to students in a typical classroom. Ordinarily, students are not given unlimited options regarding the activities they will engage in over the course of the day.

Manipulations of the type of information given to control condition participants provide another focus for future research. While, in this study, students under the control condition were told that there was no opportunity for a reward, future research could explore the effects of saying nothing about the prospects of receiving or not receiving a

reward. By not ruling out the possibility of bonus points a priori, researchers may see different performance patterns from students, especially if the control condition is presented after one of the contingency conditions. In addition, researchers could also tell students in the control group what levels of performance typically are considered low, average, and high. Students in the control group in this study were not given these performance indicators, whereas they were under the contingency conditions simply by the nature of the contingencies. However, students in the control condition seemed to have just as much understanding of what was considered low, average, and high performance as they did under the contingency conditions. The correlations between perceived success and actual performance were the same for contingency and control conditions. This differential in the amount of performance information received by students under the reward contingencies versus the control condition did not seem to affect performance in this study, but it presents another variable that could be isolated in future research.

Future research also should explore the effects of different reward contingencies on intrinsic motivation for different types of academic tasks. Many of the studies included in the Deci et al. (2001) and Cameron et al. (2001) meta-analyses used nonacademic tasks (e.g., puzzles, mazes, coloring) as the target activity. A meta-analyses focusing only on studies using reading (e.g., Flora, & Flora, 1999; Griffith, DeLoach, & LaBarba, 1984; McLoyd, 1979), math (e.g., Schunk, 1983) and other academic tasks as target activities may provide results that better generalize to educational settings. Although it is likely that the results of this study would generalize to other academic tasks with similar levels of initial intrinsic interest to students, more research

demonstrating effects of external rewards on academic task performance and interest may help educators understand how best to apply reward contingencies in the classroom.

Although it is likely that the results of this study will generalize to other elementary aged students, Boggiano and Ruble (1979) found that the effects of task-contingent and performance-contingent rewards on intrinsic interest in a task may vary according to age group. In their study, social comparison information mediated the negative effects of task-contingent rewards on intrinsic interest for older elementary school children but not for younger preschool children. Children's developmental level may influence how they interpret reward contingencies and the competency information contingencies convey. Further study is needed to understand how cognitive development mediates the effects of different types of reward contingencies.

Although it appears that the bonus points promised in the reward contingencies applied in this study were potentially reinforcing to students, it is unclear exactly how valued the points were to students. Research suggests that attaining highly valued rewards may increase student perceived competence and in turn intrinsic interest (McLoyd, 1979). On the other hand, rewards of low value may trivialize an activity and decrease intrinsic interest. If the bonus points promised in this study were of little value to students, they may have conveyed the idea that the math assignments were not an important activity and thus led to decreases in intrinsic motivation. Future research should attempt to determine how valued the rewards employed in studies of intrinsic interest are to students. By simply testing the effects of different rewards on behavior, researchers could determine student preferences for rewards.

Also related to the reward contingencies used in this study, the way the

contingencies were presented to students may have influenced their intrinsic interest. Students were promised rewards based on their accuracy and completion on the experimental assignments. However, both the meta-analyses of Cameron et al. (2001) and Deci et al. (2001) concluded that unexpected rewards promote better future free-choice participation in a target task than do expected rewards. Replications of this study by using unexpected rewards may reveal fewer decreases in intrinsic interest as a result of rewards.

The timing of the presentation of the rewards or rate of reinforcement in this study also may have influenced student performance and follow-up math engagement. Students were presented with their reward based on the contingencies after the 10 minutes allowed for the experimental assignment. In addition, all problems on experimental assignments were equivalent in terms of difficulty. Research on the interspersal procedure has suggested that adding or substituting briefer and easier problems in math assignments increases task engagement (McCurdy, Skinner, Grantham, Watson, & Hindman, 2001; Skinner, Hurst, Teeple, & Meadows, 2002), accuracy (Robinson, & Skinner, 2002) and choice behavior (Johns, Skinner, & Nail, 2000; Logan, & Skinner, 1998; Wildmon, Skinner, McCurdy, & Sims, 1999). According to Skinner (2002), in assignments consisting of many discrete tasks (i.e., math problems), completion of each task may serve as a conditioned reinforcer. This discrete task completion hypothesis states that students are reinforced as they work on an assignment with each completed problem. Had the assignments used in this study been interspersed with easier problems, students theoretically would have received reinforcement more frequently and perhaps would have demonstrated stronger performance and intrinsic

interest.

Carton (1996) suggested that rates of reinforcement also can be increased by altering the logistics of how rewards are delivered. After reviewing studies by cognitive evaluation researchers comparing the use of tangibles and praise, Carton concluded tangible rewards typically are rewarded at the end of a experimental session and undermine intrinsic motivation. However, praise usually is delivered within experimental sessions and increases intrinsic motivation. Several studies cited by Carton indicated that when tangible rewards were delivered within experimental sessions, as is usually the case with praise, they increased intrinsic motivation in a no reward follow-up phase. If the bonus points used in this study had been awarded as students were working on the math assignments, perhaps increases rather than decreases in intrinsic motivation would have resulted.

Conclusion

As demonstrated through this study, performance-contingent and completion-contingent rewards can effectively increase students' math accuracy and completion rates. However, once reward contingencies are removed, students' behavior may reflect decreased intrinsic interest or an overjustification effect. Following exposure to reward contingencies, high-performing students may show the greatest declines in intrinsic interest while low-performing students' intrinsic interest may be unaffected. Although more research is needed isolating various aspects of reward contingencies and their effects on intrinsic motivation, this study suggests that teachers must carefully consider the variability of intrinsic motivation for academic tasks among students and the costs and benefits of using extrinsic rewards before applying them on a classwide basis.

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Appendixes

Appendix A

Self-Report Questionnaire of Math Interest for Fifth Grade Classes

Circle the answer that best describes how you feel about math.

1. I enjoy doing math problems.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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2. I work on math problems for fun.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
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3. I like doing multiplication problems.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
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4. I only work on multiplication problems when my teacher tells me to.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
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Appendix B

5th Grade Performance-Contingent Reward Condition Scripted Instructions

Experimental Phase

For your first math assignment of the day, you will have the chance to earn bonus points towards your math grade. You will be given an assignment of 50 math problems. If you correctly answer at least 37 of the problems, you will earn ten bonus points. If you correctly answer between 25 and 36 of the problems, you will earn five bonus points. If you correctly answer less than 25 of the problems, you will not earn any bonus points. Here is an example. This student correctly answered 32 problems correctly so they earned 5 bonus points. This student answered all of the problems but only answered 5 correctly so they did not get any bonus points. This last student answered 42 problems correctly so they earned 10 bonus points. Do not skip any problems and work carefully. You will have ten minutes to work on the assignment.

Mandatory Follow-up Phase

For this second assignment, there will be no bonus points available. This is a required class assignment. Again, do not skip any problems and work carefully. You will have 10 minutes to work on this assignment.

Continuous Choice Follow-up Phase

For the last part of class today, you have the choice of what you would like to work on. I have given you two assignments. Place these assignments side by side on your desk. You may choose to work on whatever part of either of the two assignments you would like for the last ten minutes of math.

Appendix C

Procedural Integrity Checklist

- _____ Distributed experimental math worksheets
- _____ Read scripted directions for experimental phase and showed transparencies
- _____ Wrote criteria levels on the board (reward contingency conditions only)
- _____ Wrote the start and stop time on the board
- _____ Told students to begin working
- _____ Told students to stop working after ten minutes
- _____ Collected worksheets and scored them within 5 minutes (including information as to how many bonus points students earned and providing correct answers to incorrect problem responses)
- _____ Redistributed the experimental worksheet to students and gave students 1 minute to review their feedback
- _____ Asked students to write y/n in response to “Were you successful at this activity?”
- _____ Collected experimental worksheet.
- _____ Distributed mandatory follow-up worksheets
- _____ Read scripted directions for mandatory follow-up phase
- _____ Wrote the start and stop time on the board
- _____ Told students to stop working after ten minutes
- _____ Collected mandatory follow-up sheets
- _____ Distributed continuous choice follow-up sheets
- _____ Read scripted directions for choice follow-up phase
- _____ Collected choice worksheets after ten minutes

Vita

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