THE EFFECTS OF OBSERVATION OF LEARN UNITS DURING REINFORCEMENT AND CORRECTION CONDITIONS ON THE RATE OF LEARNING MATH ALGORITHMS BY FIFTH GRADE STUDENTS

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ABSTRACT

The Effect of Observation of Learn Units During Reinforcement and Correction Conditions on the Acquisition of Math Algorithms by Fifth Grade Students

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I conducted two studies on the comparative effects of the observation of learn units during (a) reinforcement or (b) correction conditions on the acquisition of math objectives. The dependent variables were the within-session cumulative numbers of correct responses emitted during observational sessions. The independent variables were the observation of reinforcement for correct responses as the control condition and the observation of corrections for incorrect responses. Eight 11-year-old target participants, 3 females and 5 males, were selected to participate in Experiment 1, during which a counterbalanced simultaneous treatment across participants design was used. Target participants and non-target peers were presented with math objectives that were not in repertoire. The non-target peers received feedback in the form of either reinforcement or a correction in 2 separate conditions while target students observed and received no feedback. Results from Experiment 1 showed that all of the target participants mastered the 3 math objectives presented during the observation of the correction condition and 7 of the 8 target participants mastered the objective during the reinforcement condition. Target participants met criterion with significantly fewer numbers of observing opportunities during the correction condition than during the reinforcement condition. Experiment 2 was a replication of Experiment 1 with greater experimental control. Six target participants, 4 females and 2 males, 10-year-olds, were selected to participate in Experiment 2, in which a between subjects counterbalanced reversal design across conditions and math objectives was implemented.
Results showed that all target participants mastered 18 out of 18 math objectives presented during the correction condition and target participants mastered 10 out of 18 objectives presented during the reinforcement condition.

*Keywords*: observational learning, feedback, learning, Programmed Instruction
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JAN
Dedication

I dedicate my dissertation to my mother, Adele Mary Neu. My mother was an extraordinarily beautiful woman who showed me the true meaning of love and compassion, especially for those who need it the most. Mom, I love you like crazy, you light up my life, and I miss you.
Education can be defined as the acquisition of behaviors that are useful, functional and benefit the person and others (Skinner, 1953). *A Nation at Risk* (1983), a report to the United States Secretary of Education indicated that the U.S. was significantly behind in math and science. Fifteen years following this report a second report, *A Nation Still at Risk*, indicated that insufficient improvements were made (Walberg, 2010). The U.S., despite the increased amount of funds spent on our educational system compared to other countries of similar economic wealth produce student outcomes that are less promising (Walberg, 2010). One of the reasons for the inadequacies in our educational system and the large portion of the academic discrepancies in the U. S. is the gap between impoverished and middle and upper class families (Capps, Fix, Murray, Ost, Passel, Herwantoro, 2005; Hart & Risley, 1995). Additionally, some researchers have argued the reason for the failure of our current educational system is the shortage of the wide scale use of a science of pedagogy (Greer, 1991; Skinner, 1981, 1984). This absence of educational change is due to the lack of implementation of such educational innovations (Fullman, 2007).

Skinner (1954, 1968, & 1984) stated that there are several concerns with classroom instruction. These concerns include the arrangement of contingencies of reinforcement in the educational environment, the lack of carefully sequenced curricula, and infrequency of reinforcement or feedback delivered to learners. Greer (1992) also identified three areas of ineffective teaching procedures. These areas consist of (a) the lack of the presentation of a three-term contingency (antecedent, behavior, consequence), (b) misidentification of a student’s
missing prerequisite skills, and (c) setting events and motivational states. Skinner (1984) went on to state that (a) clarifying the goals of education, (b) using individualized instruction, and (c) ensuring the learner masters material through the utilization of Programmed Instruction materials can solve most pedagogical problems in education. Porter (1960) referred to Programmed Instruction as, “…one attempt to improve the efficiency of education by applying these principles to the teaching process” (p. 206).

Schools and educators today are being held accountable for decisions that are made to education. This practice led to an increasing interest in the demand for individualized and differentiated instruction for all students in the general education setting (Greer, 2004; Hall, Strangman, & Meyer, 2011) and evidenced-based instruction (Greer, 1997; Moran, 2004). The No Child Left Behind Act (2002) calls for schools to rely solely on scientifically based instructional methods and teaching procedures as well as setting high standards, identifying measurable goals, and individualizing student outcomes (Duncan, 2011; U.S. Department of Education Office of the During Secretary Policy and Program Studies Service, 2004). In order to produce positive student outcomes, effective school design must include the continuous measurement of individualized student data throughout all areas of academic instruction (Greer, 1991). The goal of education is for students to learn a skill that they did not know prior to instruction and to implement educational methods that are effective in order for students to learn the most in the shortest amount of time (Greer, 2004). Effective instruction includes providing opportunities for students to respond and receive immediate feedback based on their responses.
Feedback

One important component of instruction is the type of feedback a teacher delivers when students emit correct responses and more importantly when students emit incorrect responses. According to Greer (2004), “The most efficient feedback for incorrect responses is to tell students the response is incorrect and then to provide the correct response and ask the student to repeat it” (p. 12). Researchers demonstrated the differences in specific types of feedback in Programmed Instruction building on the theory of B. F. Skinner. Mason and Bruning (2001) stated, “Among the most important outcomes of feedback are helping learners identify errors and become aware of misconceptions” (p. 1). Mason and Bruning went on to state that the definition of feedback was a general term for an instructor response to the behavior of the learner and that further, “this did not provide a systematic means for error correction and thus represented a somewhat limited conception of the role feedback might play in learning” (p. 2). Cohen (1985) also suggested that the main function of feedback is not to “strengthen” responses, but rather to find the error that has occurred and provide enough information in order for the learner to emit the correct response. She states that, “informational feedback has been acknowledged in research to be one of the most important aspects of feedback” (p. 34).

Gardner, Heward, and Grossi (1994) found that fifth grade students participated during classroom instruction 14 times more frequently using response cards versus calling on individual students. The experimenter provided feedback to all students during the response card instruction and provided feedback to only one student when calling on individual students during instruction. In addition, the same students emitted a higher number of correct responses on an assessment that followed the response card instruction as opposed to the single response
opportunities. Similarly, Cavanaugh, Heward, and Donelson (1996) found that students emitted a higher number of correct responses when required to provide a written response on a dry erase board along with receiving immediate teacher feedback. Students emitted a lower number of correct responses when the teacher presented a vocal explanation and examples on an overhead projector. Those studies demonstrated the effective use of response cards as a way of increasing simultaneous student participation and the importance of teacher feedback.

Today, a science of education exists and includes the following effective instructional practices, (a) Programmed Instruction, (b) Direct Instruction, (c) Personalized System of Instruction, and (d) Precision Teaching (Greer, 1992; Moran & Malott, 2004). Programmed Instruction was a technology of education developed by Skinner (1954, 1968) that provided a learner with immediate reinforcement for correct responding (Holland, 1959). The term “technology” is used to refer to, “. . .a behavioral engineering of teaching procedures” and not necessarily the utilization of an actual machine (Holland, 1959, p. 1). A key component of Programmed Instruction was what Skinner termed “frames” (Jaehnig & Miller, 2007; Skinner, 1968). These frames were made up of potential three-term contingencies or operants to be learned, that included an antecedent, a response of the student, and consequence. The frames of instruction were presented to the learner in a logically-designed sequence (Jaehnig & Miller, 2007). Research on Programmed Instruction has demonstrated greater outcomes of student achievement when compared to traditional methods of instruction, such as lessons presented in a lecture format or passive reading to acquire new information (Fernald, & Jordan, 1991; Plants, & Venable, 1975). Schramm (as cited in McDonald, Yanchar, & Osguthorpe, 2005) reviewed over 150 studies on Programmed Instruction and found that students performed at the same level or superior to other students who received instruction through alternative educational methods.
Programmed Instruction

While both Programmed Instruction and traditional approaches to education relied on a sequence of curricula, Programmed Instruction included a number of additional principles, which distinguished it from a traditional approach (Vargas & Vargas, 1991). These principles included: behaviorally or operationally defining learning objectives, delivering immediate reinforcement for correct responding, measuring rate of student responding, and obtaining mastery learning (Vargas & Vargas, 1991). They also placed an emphasis on the role of the consequence in Programmed Instruction and stated that the consequence was responsible for either increasing or decreasing a response followed by a stimulus.

The consequences that ensue increase or decrease the probability of subsequent actions occurring again. Stated in the most-simple form then, events that follow actions have a selective function over the likelihood of actions with similar effects occurring in the future. In education, specific forms or topographies of behavior may be selected by the kinds of consequences made contingent upon them (p. 2).

Although reinforcement has been cited in the literature as a key principle in Programmed Instruction, it is essential to consider the role of the correction.

In one of the earliest studies conducted on Programmed Instruction, Stephens (1953) found that participants who were provided with instructional feedback emitted more correct responses than participants who did not receive instructional feedback. Two types of teaching machines were used: the Drum Tutor and punchboards. Data were collected on the cumulative number of correct responses emitted by the participants. Collecting data on the cumulative number of errors emitted provided the experimenter with a highly sensitive measurement. Three identical practice tests and one novel practice test were administered throughout the sessions. The Drum Test utilized the “retained” method of instruction in which the students were required to repeatedly select responses on the same question until the correct answer was selected.
Conversely, the punchboard utilized the test-as-test situation in which no feedback was delivered for a correct or an incorrect response for each question presented. The “retained” method was significantly more effective and students emitted significantly fewer errors on the practice tests. In addition, the students using the Drum Test emitted more correct responses on midterms and final exams than did students in the punchboard and control groups, thus, demonstrating the effectiveness of instructional feedback in Programmed Instruction.

In another early study, Gilman (1969) found that participants emitted higher levels of correct responding when presented with instructional feedback than students who did not receive instructional feedback. Seventy-five graduate students were divided into five groups (Groups A–E) and each group received a different type of feedback on various science concepts. Students in Group A received no feedback for correct or incorrect responses. Students in Group B received the vocal feedback of either “right” or “wrong” but no further information was provided. Students in Group C were shown the correct response choice. Students in Group D were provided feedback specific to his or her response and students in Group E received all of the feedback types delivered for Groups B, C, and D. Students in Groups C, D, and E performed at higher levels than students who did not receive any feedback for responses emitted. Gilman (1969) stated, “The results and their level of significance clearly indicate the value of providing information to students in a Programmed Instruction feedback” (p. 506). The results of this study indicated the importance of the role of providing not only instructional feedback but also corrective feedback to individual learners for the acquisition of new skills through Programmed Instruction.

Similarly, Anderson, Kulhavy, and Andre (1971) found that providing students with instructional feedback and requiring the students to transcribe the corrected response emitted the
highest levels of correct responding. A Programmed Instruction lesson was implemented with 356 college-aged students to teach them how to diagnosis a myocardial infarction. The experimenter presented eight different combinations of feedback which included: (a) no feedback following any response, (b) the correct response presented following either a correct or incorrect response emitted by a student, (c) the correct response presented following a correct answer only, (d) the correct response presented after 10% of randomly selected correct responses emitted, (e) the correct response presented after an incorrect response was emitted, (f) the correct response presented following a 15-second delay following an incorrect response emitted, (g) the correct response was presented following student incorrect response, the student had an opportunity to look back to the written instructions and answer again, and upon a student emitting 10 incorrect responses on the same frame, the correct response was presented, and (h) emitting an incorrect response, the student was given the opportunity to select the correct response or move on to the next frame. The results of the study indicated that the students emitted the highest numbers of correct responses when the correct response was presented to them following each frame, during the 15-second delay, and when students were given the opportunity to receive feedback. Experiment 2 was a replication of Experiment 1 and utilized six different combinations of feedback. Results from the second experiment indicated that participants emitted the most numbers of correct responses when they received feedback in the form of the correct response following each frame. Participants also performed well during the delayed feedback and forced feedback conditions in which the participants were required to transcribe the correct response presented if they emitted an incorrect response. Therefore, students acquired new information through *transcribing the corrected response*. 
Jaehnig and Miller (2007) found that instructional feedback that included an explanation of the incorrect response was the more effective when compared to other types of instructional feedback. In this study, four different types of feedback were compared: 1) informing the learner if his/her response was correct or incorrect, 2) informing the learner if his/her response was correct or incorrect and what the correct response was, 3) informing the learner if his/her response was correct or incorrect and what the correct response was and a model of how to obtain the correct response and, 4) delaying feedback or feedback delivered after a predetermined amount of time. The researchers found that instructional feedback with an explanation seemed to yield the most positive results, however the experimenters stated that differences in the type of response this is most beneficial for should be further investigated. In addition, the researchers found that there were no differences between immediate and delayed feedback. Like the previous studies mentioned (Anderson et al., 1971; Gilman, 1969), the participants who emitted an incorrect response received a correction, and then produced the corrected response yielded greater outcomes overall than students who did not receive any feedback or reinforcement following a correct response. Although studies have reported positive outcomes on student learning through Programmed Instruction, few educational institutions today implement such scientific educational methods. Greer (1982, 1983) states several reasons for the lack of universal application of a science of teaching including, (a) the majority of educational researchers studied their approaches from the field of the social sciences, which utilizes non-statistical standards of measurement and ideas of mentalism, (b) the lack of recognition of the contributions of behavior analysis such as mastery learning, and (c) the lack of teacher training, knowledge and understanding with the science of behavior analysis including the vast literature base. However, the Comprehensive Application of Behavior Analysis to
Schooling® (Greer, 1991 & 1992) is one organization that implement these methods of instruction.

The Comprehensive Application of Behavior Analysis to Schooling® Model and the Learn Unit

The Comprehensive Application of Behavior Analysis to Schooling (CABAS®) (Greer, 1991 & 1992) is a student driven approach to education that has been in existence over 30 years (Greer, 2007) and demonstrates quality outcomes for the students they serve. This model educates children with and without disabilities, English Language Learners, and children from low socio-economic communities from 16 months of age through elementary school. The results of a study conducted by an independent experimenter indicated that students with disabilities placed in a CABAS® model classroom made more gains than students in a non-CABAS® classroom (Greer, 1997). In addition the CABAS® classroom incurred fewer costs (Greer, 1997). Another study was conducted in a CABAS® second grade inclusion classroom comprised of general and special education students. The results of this study concluded that the students in the CABAS® classroom performed two years above grade level as compared to other students of the same age that had taken the test nationally (Greer, 2007). The student gains were based on the TerraNova, a norm-referenced, standardized assessment (CTB/McGraw Hill, 2012). Furthermore, Reed, Osborne, and Corness (2007) found that preschool aged students in home based programs based on the principles of Applied Behavior Analysis (ABA) made more gains given the CABAS® model of instruction versus the two other ABA approaches implemented. The participants’ gains were measured across intellectual and educational functioning and adaptive behavior areas. In addition to increase student gains research has also demonstrated
that the cost per learning objective is more cost effective in a CABAS® program than other non-CABAS® educational programs (Greer, 1994).

The CABAS® model consists of eight components (a) individualized instruction for all learners, (b) continuous measurement of student responses, (c) graphs of the measurement of student responses, (d) use of tested curricula, (e) implementation of principles and tactics derived from the science of behavior, (f) positive classroom setting, (g) moment-to-moment decision making and analysis of student responses, (h) trained teachers and, (i) visual display of student progress in view at all times (Greer, Keohane, & Healy, 2002). However, a small number of educational systems are in existence today that implements such a sophisticated scientific approach to teaching. Teaching as an art or the use of pre-behavioristic practices in education is more widely used (Greer, 1983). One common educational practice of non-scientific teachers is the presentation of instructional materials to large groups of students without the use of rigorous measurement (Greer, 1983). One effective measure of teaching and learning derived from a science of teaching is the learn unit (Greer & McDonough, 1999).

The learn unit is a measurement of instruction that may be described as an interlocking contingency between the teacher and student that consists of at least one interlocking contingency for the student and at least two interlocking contingencies for the teacher or teaching device (Greer & McDonough, 1999). Learn units, when presented accurately to students increase the number of correct student responses (Albers & Greer, 1991; Greer & McDonough, 1999; Ingham & Greer, 1992). The definition of the lean unit includes the following components, 1) the teacher obtains the attention of the student(s), 2) the teacher or device presents an unambiguous antecedent to the student(s), 3) the student has the opportunity to respond, and 4) teacher feedback, which includes either reinforcement or a correction in which the student(s)
who emit the incorrect response is to then independently repeat the correct response while observing the antecedent. Several studies have demonstrated the effectiveness of learn units during instruction (Emurian, 2007; Emurian, Wang, & Durham, 2000; Hogin, 1996; Meincke & Hong, 2002).

Hogin (1996) analyzed correction procedures in the learn unit and in a three term contingency and found that the delivery of learn units was most effective. A correction procedure was implemented with second grade male students who were given mathematical problems to solve. During the first condition the correction procedure consisted of students revisiting the problem in the absence of the antecedent, or, an incomplete learn unit. During the second condition the correction procedure consisted of students revisiting the problem in the context of a complete learn unit; in this condition the antecedent was re-presented. Students emitted higher rates of correct responding during the condition in which they were exposed to the learn unit following an incorrect response.

Bennett and Cavanaugh (1998) replicated the results in addition to analyzing the differences between immediate self-correction, delayed self-correction, and no correction through the presentation of multiplication facts to an elementary aged student. The student was required to respond to multiplication facts through a written topography. During the first condition, the student received no instructional feedback for correct or incorrect responses, during the second condition, the immediate feedback condition, the student corrected her responses using an answer key immediately following the completion of the objective, and during the third condition, the delayed feedback condition, the student corrected her responses using the answer key following four assigned objectives. Higher rates of correct responding were emitted during the immediate feedback session versus the no feedback and delayed
feedback session. The results from the no feedback and delayed feedback sessions yielded similar means.

Emurian et al. (2000), found that presenting learn units through Programmed Instruction to teach a group of participants how to write a Java™ script computer program was effective during post-assessments. The program consisted of five stages, which required the learner to emit transcription responses, selection responses, and production responses. The cumulative numbers of correct responses were recorded for each participant throughout all stages. In order to meet mastery criterion for the program, participants had to pass the program six consecutive times by creating six Java™ scripts. The researchers found that over time, the numbers of learn-units-to-criterion collected during the passes steadily decreased along with significantly fewer incorrect responses. Likewise, Emurian (2007) found that the learn unit as an independent variable was effective in teaching students how to create a Java script basic computer program for nine graduate students. The dependent variable in that study was the number of correct responses to a pre- and post multiple-choice assessment on the components of creating a Java™ program using novel exemplars from the tutor program. The results of that study showed that the numbers of learn units required for mastery during the Java™ tutor sessions led to a decrease of learn units in the post-assessment score and the fewer numbers of learn units required for mastery led to an increase in post-assessment scores. Emurian (2007) hypothesized that providing students with a multiple-choice assessment provided a low level learning opportunity. Therefore, an assessment that requires the student to produce a response and transcribe the corrected response for an incorrect response emitted may have produced better post-assessment results. In addition, Emurian (2007) also noted the possibility of a lack of student motivation for the required subject matter.
Learn units delivered to individual students are effective in increasing the rates of learning in one to one settings. However, most students today are educated in settings in which they depend upon acquiring new repertoires through the observation of other students (e.g. Catania, 2007; Charania, LeBlan, Sabanthan, Kteach, Carr, & Gunby, 2010; Greer, Singer-Dudek, & Gautreaux, 2006; Rachman, 1972).

**Observational Learning**

Research conducted on appointed academic time has concluded that between 50% and 90% of a student’s school day lacks learning engagement (Gettinger & Seibert, 2002). Hollowood, Salisbury, Rainforth, and Palombaro (1995 as cited in Gettinger & Seibert, 2002) stated that the reasons for such student disengagement include, “…teachers’ [lack of] managerial competencies, type of instruction, grouping practices, or individual student characteristics” (p.1). Learning by observing others learn or perform a behavior is how humans come to acquire a considerable part of what they know (Catania, 2007; Greer, Singer-Dudek, and Gautreaux, 2006; Rachman, 1972). Although, learning during observational conditions is a significant concern in education, little research on the acquisition of new skills under observational conditions has been conducted over the past 10 years (Greer, Singer-Dudek, Longano, & Zrinzo, 2008). One of the concerns of teaching large numbers of students in a classroom is the assumption that students are acquiring new information through the observation of their peers’ responses. In a typical classroom, it is the belief that students will learn by watching other students learn. As a result of this interaction between the teacher and the target student, other observing students who are not directly interacted with, but are in physical proximity of will also learn (Van Wagenen, & Travers, 1963). Van Wagenen and Travers (1963) stated, “One of the major goals of working
with children either with or without disabilities is to provide them with the wherewithal to be successful in mainstream settings or settings that do not provide sufficient incidences of direct instruction” (p. 491). A large portion of research on various types of feedback has been conducted on single students in one-to-one setting (Travers, Van Wagenen, & Haygood, 1964). It is then left up to the students to acquire the necessary information. In order for students to learn during observational conditions, they must have a verbal behavior repertoire and discriminate the behaviors of another person and the consequences of those behaviors (Catania, 2007). Greer et al., (2006) indicated, “the need for good observational repertoires is critical because classrooms that approach teaching as an art or craft provide inadequate exposures to direct contingencies in the form of learn units and provide even fewer exposures for children who enter school with deficit repertoires” (p. 490).

Research on observational learning has shown that humans can perform and learn new behaviors by watching others (Greer et al., 2006). However, several definitions of observational learning differ among researchers. Zentall and Levine (1972) (as cited in Catania, 2007) defined observational learning as learning based on the observation of another. Zentall (1972) did not specify learning in terms of the acquisition of new operants or the performance of previously acquired behavior. It is important that the differences between learning and performance behaviors are defined. Catania (2007) defines learning as the acquisition of a somewhat permanent change in behavior added to a person’s repertoire. In 2007, Catania expanded upon the definition of observational learning and defined it as learning based upon observing the behavior of another person and/or the consequences. Learning, as defined by Greer et al. (2006), “… is the acquisition of operants or higher-order operants as a function of direct contact with contingencies of reinforcement or punishment, or as a function of the observation of others.
receiving contact with the contingencies of reinforcement, punishment, and corrections of incorrect responses” (p. 489). Performance behaviors as defined by Greer et al. (2006) are behaviors or operants already in the repertoire of a student. True observational learning according to Greer et al. (2006), results from new operants acquired through the observation of others coming into contact with contingencies of reinforcement or punishment or a correction.

The lack of a universal definition of learning as well as the use of terms in place of observational learning such as modeling, imitation, and social learning theory (Bandura, 1986) have led to discrepancies in the field. Greer et al. (2006) proposed a definition of observational learning that they suggested to be more precise.

Greer et al. (2006) identified five components in which observational learning can be identified. These components include 1) the acquisition of new operants, or learning (e.g. Werts, Caldwell, & Wolrey, 1996; Nuzzolo, 2002), 2) the acquisition of higher order operants (e.g. Greer, & Yuan, 2008; Walsh, 2009; Yuan, 2005), 3) the acquisition of conditioned reinforcers (e.g. O’Rourke, 2006; Greer, & Singer-Dudek 2008; Singer-Dudek, Greer, & Schmelzkopf, 2008; Schmelzkopf, & Greer, submitted; Zrinzo, & Greer, 2013), 4) the emission of behavior already in one’s repertoire, or performance (e.g. Kazdin, 1973), and 5) the induction of observational learning as a behavioral developmental cusp or capability (e.g. Davies-Lackey, 2005; Gautreaux, 2005; Pereira-Delgado, & Greer, 2009; Rothstein & Gautreaux, 2007).

Recent research suggests that in order to acquire new repertoires by observing others, one must have the observational learning capability (Greer et al., 2006). The effects of a “peer yoked contingency” were implemented to induce the observational learning capability (Davies-Lackey, 2005 & Stolfi, 2005). During the intervention, students were presented with a game board designed with twenty spaces. The game board was divided vertically in half, so that the
experimenter had an opportunity to move up twenty spaces and the pair of “yoked peers” had an opportunity to move up twenty spaces. Learn units were presented to a non-target peer and observational probe trials were then presented to the participant. During the observational probes no feedback was provided to the participants. Upon the participant responding correctly, the pair of students moved up on the game board. Upon the participant responding incorrectly, the experimenter moved up on the game board. Following the participant meeting criterion during the intervention, a post-experimental assessment was conducted that replicated the pre-experimental assessment. All participants met criterion following the implementation of the “yoked contingency” game board and acquired the observational learning capability.

Additionally, studies have found that the observational learning capability has been induced through an intervention in which target students observe and monitor the behavior of their peers (Gautreaux, 2005; Periera-Delgado & Greer, 2009). In Gautreaux’s (2005) study three middle school students were trained in tutoring math tacts to tutees. Prior to the start of the study all participants were given a pre-experimental assessment in which no feedback was provided. This assessment indicated that none of the participants who acted in the role of the tutor and tutee had the math tacts in repertoire. Following the implementation of the observational procedure, all participants increased the numbers of correct responses emitted to the math stimuli. An increase in collateral behaviors was also observed for listening skills and self-monitoring behaviors. The presence of the observational learning capability allows students to learn during observational conditions in which they could not before. Several studies demonstrated the acquisition of skills during various types of observational conditions.

Current research has been conducted on the acquisition of conditioned reinforcers through observation (e.g. Greer, & Singer-Dudek 2008; Greer, Singer-Dudek, Longano, &
Zrinzo, 2008; O’Rourke, 2006; Schmelzkopf, 2010; Singer-Dudek, Greer, & Schmelzkopf, 2008; Zrinzo, 2010). It is the assumption that vocal praise functions as a reinforcer for typically developing students. However, research has demonstrated that this may not be the case (Catania, 2007 as cited in Greer et. al. 2006). The learning experiences of students who are taught in the general education setting and who are not reinforced by vocal praise are hindered, since vocal praise is the most common type of reinforcer used in a classroom (Skinner, 1968 as cited in Greer, et. al., 2006).

Greer et al. (2008) found that students acquired vocal praise as a conditioned reinforcer through the implementation of an observational intervention procedure. Results from the pre-intervention assessment indicated that vocal praise did not function as a reinforcer for performance and learning tasks. During the observational intervention, a participant was seated next to a peer and a partition was used to block the view from the participant and peer seeing each other’s task being completed. Upon the non-target peer emitting correct responses, the experimenter delivered vocal reinforcement to the non-target peer only. The participant did not receive feedback for any responses emitted, but did hear the vocal praise delivered to the non-target peer. Following the observational intervention session participants emitted higher rates of responding to performance tasks and an increase in correct responding to learning tasks. The participants in the study acquired vocal praise delivered by the instructor through observation.

In an experiment conducted by Schmelzkopf and Greer (submitted), adult approvals were conditioned as a reinforcer for performance and learning tasks for three preschool aged students. A pre-experimental assessment was conducted on the number of vocal verbal operants emitted in three non-instructional settings. A replication of the observational intervention procedure used in the previous study (Greer et al., 2008) was implemented. Following the implementation of the
observational conditioning intervention, adult approvals were conditioned as reinforcers and vocal verbal operants increased for all three participants. These studies not only demonstrate the acquisition of new academic skills via observational procedures but also demonstrate the expansion of communities of reinforcers, such as vocal praise. The expansion of communities of reinforcers for students at a basic level prepares students for opportunities to acquire new skills during typical observational conditions in a general education classroom setting.

In addition to the expansion of communities of reinforcers by conditioning vocal praise for younger students via observation, research on learning academic skills via observation has been conducted with primary aged students and adults. In an unpublished doctoral dissertation, O’Rourke (2006) found that the number of correct responses to unknown math objectives increased following an observational intervention procedure. During the observational intervention, one target participant and one peer were seated side by side with a partition placed in between the two students so that neither student could see any materials, or written responses from the neck to the waist of the students. Two easels were placed in front of each student and upon completion of a mastered task presented by the experimenter, the target participant was given a blank piece of paper and the peer was given a piece of paper with math problems. The sessions continued until the target participant requested the paper with the math problems. Following the observational intervention, the rate of completed math tasks and the rate of the acquisition of new math operants increased.

In an early study, Van Wagenen and Travers (1963) found that students who received direct instruction emitted higher correct responses for unknown German sight words than students who only observed the instruction. The participants were divided into four groups and each group received a different type of feedback following a response. Two different types of
feedback were presented during four different treatment conditions to nine groups of eight participants. The four treatment conditions included, (a) an instructor only provided direct feedback to four out of eight of the participants in the group, (b) an instructor provided no feedback to four out of eight of the participants in the group, (c) a teaching machine delivered instruction to the participants and gave the correct response once the participant entered in his response, and (d) a teaching machine delivered instruction to the participants along side of an instructor, the instructor delivered vocal praise following a correct response, no feedback upon the participant emitting an incorrect response, and the correct response once the participant entered in his response by the teaching machine. The participants were further divided in two additional groups, in which only four of the eight participants received the instruction directly from the experimenter and the other four participants observed the lesson. The participants in the direct learning group received direct instruction and had observing opportunities. A post-experimental assessment was administered following each set of 20 words. The results from this study indicate that the participants who received the instruction from the experimenter emitted higher percentages of correct responses than participants in the observation only groups. The results of that study were extended and examined the role of the specific feedback upon a participant emitting an incorrect response (Travers, Van Wagenen, Haygood, & McCormick, 1964).

Travers et al. (1964) found that students who received direct instruction emitted higher rates of correct responding matching German sight words to the correct English word than observing peers. The participants and general procedures directly replicated the previous study mentioned with the exception of modifications made to the treatment conditions. The experimenter presented various types of feedback during four different conditions. Results from
the study indicated that participants yielded the highest number of correct responses during the post-experimental assessment during the third treatment condition and even slightly higher percentages of correct responses during the fourth treatment condition. During the second treatment condition, in which the participants were not given any feedback for a correct response and were told they emitted an incorrect response, yielded the lowest percentages of correct responses on the post-experimental assessment. Results also indicated that the participants who received the direct instruction emitted higher percentages of correct responses on the post-experimental assessment, followed by the participants who only acted as observers.

Ramirez and Rehfeldt (2009) found that additional observational opportunities were required for a student to acquire the untaught relations of the names of items in Spanish with two typically developing elementary-aged students. During the pre- and post-experimental assessments, both participants were tested on their ability to match Spanish spoken words to pictures and pictures to spoken words in Spanish on a computer. No feedback was provided during pre- and post-experimental assessments. One participant received instruction from the experimenter while a second participant observed. The same procedures were used in the pre and post-experimental assessments and during intervention sessions. Feedback during instruction was delivered for correct and incorrect responses to the participant who was delivered the instruction. Once mastery criterion was met during the intervention sessions, both participants were given the post-experimental assessment. If criterion was not met, instruction was delivered again in remedial training sessions. Following initial intervention sessions and remedial training sessions, both participants met criterion on the symmetry relations on the post-experimental assessment. However, more remedial sessions were required for the observing participant than the participant who received direct instruction.
It has also been demonstrated that adults learn through the observation of others (Nuzzolo, 2002). Three teachers received direct learn units on scientific tacts during a weekly supervisor meeting while three other teachers observed (Nuzzolo, 2002). During the group supervisor meeting the three observing teachers had an opportunity to see and hear feedback delivered by the supervisor to the three teachers who received the direct learn units. The dependent variable was the numbers of correct responses to student instruction with the behavior analytic term embedded in the antecedent and the results indicated that all six participants showed an increase in the number of correct responses after receiving either direct or indirect learn units. A follow-up study was conducted in which the dependent variable was the maintenance of the number of correct scientific tacts for the observing teachers, the number of correct graphical decisions made and the percentage of correct student responses during instruction. The results of the second study also indicated that the numbers of correct decisions increased for the teachers who received both the direct and indirect learn units as well as an increase in the percentages of student responses. The outcomes of several studies have demonstrated slower rates of learning during observational conditions versus learning in one-to-one settings (Nuzzolo, 2002; Ramirez & Rehfeldt, 2009; Travers et. al., 1964; Van Wagenen & Travers, 1963).

The results of one study (Greer, et. al., 2004) demonstrated the effects of observation of peer tutoring sessions on the acquisition of 30 social studies terms on five middle school aged students during two conditions. The first condition presented instruction through the learn unit and the second condition did not present learn units. Pre-experimental probe and post-experimental probe sessions were conducted in which no feedback was provided by the experimenter. The results indicated that the observing students emitted significantly higher numbers of correct responses when observing the presentation of learn units. The study
demonstrated the importance of delivering learn units for the acquisition of new skills through observation. However, it is not clear during what observational conditions the students learned. Did they learn through the observation of reinforcement delivered to others or did they learn through the observation of a correction delivered to others? One study attempted to identify the differences in the types of feedback delivered during observational conditions on the acquisition of Korean terms (Greer, Keohane, Meincke, Gautreaux, Pereira, Chavez-Brown, and Yuan, 2004).

Greer, et al. (2004) found that the observer emitted fewer correct responses to Korean terms during the post-experimental probe than the tutor and tutee for three middle school-aged male students. The tutors were trained to deliver learn units (Greer, 1991). Five Korean terms not in the repertoires of any of the participants were selected and presented for a total of 20 trials. During both experiments, the tutor delivered learn units to the tutee, and third participant observed the tutoring sessions. Results of Experiment 1 indicated that the tutor emitted 20 correct responses, the tutee emitted 19 correct responses and the observer emitted 11 correct responses during the post-experimental probe session.

The procedures for Experiment 2 retained many of the features of Experiment 1 and included two conditions. During the first condition, the observing participant observed feedback in the form of reinforcement being delivered by the tutor to the tutee, during the second condition, the observing participant observed feedback in the form of a correction being delivered by the tutor to the tutee. Results from Experiment 2 indicated that the tutor, tutee, or observer did not emit any correct responses during the post-experimental probe session following the reinforcement conditions. The results did indicate that the tutor, tutee, and observer did emit
correct responses during the post-experimental probe session following the correction condition. The study emphasizes the importance of the role of the correction through observation.

**Rationale**

Learning under observational learning conditions has received little attention in the literature, (Greer et al., 2006) which has led to unanswered research questions in the educational field. The majority of the research that has been conducted on observational learning has studied the performance behaviors of students classified with disabilities working in individual settings and without the presence of a group. Although a few studies have looked at the acquisition of new behaviors through observational learning, even fewer studies have examined the differences in rates of learning through observation during reinforcement versus correction conditions (e.g. Gautreaux, 2002; Meincke, & Hong, 2002; Nuzzolo, 2002; Ramirez, & Rehfeldt, 2009; Travers et al., 1964; Van Wagenen, & Travers, 1963).

I investigated two conditions in which students acquired new math operants by observing instruction delivered to peers. In Experiments 1 and 2, the following experimental question was asked: During which conditions would students acquire new math objectives at different rates during observational conditions as a function of two types of instructor feedback: 1) reinforcement for a correct response and 2) a correction for an incorrect response? The reinforcement and corrections conditions were compared to each other and examined individually. During the experiment, a second experimenter and myself presented math objectives to small groups of students that consisted of target participants and non-target peers. The experimenters delivered learn units on these math objectives to non-target peers, while the target participants observed their peers either receiving reinforcement for a correct response or
correction for an incorrect response. The experimenters delivered only one type of instructional feedback during each session. The study reported herein addresses the role of feedback and the correction in the learn unit and Programmed Instruction during two observational conditions. To assist the reader, I have provided a definition of terms (Appendix A).
Chapter II

General Method

Overview

I studied the effects of the observation of two types of feedback on the rates of acquisition of math objectives in two experiments. The following research question was asked: Will students acquire math objectives during observational conditions through two types of instructor feedback? The instructors delivered feedback in the form of (a) reinforcement for a correct response and (b) a correction for an incorrect response, during two separate conditions. The method components that were shared between both experiments will be reported here, while components that were specific to either of the experiments will be reported in sections devoted to each experiment.

Participants

All of the target participants from Experiment 1 and Experiment 2 included 10 and 11-year-old students. Students who were selected to participate in this study did not emit correct responses to all of the math problems presented on the pre-experimental screening assessments, demonstrated language arts and literacy skills categorized as at least partially proficient, and demonstrated math skills categorized as proficient on the New Jersey Assessment of Skills and Knowledge (NJ ASK). The NJ ASK assessment is a statewide curricular-based standardized test given to students in grades three through five at the end of each school year that measures student academic performance in reading, writing, and math. The results of the NJ ASK
assessment categorize student skills according to one of three categories, (a) below proficient, in which a student scored below 200 points in a given area; (b) proficient, in which a student scored between 200 and 250 points in a given area; and (c) advanced proficient, in which a student scored above 250 points in a given area.

Some of the target participants from Experiments 1 and 2 qualified for the Basic Skills program and services under Section 504. The Basic Skills Improvement Program is a federally supported program, which allocates additional funding to school districts that serve a minimum number of students from low-income families including families that receive federal assistance (United States Department of Education, 2011). The criterion for the implementation of the Basic Skills program is decided upon by each school district. In order to qualify for Basic Skills instruction in this particular school district, students have scored partially proficient on the NJ ASK assessment or perform below grade level in the areas of reading, writing, or math. Section 504 is federal law that provides students with modifications and accommodations whom have a documented mental or physical impairment that affects a minimum of one significant life activity (United States Department of Education Office for Civil Rights, 2011).

The students’ names who emitted zero correct responses to the pre-experimental screening assessment were written on a piece of notebook paper and placed into a bag. The first students’ names selected by the experimenter were asked to participate in this study. All of the parents of the students who were asked to join in the study consented to their child’s participation. The target participants’ names were then assigned a letter using a random number generator application (van Zanten, 2010). The remaining students in the classroom who were not asked to participate in the study were utilized as non-target peers. The non-target peers were
rotated through each of the experimental sessions based upon their knowledge of math objective presented.

The Institutional Review Board at Teachers College, Columbia University approved the application for this study, which requires written parental consent that was obtained for each of the target participants and non-target peers prior to the start of the study.

**Setting**

All of the target participants from Experiment 1 and Experiment 2 were recruited from one elementary school. The school was a publicly funded, Title I suburban school, located approximately 40 miles outside a major city. A school qualifies for additional funding during the Title I, Part A of the Elementary and Secondary Education Act if the school has a higher population of students from low-income families (United States Department of Education, 2011). The public school served 8 to 11-year-old children, with and without disabilities. The school also served children diagnosed with various disabilities from surrounding area school districts. The classroom employed the Comprehensive Application of Behavior Analysis to Schooling (CABAS®) Accelerated Independent Learner (AIL) model of general education.

The CABAS® AIL model of education is a research-based and learner-driven approach, in which scientifically based procedures are implemented in all areas of student learning and performance. The model served both general and special education students, pre-kindergarten through grade five. Thus, the students in this study were taught using the procedures and principles of this model. Students placed in the CABAS® AIL program are required to demonstrate advanced self-management skills such as recording, graphing, and analyzing data. These skills are taught in the beginning of each school year to mastery and performed on a daily
basis across all subject areas. Students record data and classroom points earned on the same sheet. Therefore, the participants and non-target peers had a long instructional history with receiving immediate feedback for a correct or incorrect response in the presence of their peers and assisted in making decisions about their learning based on their responses to instruction. The experimenter presented the pre-experimental screening assessment and experimental sessions in the CABAS® AIL classroom. Graphs of student achievement of learning standards and performance behaviors for each student and for the class were updated daily. Additional components of the classroom specific to this study were learn units, mastery learning to a predetermined criterion, the use of response boards during group instruction, and homogenously devised, small group instruction across academic areas and individualized curricula. In addition, students in the classroom earned points throughout the day for emitting targeted learning and performance behaviors. Once a predetermined number of points were earned, students had an opportunity to trade in their points to use the leisure area for back up reinforcers such as access to puzzles, books, computer games, or opportunities for peer tutoring students in other classrooms.

The pre-experimental screening assessment was administered in the classroom of the experimenters and students utilized in this study. The classroom measured 10.973 m x 7.0104 m. The classroom consisted of 21 student-sized desks, four tables for student and teacher materials, a round table, approximately 26 chairs, two computers, and a leisure area, which consisted of five bookshelves, approximately 200 books, games, and magazines. There were two bulletin boards hanging on the walls. The bulletin boards contained graphs depicting classroom data, the daily schedule, and calendar. The bulletin boards were covered with colored paper and colorful
borders. In addition, there was a map of the world and posters of the continents and oceans. A photograph of the classroom setting is shown in Appendix B.

One to two experimental sessions were conducted daily in an open study area outside of the classroom. The open study area measured 3.6576 m x 2.484 m at a round table that measured 121.92 cm in diameter. The use of this open study areas was a constant fracture of the classroom procedure. Thus, presenting instruction in this area was a part of the general instruction. There were approximately six chairs around the table. A large dry erase board that was used by the experimenter was hung on a wall in the open study area and faced the participants and non-target peers. This board measured 90 cm wide x 28 cm long. A red partition was used to block extraneous hallway traffic noise, which measured 1.8288 m wide x 1.219 m tall. The hallway walls were filled with student work samples and nearby rooms consisted of two classrooms, the nurse’s office, the child study team office, and the elevator. A photograph of the experimental setting is shown in Appendix C.

Materials

Experimenter materials utilized in Experiments 1 and 2 consisted of Expo® dry erase markers, dry erase erasers, pens, scripted learn units for each objective and data form (Appendix D). The experimenter data form consisted of the participant code (i.e. “Participant A”), the name of the first and second experimenter, session number, and date. Student materials utilized in Experiments 1 and 2 consisted of individual dry erase boards that measured 29.5 cm wide x 22.5 cm long, pencils, individualized student data sheets (Appendix E), Expo® dry erase markers, dry erase eraser, and TI-108 Texas Instruments® calculators.
Materials also included the pre-experimental screening assessment. The pre-experimental screening assessment consisted of worksheets that measured 21.9 cm x 27.9 cm. The top of the pre-experimental screening worksheets asked for the student’s name and date that the assessments were completed. Each worksheet consisted of directions for each objective on the top of the page and a mathematical formula for each objective. Math objectives that were not taught to the students were selected and based on the 5th grade and middle school New Jersey Core Curriculum Content Standards (State of New Jersey Department of Education, 2008), the Common Core State Standards Initiative© (United States Department of Education, 2010) for Mathematics. Objectives were also selected from lessons not yet presented from the Everyday Mathematics© Teacher’s Lesson Guide, Grade 5 Volumes 1 and 2 (Bell, Bretzlauf, Dillard, Hartfield, Isaacs, McBride, Pitvorec, Saecker, & Winningham, 2007) were selected for the pre-experimental screening assessment.

**Dependent Variable**

The primary dependent variable of interest in this study for Experiments 1 and 2 was the cumulative numbers of correct responses to completed math problems. A math problem was defined as a single completed math algorithm. The number of math problems presented varied between conditions and target participants. The experimenters continued to present the math problems until mastery criterion was met for each condition or until the session was terminated. The number of math problems presented during the reinforcement conditions in both experiments ranged from 9 to 37 and the number of math problems presented during the correction condition in both experiments ranged from 5 to 17. A response was considered a correct response if the participant calculated the math objective presented accurately. For
example, if the math objective presented to the group stated, “What is the compound interest on $890.00 at 12.5% for 10 days?” and the participant wrote $2,002.5 on his dry erase board the response was scored as correct. A response was considered correct if the participant rounded his answer to a whole number, to the tenths place, or to the hundredths place. A response was considered incorrect if the participant calculated the math objective inaccurately. For example, if the math objective presented to the group stated, “Solve: $8^2 \times (36/9) + 5 - 2 =$” and the participant wrote 256 on his dry erase board the response was scored as incorrect.

**Independent Variable**

The independent variable in this study for Experiments 1 and 2 was the manipulation of types of consequences to student responding delivered during the learn units presented to the non-target peers while the target participants observed and attempted to complete the objective themselves. The variable that was manipulated was either (a) the delivery of reinforcement in the form of vocal praise, or (b) a correction procedure in which non-target peers were required to identify their error and emit the correct response in written form on the students’ individual dry erase board. During the reinforcement condition, if the non-target peer emitted a correct response, the experimenter provided vocal praise for each step in the learn unit to the selected non-target peer in view of the target participants and other non-target peers. During the correction condition, if the non-target peer emitted an incorrect response, the experimenter provided a demonstration of the math operation for the presented antecedent for each step in the learn unit and required the selected non-target peer to then identify his/her error and emit the correct response in view of the target participants and other non-target peers.
Data Collection

Data were collected on all correct and incorrect responses to problems emitted by the target participants in a session. To obtain observer agreement, two experimenters independently collected data for all of the pre-experimental screening assessments and many of the experimental sessions. The second experimenter was a Masters level student in a teaching as Applied Behavior Analysis graduate program. Both experimenters were trained to collect data by a classroom and University supervisor through the graduate program prior to the start of the study. Data were recorded on a form (Appendix D) that had spaces at the top of the page to record the date, target participant’s name, and the condition. There were columns and rows set up for recording each written response for the total problem emitted within the session. Data were graphed using a cumulative graph to demonstrate the rate of learning. A cumulative graph depicts the number of accumulated frequencies of responses emitted (Skinner, 1956). The experimenter recorded each response of the target participants during the session and following each response emitted. The x-axis represented the number of response opportunities and the y-axis represented the cumulative number of correct and incorrect responses emitted. For example, if the target participants emitted an incorrect response on the first and second observing opportunities, the data points were plotted at 0 on the y-axis and at 1 and 2 on the x-axis. If the target participant emitted a correct response on the third observing opportunity, the data point was plotted at 1 on the y-axis and at 3 on at the x-axis.
**Procedure**

**Pre-experimental Screening Assessment**

During the pre-experimental screening assessments, all of the students in the experimenters’ classroom were asked to complete worksheets that consisted of written math problems. Students were seated at their individual student desks in the classroom and given a pencil and a *TI-108 Texas Instruments®* calculator. The experimenter instructed all of the students in the classroom to complete the worksheets “as best they could.” Students completed the pre-experimental screening assessments in approximately 25 minutes. No feedback was given to any of the students following the completion of the pre-experimental screening assessment. The same math objectives were presented during the pre-experimental screening assessment as in the experimental sessions, however the experimenter presented different problems. For example, if the problem, “What is the compound interest on $890.00 at 12.5% for 10 years?” was presented on the pre-experimental screening assessment, the same antecedent was not presented at any time during the experiment. Yet a similar antecedent, “What was the compound interest on $750.00 at 13% for 5 years?” was presented during the same objective, calculating interest. Two experimenters independently scored the pre-experimental screening assessments.

**Experimental Sessions**

Some experimental sessions involved two experimenters, one experimenter who delivered direct learn units to the non-target peers and a second experimenter who independently collected data on the responses of the target participants for interobserver agreement. During the sessions in which two experimenters were present, the lead experimenter and second
experimenter independently collected data and alternated sessions delivering learn units. During the session in which one experimenter was present, the lead experimenter delivered direct learn units to the non-target peers and collected data on the responses of the observing target participants.

For each session, the experimenter asked one target participant and three to four alternated non-target peers to go into the open study area outside of the classroom. The non-target peers were asked to join each session based upon their knowledge of the targeted objective. For example, if a non-target peer was pre-taught or learned an objective by participating in condition in which a particular objective was presented that non-target peer was asked to join the reinforcement condition for the same objective. If a non-target peer did not learn a particular objective presented in another condition that non-target peer was asked to join the correction condition for the same objective. The round table mentioned above was used in the open study area. The target participants were asked to sit next to a non-target peer around the round table mentioned above. All students sat facing a large dry erase board. Experimental sessions required between three and four months to complete for all target participants for each experiment.

**Reinforcement condition.**

Prior to the start of the experimental sessions, non-target peers were taught the first objective presented during the reinforcement condition (i.e. how to find the length of an arc). This first objective was taught to the non-target peers outside of the experimental sessions in order for the experimenter to deliver reinforcement for correct responses while the target participants observed. Following the session, the non-target peers were asked to participate in
the reinforcement condition once they had learned the same objective in the correction condition. Non-target peers were considered to have learned the objective after emitting five correct consecutive responses. A non-target peer who learned to “find the length of an arc” in the correction condition was then asked to participate in the reinforcement condition when the objective “finding the length of an arc” was presented.

During the onset of the reinforcement condition, the experimenter said, “I am going to write a math problem on the board and I want you to solve it on your dry erase board.” The experimenter wrote the math problem or figure and formula on the large dry erase board facing the target participants and the non-target peers and read the problem aloud. The experimenter did not provide the target participants with a demonstration of the math problems presented prior to start of the condition. The target participants and the non-target peers solved the math problem on their individual dry erase boards. Once the target participants and non-target peers completed the responses in their entirety on their individual dry erase boards, the experimenter said, “Please hold your boards up.” All of the students held up their dry erase boards with their responses on the boards facing towards the experimenter. The experimenter selected a non-target peer who emitted a correct response. The experimenter picked up the individual dry erase board of the non-target peer who was selected and held it up in front of all of the students in the group to view. A learn unit was delivered for each step of the 4 or 5 step math objectives. The experimenter looked at the non-target peer and delivered vocal praise for each step in the learn unit as the consequence. Upon the final step, the experimenter said, “Great job (non-target peer), you found the length of the arc correctly.” All target participants and non-target peers were then asked to record their data on their individual data sheets. No feedback was delivered to the target participants during the reinforcement condition however classroom points were delivered by the
experimenter to both the target participants and non-target peers for compliant behaviors such as attempting to respond and following directions. Upon the completion of the response and the target participants and non-target peers recording their data, the experimenter said, “Thank you for recording your data and sitting nicely everyone, give yourself a point.” The experimenter recorded the response of the target participant on the experimenter data sheet. All of the students erased their boards. The experimenter then erased the completed problem on the board and presented the next problem.

**Correction condition.**

During the onset of the correction condition, the experimenter said, “I am going to write a math problem on the board and I want you to solve it on your dry erase board.” The experimenter wrote the math problem or figure and formula on the large dry erase board facing the target participants and the non-target peers and read the problem out loud. The experimenter did not provide the target participants and the non-target peers with a demonstration of the math problems presented prior to start of the condition. The target participants and the non-target peers solved the math problem on their individual dry erase boards. Once the target participants and non-target peers completed the responses in their entirety, the experimenter said, “Please hold your boards up.” All of the students held up their dry erase boards facing towards the experimenter. The experimenter randomly selected a non-target peer who emitted an incorrect response and said, “(Non-target peer) let’s review the steps on the board.” The experimenter delivered a correction procedure on the large dry erase board. The antecedent was presented again and a learn unit was delivered for each of the 4 or 5 step math objectives. The non-target peer was required to emit the correct response by writing out the steps in solving the algorithm as
the experimenter was writing out the correct steps on the board. Once the non-target peer completed the correction, all of the students were asked to record their data on their individual data sheets and the experimenter recorded the response of the participant on the experimenter data sheet. The experimenter erased the completed problem on the board and presented the next problem. The math problems for the same objective were presented until the target participant met criterion. Once the non-target peers selected for the session began emitting the correct response for the presented objective, the session was stopped and restarted with different non-target peers who had not mastered the objective.

Criterion for the correction condition for Experiments 1 and 2 was defined as the target participants emitting five correct responses in a row. No feedback was delivered to the target participants during the correction condition however classroom points were delivered by the experimenter to both the target participants and non-target peers for compliant behaviors. Upon a target participant immediately recording his data following the completion of a learn unit delivered to a non-target peer, the experimenter said, “Great job students thank you for recording your data and participating, give yourself a point.”
EXPERIMENT I

Method

Participants

Eight 10 and 11-year-old target participants, five males and three females, were selected for this experiment. They were selected from the fifth grade CABAS® AIL classroom that was described in the General Method section. As a part of the school-wide math program, students in the fifth grade were grouped according to academic skill level. These grouping were based on the NJ ASK assessment, the Everyday Math© assessment, and teacher input. Participants A and B received general math instruction in the CABAS® AIL classroom. Participants C, D, E, F, G, and H received general math instruction in other classrooms. The NJ ASK assessment for math and language arts/literacy standardized test scores are depicted in Table 1.
Table 1

Participant Characteristics

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age/Gender/Ethnicity</th>
<th>Free/Reduced Lunch Qualifications</th>
<th>Standardized Test Scores</th>
<th>Diagnosis or Qualifying Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10/Male/Hispanic</td>
<td>- Free lunch</td>
<td>-NJ ASK Math: 205 Proficient -NJ ASK Language Arts Literacy: 188 Partially Proficient</td>
<td>-Basic Skills for Language Arts Literacy</td>
</tr>
<tr>
<td>B</td>
<td>10/Female/Other</td>
<td>-N/A</td>
<td>-NJ ASK Math: 215 Proficient -NJ ASK Language Arts Literacy: 201 Proficient</td>
<td>-N/A</td>
</tr>
<tr>
<td>C</td>
<td>11/Female/Caucasian</td>
<td>-N/A</td>
<td>-NJ ASK Math: 239 Proficient -NJ ASK Language Arts Literacy: 209 Proficient</td>
<td>-N/A</td>
</tr>
<tr>
<td>D</td>
<td>11/Male/Caucasian</td>
<td>-N/A</td>
<td>-NJ ASK Math: 224 Proficient -NJ ASK Language Arts Literacy: 229 Proficient</td>
<td>-N/A</td>
</tr>
<tr>
<td>E</td>
<td>11/Female/Caucasian</td>
<td>-N/A</td>
<td>-NJ ASK Math: 218 Proficient -NJ ASK Language Arts Literacy: 201 Proficient</td>
<td>-504 Plan ADD</td>
</tr>
<tr>
<td>F</td>
<td>11/Male/Hispanic</td>
<td>-Free Lunch</td>
<td>-NJ ASK Math: 250 Advanced Proficient -NJ ASK Language Arts Literacy: 216 Proficient</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>11/Male/Caucasian</td>
<td>-N/A</td>
<td>-NJ ASK Math: 286 Advanced Proficient -NJ ASK Language Arts Literacy: 224 Advanced Proficient</td>
<td>-504 Plan ADD</td>
</tr>
<tr>
<td>H</td>
<td>11/Male/Caucasian</td>
<td>-N/A</td>
<td>-NJ ASK Math: 295 Advanced Proficient -NJ ASK Language Arts Literacy: 229 Proficient</td>
<td>-N/A</td>
</tr>
</tbody>
</table>
Materials

The math objectives and stimuli used during the pre-experimental screening assessment consisted of five exemplars of four, 4 to 5 step math problems for a total of 20 problems. The four math objectives that were targeted included, (a) finding the length of an arc, (b) calculating interest, (c) finding the permutation of numbers, and (d) finding sine, cosine, and tangent of a triangle. See Appendix F for an example of the pre-experimental screening assessment, Appendix G for an example of a learn unit presented for each objective during the reinforcement condition, and Appendix H for an example of a learn unit presented for each objective during the correction condition used in Experiment 1.

Design

The design was a counterbalanced simultaneous treatment across participants. In this design, the experimenters compared two types of feedback in two conditions. The two conditions were either (a) reinforcement delivered to a non-target peer for a correctly completed math problem for one objective, or (b) a correction delivered to a non-target peer for an incorrectly completed math problem for three objectives.

Procedures

Reinforcement Condition

The math objective presented during the reinforcement condition was controlled for across target participants. The experimenter presented the single math objective under the reinforcement first to Participants A, C, E and G followed by the three math objectives under the correction condition. The experimenter presented the three math objectives under the correction
condition first to Participants B, D, F, and H followed by the single math objective under the reinforcement condition. A sequence of objectives presented for each participant during the reinforcement and correction conditions are presented in Table 2. Participants A and E observed the objective finding the length of an arc, Participants B and F observed the objective calculating interest, Participants C and G observed the objective finding the permutation of numbers, and Participants D and H observed the objective finding sine, cosine, and tangent of a triangle during the reinforcement condition.

The criterion for the reinforcement condition was defined as the target participants emitting five consecutive correct responses to math problems. If criterion was not met before a pre-determined number of math problems were presented, then the condition was terminated. The pre-determined number of math problems presented during the reinforcement condition was selected based on a pilot study conducted prior to Experiment 1. The total number of correct problems to criterion was calculated for all three objectives presented in the pilot study during the correction condition. The highest number of math problems to criterion emitted among all of the target participants was the number of math problems presented during the reinforcement condition in Experiment 1 prior to terminating the session. Therefore 37 observational opportunities were presented before a session was terminated. Once the reinforcement condition was terminated, and if it was not the final condition to be presented in the sequence of objectives a correction condition began. The target participants in Experiment 1 were the same students who participated in the pilot study. The experimenters presented four objectives in the pilot study that were different from the objectives presented in Experiment 1.
Table 2

*Sequence of Objectives Presented for Each Participant, the Reinforcement Conditions are Indicated in Italics.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Sequence of Objectives</th>
</tr>
</thead>
</table>

**Interobserver Agreement**

Interobserver agreement (IOA) was calculated by dividing the number of agreements by the total number of agreements plus disagreements and then multiplying by 100%. During the pre-experimental screening assessment, IOA was collected for the correct or incorrect responses.
of all of the participants with 100% agreement. Throughout the experimental conditions, IOA
was collected based on the correct or incorrect responses of Participants A, B, C, E, F, and G for
100% of all sessions with 100% agreement. Interobserver agreement was collected for 79% of
the experimental sessions with a mean agreement of 100% for Participant D and for 78% of all
sessions with an agreement of 100% for Participant H. In total during the experimental
conditions, IOA was collected for 95% of the sessions with an agreement of 100%.

Results

None of the target participants emitted any correct responses during the pre-experimental
screening assessment. Table 3 displays the number of completed math problems to criterion
during the reinforcement and correction conditions. Table 4 displays the number of completed
math problems to criterion during the reinforcement condition and the mean and range of
completed math problems to criterion during the correction condition. Figures 1 through 4
depict a comparison of the cumulative numbers of correct responses to math problems emitted
during the correction and reinforcement conditions. Each of the 8 target participants is
represented by his or her individual graph. The x-axis on the graph represents the number of
response opportunities and the y-axis represents the number of correct cumulative responses and
each data point represents 1 response. Figures 5 through 8 depict the number of correct
responses to criterion emitted or the numbers of math problems presented until a session was
terminated during the reinforcement and correction conditions for each objective presented. Each
of the 8 target participants is represented by his or her, own individual graph. The x-axis on the
graph represents the number of response opportunities and the y-axis represents the cumulative
number of correct responses to math problems during each condition (i.e. reinforcement or condition).

Following the observation of the reinforcement condition, 7 target participants met criterion on the 1 math objective presented. Participant H did not meet criterion during this condition so the condition was terminated follow the presentation of 37 math problems to non-target peers. Following the observation of the correction condition all target participants met criterion on the 3 math objectives (i.e. finding the length of an arc, calculating interest, finding the permutation of numbers, and solving for sine, cosine, and tangent of a triangle). The range of completed math problems to criterion, including the data for Participant H was between 13-37 with a mean of 25.

Target participants required a range of 5-17 completed math problems to meet criterion with a mean of 9 completed math problems to criterion on all 3 math objectives during the correction conditions. Participant A met criterion for finding the length of an arc during the reinforcement with a total of 29 completed math problems. The data for this condition show a data path with no trend for the first 18 response opportunities followed by 2 correct responses, a short period of no trend and a steady ascending trend. Participant A met criterion during the correction condition for calculating interest problems with a total of 12 completed math problems, for finding the permutation of numbers with a total of 8 completed math problems, and for solving sine, cosine, and tangent of a triangle with a total of 8 completed math problems. Participant A mastered all 3 math objectives during the correction condition with a total of 28 completed math problems and a mean of 9 completed math problems to criterion for each objective. The data paths for all 3, correction conditions show steady, ascending trends.
Participant B met criterion during the correction condition for finding the length of an arc with a total of 12 completed math problems, for finding the permutation of numbers with a total of 7 completed math problems, and for solving sine, cosine, and tangent of a triangle with a total of 12 completed math problems. Participant B mastered all 3 math objectives during the correction condition with a total of 31 completed math problems and a mean of 10 math problems to criterion for each objective. The data paths for the 1st and 3rd correction conditions show a brief period of little or no trend followed by steady, ascending trends. The data path for the 2nd correction condition shows an ascending, steady trend. Participant B met criterion for calculating interest problems during the reinforcement condition with a total of 13 completed math problems. The data path for this condition show a brief period of no trend followed by a steady, ascending trend.

Participant C met criterion for finding the permutation of numbers during the reinforcement condition with a total of 30 completed math problems. The data path for this condition shows a variable, ascending trend. Participant C met criterion during the correction condition for finding the length of an arc with a total of 6 completed math problems, for calculating interest problems with a total of 5 completed math problems, and solving for sine, cosine, and tangent of a triangle with a total of 17 completed math problems. Participant C mastered all 3 math objectives during the correction condition with a total of 28 completed math problems and a mean of 9 math problems to criterion for each objective. The data paths for the 1st and 2nd correction conditions show a steady, ascending trend and the data path for the 3rd correction condition shows a variable, ascending trend.

Participant D met criterion during the correction condition for finding the length of an arc with a total of 11 completed math problems, calculating interest problems with a total of 7
completed math problems, and finding the permutation of numbers with a total of 13 completed math problems. Participant D mastered all 3 math objectives during the correction condition with a total of 31 completed math problems and a mean of 10 math problems to criterion for each objective. The data paths for all 3 correction conditions show steady, ascending trends and the data path for the reinforcement condition show an initial no trend for the first 13 response opportunities followed by a variable, ascending trend. Participant D met criterion for solving sine, cosine, and tangent of a triangle with a total of 27 completed math problems.

Participant E met criterion for calculating interest problems during the reinforcement condition with a total of 26 completed math problems. The data path for this condition shows an initial no trend for the first 8 response opportunities followed by a steady, ascending trend. Participant E met criterion during the correction condition for finding the length of an arc with a total of 10 completed math problems, finding the permutation of numbers with a total of 7 completed math problems, and solving sine, cosine, and tangent of a triangle with a total of 9 completed math problems. Participant E mastered all 3 math objectives during the correction condition with a total of 26 completed math problems and a mean of 8 math problems to criterion for each objective. The data paths for the 1st and 3rd correction conditions show a brief period of no trend followed by a steady, ascending trend. The data path for the 2nd correction condition shows a steady, ascending trend.

Participant F met criterion during the correction condition for calculating interest problems with a total of 11 completed math problems, finding the permutation of numbers with a total of 9 completed math problems, and solving sine, cosine, and tangent of a triangle with a total of 9 completed math problems. Participant F mastered all 3 math objectives during the correction condition with a total of 29 observational learning and a mean of 9 math problems to
criterion for each objective. The data paths for all 3 correction conditions show steady, ascending trends. Participant F met criterion for finding the length of an arc during the reinforcement condition with a total of 20 completed math problems. The data paths for the reinforcement condition show an initial no trend for the first 11 response opportunities followed by a variable, ascending trend.

Participant G met criterion for finding the permutation of numbers during the reinforcement condition with a total of 21 completed math problems. The data paths for the reinforcement condition show a brief period of no trend followed by a steady, ascending trend. Participant G met criterion during the correction condition for finding the length of an arc with a total of 10 completed math problems, calculating interest problems with a total of 10 completed math problems, and for solving sine, cosine, and tangent of a triangle with a total of 7 completed math problems. Participant G mastered all 3 math objectives during the correction condition with a total of 25 completed math problems and a mean of 8 math problems to criterion for each objective. The data paths for all 3, correction conditions show steady, ascending trends.

Participant H met criterion during the correction condition for finding the length of an arc with a total of 11 completed math problems, calculating interest problems with a total of 7 completed math problems, and finding the permutation of numbers with a total of 6 completed math problems. Participant H mastered all 3 math objectives during the correction condition with a total of 24 completed math problems and a mean of 8 math problems to criterion for each objective. The data path for the 1st correction condition show an initial brief period of no trend followed by a steady, ascending trend. The data paths for the 2nd and 3rd correction conditions show steady, ascending trends. Participant H did not meet criterion for solving sine, cosine, and tangent of a triangle. The session was terminated after the maximum numbers of math problems
of 37 were presented to non-target peers. The data path for the reinforcement condition shows a variable, ascending trend. The results of this study are meaningful because learning during correction conditions took place at significantly faster rates than learning during the reinforcement condition.
Table 3

*Number of Completed Math Problems to Criterion During the Reinforcement and Correction Conditions.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Number of Completed Math Problems to Criterion</th>
<th>Number of Completed Math Problems to Criterion</th>
<th>Number of Completed Math Problems to Criterion</th>
<th>Number of Completed Math Problems to Criterion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reinforcement Condition</td>
<td>Correction Condition</td>
<td>Correction Condition</td>
<td>Correction Condition</td>
</tr>
<tr>
<td>Objective 1</td>
<td>Objective 2</td>
<td>Objective 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>29</td>
<td>12</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>13</td>
<td>12</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>C</td>
<td>30</td>
<td>6</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>D</td>
<td>27</td>
<td>11</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td>E</td>
<td>26</td>
<td>10</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>F</td>
<td>20</td>
<td>11</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>G</td>
<td>21</td>
<td>10</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>H</td>
<td>31</td>
<td>11</td>
<td>7</td>
<td>6</td>
</tr>
</tbody>
</table>
Table 4

*Number of Completed Math Problems to Criterion Emitted During the Reinforcement Condition and Mean and Range of Completed Math Problems to Criterion Emitted During the Correction Condition.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Condition</th>
<th>Number of Responses to Criterion During the Reinforcement Condition</th>
<th>Mean Number of Responses to Criterion During the Correction Condition</th>
<th>Range of Responses to Criterion During the Correction Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Reinforcement</td>
<td>29</td>
<td>9</td>
<td>8-12</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Reinforcement</td>
<td>13</td>
<td>10</td>
<td>7-12</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Reinforcement</td>
<td>30</td>
<td>9</td>
<td>5-17</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>Reinforcement</td>
<td>27</td>
<td>10</td>
<td>7-13</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Reinforcement</td>
<td>26</td>
<td>9</td>
<td>7-10</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Reinforcement</td>
<td>20</td>
<td>10</td>
<td>9-11</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Reinforcement</td>
<td>21</td>
<td>8</td>
<td>7-10</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Reinforcement</td>
<td>37</td>
<td>8</td>
<td>6-11</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1. A comparison of the cumulative number of correct responses to math problems emitted during the reinforcement and correction conditions for Participants A and B.
Figure 2. A comparison of the cumulative number of correct responses to math problems emitted during the reinforcement and correction conditions for Participants C and D.
Figure 3. A comparison of the cumulative number of correct responses to math problems emitted during the reinforcement and correction conditions for Participants E and F.
Figure 4. A comparison of the cumulative number of correct responses to math problems emitted during the reinforcement and correction conditions for Participants G and H.
Figure 5. The number of correct responses to criterion emitted during the reinforcement and correction conditions.
Figure 6. The number of correct responses to criterion emitted during the reinforcement and correction conditions.
Figure 7. The number of correct responses to criterion emitted during the reinforcement and correction conditions.
Figure 8. The number of correct responses to criterion emitted during the reinforcement and correction conditions.
**Discussion of Experiment I and Rationale for Experiment II**

The purpose of this study was to test the role of feedback in the form of reinforcement for a correct response and a correction for an incorrect response during observational conditions. The results of this investigation demonstrated that observing instructor-delivered feedback in the form of a correction procedure was effective in the acquisition of three math objectives for all participants. The results also indicate that observing instructor-delivered feedback in the form of reinforcement was not as effective in the acquisition of a single math objective. The rate of learning was significantly greater in the correction condition than in the reinforcement condition.

Participants in this study met criteria for three math objectives in the correction condition in approximately the same amount of completed math problems that they acquired a single new math objective in the reinforcement condition. It is important to note that Participant E may have met mastery criterion during the reinforcement condition if more observational opportunities of math problems had been presented and the session had not been terminated.

Although the findings from Experiment I were compelling, there were several limitations including a possible confound. I did not control for the number of objectives presented during the reinforcement and correction conditions. During the reinforcement condition, one math objective was presented and during the correction condition, three math objectives were presented. In addition, the objectives in the correction and reinforcement conditions were not controlled for between participants and therefore were a procedural limitation of this study. These procedural limitations will be addressed in Experiment 2 in which one math objective will be presented during the correction and reinforcement conditions. These sessions will alternate until a total of six objectives are presented to each non-target peer and observed by the participant in an alternating fashion. Prior research has demonstrated students’ acquisition of
new skills through observational learning however it was unclear during what specific feedback conditions the students acquired these new skills (Van Wagenen, & Travers, 1963; Werts, Caldwell, & Wolrey, 1996; Nuzzolo, 2002).

In Experiment 2, the following experimental question was asked: Using greater experimenter control, will the cumulative number of completed math problems for the acquisition of math objectives during observational conditions of reinforcement and correction procedures from Experiment 1 replicate in Experiment 2?
Chapter III

EXPERIMENT 2

Method

Participants

Six 10 and 11-year-old target participants, two males and four females, were selected for this experiment. Experiment 2 was conducted the following school year after Experiment 1. The target participants and non-target peers selected for Experiment 2 were different from the target participants selected for Experiment 1. The target participants in Experiment 2 were selected the following school year from the same fifth grade CABAS® AIL classroom that was described in the General Method section. All target participants received math instruction in the CABAS® AIL classroom. The NJ ASK assessment for math and language arts/literacy is the standardized test scores are depicted in Table 5.
### Table 5

**Participant Characteristics**

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age/Gender/Ethnicity</th>
<th>Free/Reduced Lunch Qualifications</th>
<th>Standardized Test Scores</th>
<th>Diagnosis or Qualifying Services</th>
</tr>
</thead>
</table>
| A            | 10/Female/Caucasian  | - N/A                             | -NJ ASK Math: 224 Proficient  
- NJ ASK Language Arts Literacy: 193 Partially Proficient | - N/A |
| B            | 10/Female/Black      | -Reduced Lunch                    | -NJ ASK Math: 258 Advanced Proficient  
- NJ ASK Language Arts Literacy: 188 Proficient | - Basic Skills for Language Arts Literacy |
| C            | 10/Male/Hispanic     | -Reduced Lunch                    | -NJ ASK Math: 215 Advanced Proficient  
- NJ ASK Language Arts Literacy: 193 Partially Proficient | - Basic Skills for Language Arts Literacy |
| D            | 10/Male/Caucasian    | -N/A                              | -NJ ASK Math: 289 Proficient  
- NJ ASK Language Arts Literacy: 212 Proficient | - N/A |
| E            | 10/Female/Caucasian  | -N/A                              | -NJ ASK Math: 241 Proficient  
- NJ ASK Language Arts Literacy: 234 Partially Proficient | - N/A |
| F            | 10/Female/Caucasian  | -N/A                              | -NJ ASK Math: 205 Proficient  
- NJ ASK Language Arts Literacy: 200 Proficient | - N/A |
Materials

The objectives and stimuli used during the pre-experimental screening assessment in Experiment 2 consisted of five exemplars of six, 4 to 5 step math algorithms for a total of 30 problems. The six math objectives that were targeted included, (a) finding the volume of a prism, (b) finding the slope of a line, (c) solving for sine, cosine, and tangent of a triangle, (d) finding the permutation of numbers, (e) solving an algebraic equation using order of operations and, (f) finding the length of an arc. See Appendix I for an example of the pre-experimental screening assessment.

Independent Variable and Procedure

Experiment 2 was a direct replication of Experiment 1 for the reinforcement and correction experimental conditions. Two target participants and three to four non-target peers were present during the sessions similar to the first experiment. However, during the second experiment, sessions were rotated between reinforcement and correction conditions and the math objectives were controlled for between target participants. A sequence of objectives is presented in Table 6. Three objectives that were not used in Experiment 1 were used in Experiment 2 during the reinforcement and correction conditions. See Appendix J and K for an example of a learn unit presented during the reinforcement and correction conditions. These objectives were (a) finding the volume of a prism, (b) finding the slope of a line, and (c) solving an algebraic equation using order of operations.

The total number of completed math problems to criterion was calculated for all three objectives presented in Experiment 1 during the correction condition. The correction condition required the target participants to emit five consecutive correct responses to three math
objectives presented consecutively. The highest number of math problems to criterion emitted among all of the target participants was the number of math problems presented during the reinforcement condition in Experiment 2 prior to terminating the session. The 31 observational opportunities were presented before a session was terminated. Once the reinforcement condition was terminated, and if it was not the final condition to be presented in the sequence of objectives a correction condition began.

**Design**

The design was a between subjects counterbalanced reversal design across conditions and math objectives. In this design, the experimenters compared two types of feedback in two conditions. The two conditions were either (a) reinforcement delivered to a non-target peer for a correctly completed math problem for three objectives, or (b) a correction delivered to a non-target peer for an incorrectly completed math problem for three objectives.

**Interobserver Agreement**

During pre-experimental screening assessments, interobserver agreement (IOA) was collected for 100% of all sessions with 100% agreement for all target participants. Throughout the experimental conditions, IOA was collected for 17% of all sessions with an agreement of 100% for Participant A, 10% of all sessions with an agreement of 100% for Participant B, 13% of all sessions with an agreement of 100% for Participant E, and 14% of all sessions with an agreement of 100% for Participant F. In total during the experimental conditions, IOA was collected for 10% of the sessions with an agreement of 100%. Interobserver agreement was not collected for Participants C and D.
Table 6

Sequence of Objectives

<table>
<thead>
<tr>
<th>Participant</th>
<th>Condition</th>
<th>Correction</th>
<th>Reinforcement</th>
<th>Correction</th>
<th>Reinforcement</th>
<th>Correction</th>
<th>Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Volume of Pyramid</td>
<td>Slope of a Line</td>
<td>Sine, Cosine, and Tangent</td>
<td>Permutation</td>
<td>Order of Operations</td>
<td>Length of an Arc</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Slope of a Line</td>
<td>Sine, Cosine, and Tangent</td>
<td>Permutation</td>
<td>Order of Operations</td>
<td>Length of an Arc</td>
<td>Volume of a Pyramid</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>Sine, Cosine, and Tangent</td>
<td>Permutation</td>
<td>Order of Operations</td>
<td>Length of an Arc</td>
<td>Volume of a Pyramid</td>
<td>Slope of a Line</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant</th>
<th>Reinforcement</th>
<th>Correction</th>
<th>Reinforcement</th>
<th>Correction</th>
<th>Reinforcement</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>Permutation</td>
<td>Order of Operations</td>
<td>Length of an Arc</td>
<td>Volume of a Pyramid</td>
<td>Slope of a Line</td>
<td>Sine, Cosine, and Tangent</td>
</tr>
<tr>
<td>E</td>
<td>Order of Operations</td>
<td>Length of an Arc</td>
<td>Volume of a Pyramid</td>
<td>Slope of a Line</td>
<td>Sine, Cosine, and Tangent</td>
<td>Permutation</td>
</tr>
<tr>
<td>F</td>
<td>Length of an Arc</td>
<td>Volume of a Pyramid</td>
<td>Slope of a Line</td>
<td>Sine, Cosine, and Tangent</td>
<td>Permutation</td>
<td>Order of Operations</td>
</tr>
</tbody>
</table>

Results

Table 7 displays the number of math problems to criterion during the reinforcement and correction conditions. Table 8 displays the means and ranges of math problems to criterion during the reinforcement and correction conditions. None of the target participants emitted any correct responses during the pre-experimental screening assessment. All target participants met criterion during the correction conditions with a range of 6-21 correct responses to criterion and a mean of 10 correct responses to criterion. Target participants met criterion during the
reinforcement conditions for 10 out of 18 objectives presented with a range of 9-31 correct responses to criterion and a mean of 23 correct responses to criterion.

Figures 9 through 11 depict a comparison of the cumulative number of correct responses to math problems emitted during the reinforcement and correction conditions for the target participants. Figures 12 through 14 depict the number of correct responses to criterion emitted during the reinforcement and correction conditions for the target participants. Figure 15 depicts the mean number of correct responses to criterion emitted for each objective during the reinforcement and correction conditions for Participants A-F. Participants A, C, D, and F observed a non-target peer receive a correction for finding the volume of a prism, solving for sine, cosine, and tangent of a triangle, and solving an algebraic equations using order of operations. Participants A, C, D, and F observed a non-target peer receive reinforcement for finding the slope of a line, finding the permutation of numbers, and finding the length of an arc. Participants B and E observed a non-target peer receive a correction for finding the slope of a line, finding the permutation of numbers, and finding the length of an arc. Participants B and E observed a non-target peer receive reinforcement for finding the volume of a prism, solving for sine, cosine, and tangent of a triangle, and solving an algebraic equation using order of operations.

Participant A met criterion during the correction condition for 1st objective, finding the volume of a pyramid with a total of 7 completed math problems. This participant did not meet criterion during the reinforcement condition for the 2nd objective, finding the slope of a line and the condition was terminated following 31 completed math problems. Participant A met criterion during the correction condition for the 3rd objective, finding sine, cosine, and tangent of a triangle with a total of 10 completed math problems. This participant met criterion during the
reinforcement condition for the 4\textsuperscript{th} objective, finding the permutation of numbers with a total of 17 completed math problems. Participant A met criterion during the correction condition for the 5\textsuperscript{th} objective, solving an algebraic equation using order of operations with a total of 14 completed math problems and during the reinforcement condition for the 6\textsuperscript{th} objective, finding the length of an arc with a total of 11 completed math problems. This participant mastered all 3 math objectives during the correction conditions with a total of 31 completed math problems and a mean of 10 math problems to criterion. The data paths for all 3, correction conditions show an initial no trend followed by steady, ascending trends. During the reinforcement condition, Participant A was presented with a total of 59 completed math problems for all 3 objectives in order to meet mastery criterion or until a session was terminated with a mean of 19 observed responses to math problems. The data path for the 1\textsuperscript{st} reinforcement conditions shows no trends. The data paths for the 2\textsuperscript{nd} and 3\textsuperscript{rd} reinforcement condition show an initial no trend followed by a steady ascending trend.

Participant B met criterion during the correction condition for the 1\textsuperscript{st} objective, finding the slope of a line with a total of 8 completed math problems. This participant did not meet criteria during the reinforcement condition for the 2\textsuperscript{nd} objective, finding sine, cosine, and tangent of a triangle and the condition was terminated following 31 completed math problems. Participant B met criterion during the correction condition for the 3\textsuperscript{rd} objective, finding the permutation of numbers with a total of 8 completed math problems. This participant did not meet criteria during the reinforcement condition for the 4\textsuperscript{th} objective, solving an algebraic equation using order of operations and the condition was terminated following 31 completed math problems. Participant B met criterion during the correction condition for the 5\textsuperscript{th} objective, finding the length of an arc with a total of 7 completed math problems and during the
reinforcement condition for the 6th objective, finding the volume of a pyramid with a total of 9 completed math problems. This participant mastered all 3 math objectives during the correction conditions with a total of 23 completed math problems and a mean of 7 math problems to criterion. The data paths for the correction conditions show an initial no trend followed by steady, ascending trends. During the reinforcement condition, Participant B was presented with a total of 71 completed math problems for all 3 objectives in order to meet mastery criterion or until sessions were terminated with a mean of 24 observed responses. The data paths for the 1st and 2nd reinforcement conditions show variable ascending trends. The data paths for the 3rd reinforcement condition show an initial no trend followed by a steady ascending trend.

Participant C met criterion during the correction condition for the 1st objective, finding sine, cosine, and tangent of a triangle with a total of 11 completed math problems. This participant met criterion during the reinforcement condition for the 2nd objective, finding the permutation of numbers with a total of 26 completed math problems. Participant C met criterion during the correction condition for the 3rd objective with a total of 9 completed math problems. This participant met criterion during the reinforcement condition for the 4th condition, finding the length of an arc with a total of 26 completed math problems. Participant C met criterion during the correction condition for the 5th objective, finding the volume of a pyramid with a total of 10 completed math problems. The participant did not meet criterion during the reinforcement condition for the 6th objective, finding the slope of a line and the session was terminated following 31 completed math problems. Participant C met mastered all 3 math objectives during the correction conditions with a total of 30 completed math problems and a mean of 10 math problems to criterion. The data path for the first correction condition show an initial no trend followed by a steady ascending trend. The data paths for the 2nd and 3rd correction conditions
show steady, ascending trends. During the reinforcement condition, Participant C required a total of 83 completed math problems for all 3 objectives in order to meet mastery criterion or until a session was terminated with a mean of 28 math problems. The data paths for the first 2 reinforcement conditions show an initial no trend followed by steady, ascending trends and the data path for the 3rd condition show no trend.

Participant D met criterion during the reinforcement condition for the 1st objective, finding the permutation of numbers with a total of 10 completed math problems. This participant met criterion during the correction for the 2nd objective, solving an algebraic equation using order of operations with a total of 6 completed math problems. Participant D met criterion during the reinforcement condition for the 3rd objective, finding the length of an arc with a total of 18 completed math problems. This participant met criterion during the correction condition for the 4th objective, finding the volume of a pyramid with a total of 6 completed math problems. Participant D did not meet criterion during the reinforcement condition for the 5th objective, finding the slope of a line and the condition was terminated following 31 completed math problems. The participant met criterion during the correction condition for the 6th objective, finding sine, cosine, and tangent of a triangle with a total of 16 completed math problems. During the reinforcement condition, Participant D was presented with a total of 59 completed math problems for all 3 objectives in order to meet mastery criterion or until the session was terminated with a mean of 20 observed responses to math problems. The data paths for the first 2 reinforcement conditions show in initial no trends following steady, ascending trends and the data path for the 3rd condition show no trend. Participant D mastered all 3 math objectives during the correction conditions with a total of 28 completed math problems with a mean of 9 correct responses to criterion. The data paths for the 1st and 2nd, correction conditions show
steady, ascending trends and the data path for the 3rd condition show an initial variable ascending trend followed by a steady ascending trend.

Participant E did not meet criterion during the reinforcement condition for the 1st objective, solving an algebraic equation using order of operations and the condition was terminated following 31 completed math problems. This participant met criterion during the correction condition for the 2nd objective, finding the length of an arc with a total of 13 completed math problems. Participant E met criterion during the reinforcement condition for the 3rd objective, finding the volume of a pyramid with a total of 14 completed math problems. This participant met criterion during the correction condition for the 4th objective, finding the permutation of numbers with a total of 7 completed math problems. Participant E met criterion during the reinforcement condition for the 5th objective, finding sine, cosine, and tangent triangle with a total of 13 completed math problems and for the 6th objective, finding the slope of a line with a total of 7 completed math problems. During the reinforcement condition, Participant E was presented with a total of 58 completed math problems for all 3 objectives in order to meet mastery criterion or until the session was terminated with a mean of 19 observed responses to math problems. The data paths for all 3 reinforcement conditions show variable ascending trends. Participant E mastered all 3 math objectives during the correction conditions with a total of 27 completed math problems with a mean of 9 correct responses to criterion. The data paths for all 3, correction conditions show steady, ascending trends.

Participant F did not meet criterion during the reinforcement condition for the 1st objective, finding the length of an arc and the condition was terminated following 31 completed math problems. This participant met criterion during the correction condition for the 2nd objective, finding the volume of a pyramid with a total of 21 completed math problems.
Participant F did not meet criterion during the reinforcement condition for the 3rd objective, finding the slope of a line and the condition was terminated following 31 completed math problems. This participant met criterion during the correction condition for the 4th objective, finding sine, cosine, and tangent of a triangle with a total of 8 completed math problems. Participant F met criterion during the reinforcement condition for the 5th objective, finding the permutation of numbers with a total of 26 completed math problems and during the correction condition for the 6th objective, solving an algebraic equation using order of operations with a total of 19 completed math problems. During the reinforcement condition, Participant F was presented with a total of 88 completed math problems for all 3 objectives in order to meet mastery criterion or until the session was terminated with a mean of 29 math problems. The data path for the 1st reinforcement condition shows no trend and the data paths for the 1st and 2nd reinforcement conditions show an initial no trend followed by slight ascending trends. Participant F mastered all 3 math objectives during the correction condition with a total of 48 completed math problems with a mean of 16 math problems to criterion. The data paths for the 1st and 3rd, correction conditions shows initial no trends followed by steady, ascending trends. The data path for the 2nd correction condition shows a steady ascending trend.
Table 7

*Number of Completed Math Problems to Criterion Emitted During the Reinforcement and Correction Conditions.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Correction</th>
<th>Reinforcement</th>
<th>Correction</th>
<th>Reinforcement</th>
<th>Correction</th>
<th>Reinforcement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7</td>
<td>31</td>
<td>10</td>
<td>17</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>31</td>
<td>8</td>
<td>31</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>C</td>
<td>11</td>
<td>26</td>
<td>9</td>
<td>26</td>
<td>10</td>
<td>31</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Participant</th>
<th>Reinforcement</th>
<th>Correction</th>
<th>Reinforcement</th>
<th>Correction</th>
<th>Reinforcement</th>
<th>Correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>10</td>
<td>6</td>
<td>18</td>
<td>6</td>
<td>31</td>
<td>16</td>
</tr>
<tr>
<td>E</td>
<td>31</td>
<td>13</td>
<td>14</td>
<td>7</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>F</td>
<td>31</td>
<td>21</td>
<td>31</td>
<td>8</td>
<td>26</td>
<td>19</td>
</tr>
</tbody>
</table>
Table 8

*Means and Ranges of Completed Math Problems to Criterion Emitted During the Reinforcement and Correction Conditions.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Condition</th>
<th>Mean</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Correction</td>
<td>10</td>
<td>7-14</td>
</tr>
<tr>
<td></td>
<td>Reinforcement</td>
<td>20</td>
<td>11-31</td>
</tr>
<tr>
<td>B</td>
<td>Correction</td>
<td>8</td>
<td>7-8</td>
</tr>
<tr>
<td></td>
<td>Reinforcement</td>
<td>24</td>
<td>9-31</td>
</tr>
<tr>
<td>C</td>
<td>Correction</td>
<td>10</td>
<td>9-11</td>
</tr>
<tr>
<td></td>
<td>Reinforcement</td>
<td>28</td>
<td>26-31</td>
</tr>
<tr>
<td>D</td>
<td>Reinforcement</td>
<td>20</td>
<td>10-31</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td>9</td>
<td>6-16</td>
</tr>
<tr>
<td>E</td>
<td>Reinforcement</td>
<td>19</td>
<td>13-31</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td>9</td>
<td>7-13</td>
</tr>
<tr>
<td>F</td>
<td>Reinforcement</td>
<td>29</td>
<td>26-31</td>
</tr>
<tr>
<td></td>
<td>Correction</td>
<td>16</td>
<td>8-21</td>
</tr>
</tbody>
</table>
Figure 9. A comparison of the cumulative number of correct responses to math problems emitted during the correction and reinforcement conditions for Participants A and B.
Figure 10. A comparison of the cumulative number of correct responses to math problems emitted during the reinforcement and correction conditions for Participants C and D.
Figure 11. A comparison of the cumulative number of correct responses to math problems emitted during the reinforcement and correction conditions for Participants E and F.
Figure 12. The number of correct responses to criterion emitted during the reinforcement and correction conditions for Participants A and B.
Figure 13. The number of correct responses to criterion emitted during the reinforcement and correction conditions Participants C and D.
Figure 14. The number of correct responses to criterion emitted during the reinforcement and correction conditions for Participants E and F.
Figure 15. The mean number of correct responses to criterion emitted for each objective during the reinforcement and correction conditions for Participants A-F.
Chapter IV

GENERAL DISCUSSION

Major Findings

In this section, the experimental questions put forth in Experiments 1 and 2 will be addressed. Findings that were not formally investigated will also be discussed, as will some limitations of the current research and future directions. The purpose of both experiments was to test the effects of learning through observation during reinforcement and correction conditions. The study sought to answer the question: During which conditions would students acquire new math objectives by observing instruction delivered to peers receiving two different types of instructor feedback; 1) reinforcement for a correct response and 2) a correction for an incorrect response? The pre-experimental screening assessments in both experiments indicated that none of the target participants had any of the math objectives used for the study in repertoire. During the experimental conditions, target participants observed reinforcement delivered to a peer for a correct response or a correction delivered to a peer for an incorrect response. A consequence was not delivered to target participants following a response during any time through the study.

The results of these experiments provide strong empirical evidence that learning through observation takes place at faster rates through the observation of a correction. These students’ acquisition of new math objectives occurred at higher rates while observing a correction procedure delivered for incorrect responses versus reinforcement delivered for correct responses. All target participants from Experiment 1, with the exception of Participant B, met criterion or were provided completed math problems until the condition was terminated for a single objective
during the reinforcement condition with approximately the same number of completed math problems presented for three objectives during the correction condition. Participant B required a significantly fewer amount of observational opportunities in order to meet criterion during the reinforcement condition. This may suggest that Participant B could have had an instructional history with the objective, calculating interest. It was noted by the experimenters that target participants in both experiments when asked to participate in the reinforcement conditions made statements on several occasions such as, “When are we going to learn this?” and “When are you going to teach this to us?” This anecdotal observation supported the results of the study, which demonstrated that students learn and at faster rates when observing a correction delivered to peers.

All target participants met criterion for each objective during the reinforcement condition with approximately double the number of completed math problems presented for each objective than during the correction condition. The results of Experiment 2 also provide some evidence that some of the target participants may have learned how to learn during the rotation of the reinforcement and correction conditions. Participants A, B, and E required fewer observational opportunities to meet criterion during the reinforcement condition following each subsequent reinforcement condition presented. If it was the case that the target participants learned how to learn during the reinforcement condition, what types of procedures can be implemented to teach the students who didn’t learn or learn as quickly how to acquire new skills and at a faster rate while observing students receive reinforcement for correct responding? Multiple exemplar instruction (MEI) is a behavior change tactic that has resulted in accelerated rates of learning and the induction of higher order developmental cusps and capabilities (Greer & Longano, 2010). During MEI, multiple exposures in a variety of contexts are presented such that students learn to
abstract and discriminate between important components of a task (Hayes, Barnes-Holmes, & Roche, 2001). The rotation of the reinforcement and correction conditions in Experiment 2 may have brought about the change in behavior for Participants A, B, E, and F.

The results of this study are similar to the findings of previous studies (Van Wagenen & Travers, 1963; Travers et. al., 1964 Nuzzolo, 2002; Ramierz & Rehfeldt, 2009) in which students learn through the observation of others. In addition, the outcomes of this study are comparable to the findings of a previous study conducted by Greer, et. al. (2004) in which the results indicated that students acquire new information at higher rates when observing other students receive a correction for an incorrect response versus reinforcement for a correct response.

Limitations

Although the results indicated that students learn at faster rates when observing peers receive a correction rather than reinforcement, there were variables in the study that could not be controlled for that may have affected the outcome. The limitations that were found in Experiment 1 were discussed in the discussion section of Experiment 1 and were addressed and improved upon in Experiment 2. First, during Experiment 2, the reinforcement and correction conditions between objectives and target participants were controlled for. In Experiment 2 three of the target participants were simultaneously presented observed learn units during the correction condition and three of the target participants were presented observed learn units during the reinforcement condition as the first objective presented. Following the completion of the first objective presented, correction and reinforcement conditions altered thereafter.

Second, the percentage of IOA collected in Experiment 2 for the experimental sessions was low and therefore a limitation of the study. Cooper, Heron and Heward (2007) state that it is common practice for researchers to obtain a minimum of 20% IOA of the sessions conducted in
a study. In addition, it is also expected that researchers achieve a minimum of 80% agreement on the data collected by the observers throughout the sessions. In Experiments 1 and 2, IOA was collected for 100% of the pre-experimental screening assessments with 100% agreement. In Experiment 1, IOA was collected for 95% of the experimental sessions with an agreement of 100%. However, Experiment 2 was conducted the following school year from Experiment 1. One of the experimenters that collected data in Experiment 1 was no longer an instructor in the school district. Therefore, IOA was only collected for 9% of experimental sessions, yet there was an agreement of 100% between the two observers during these sessions. Since Experiment 2 was a replication of Experiment 1 the procedures between the experiments were the same. Between both experiments, 10 objectives were presented. Six of these objectives were the same between the two experiments (finding the length of an arc, finding the permutation of numbers, finding the volume of a pyramid, finding the slope of a line, and solving algebraic expressions using order of operations).

Third, although a pre-experimental screening assessment was conducted prior to the start of the experimental sessions and none of the target participants emitted any correct responses, the target participants may have had some prior knowledge or an instructional history with a math objective. This may have been evident for the objective, finding the volume of a pyramid in Experiment 2. The mean number of correct math problems to criterion for this objective during the reinforcement condition was 11.5 and during the correction condition was 11. The number of correct problems to criterion required approximately the same number of opportunities during both conditions, whereas the mean number of correct math problems to criterion for other objectives during the reinforcement and correction conditions indicated significantly greater differences. This variable may have altered the results of the study.
Finally, the experimental conditions were continued until the participant emitted five consecutive correct responses or until the participant had an opportunity to observe 31 learn unit presentations. The criterion to terminate a session was based upon a pilot study conducted prior to the start of Experiment 1. However, since there were no previous studies that collected data on the number of correct responses emitted during correction and reinforcement conditions separately, it was unclear if and when the reinforcement sessions should be terminated. In Experiment 1, only one reinforcement condition was terminated for Participant H.

Future Research

The results of the current study have implications for future research. In the study of observational learning, the results from these experiments provided information on how students learn and during what conditions they learn while observing others. Given the findings and results of these two experiments, students should be instructed through a model in which the students produce their own correct response in response to a given antecedent during observational conditions. The types of conditions during which students learn by observing other students learn in the general education setting should be further investigated. A comparison of the rates of learning between students receiving direct instruction and students observing instruction during correction and reinforcement conditions should also be investigated. Educational objectives across curricular subject areas such as Science, Social Studies, and Language Arts and Literacy should be presented across similar reinforcement and correction conditions.

In addition, ways of inducing a capability for students to learn at similar rates during correction and reinforcement observational conditions should be further explored. Three students from Experiment 2 whose acquisition rate during the reinforcement conditions did not
increase following subsequent experimental conditions and students like these would benefit from a procedure to teach this capability.

Conclusions

The results from both experiments contribute to the literature on observational learning. The findings here provide evidence for a functional relation between learning at slower rates during reinforcement conditions and learning at faster rates during correction conditions under observational learning opportunities. The results of this study provide evidence that students like these acquire new skills quicker when observing peers receive a correction for emitting an incorrect response versus peers receiving reinforcement for emitting a correct response. The significance of the results of this study should potentially influence the type of instructional feedback delivered to students during group instruction. The results of this study suggest how we, as educators, should deliver instruction to our students and how these methods can have a positive impact on student learning.
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Appendix A

Definition of terms

1. *Applied Behavior Analysis*

   A science of teaching in which behavior change tactics derived from experimental studies and research change socially important behavior to a meaningful degree (Cooper, et. al., 2007). B. F. Skinner published *The Behavior of Organisms* in 1938, which summarized the first research conducted and identified operant and respondent behavior.

2. *Antecedent*

   An antecedent is a stimulus in the environment, which is observed before a particular behavior of interest (Cooper, et. al., 2007). In a learn unit (Greer, 1991), the teacher obtains the attention of the student, which is the antecedent and the attention of the student is obtained, which is the behavior of the student. The antecedent in this example is the teacher obtaining the attention of the student.

3. *Behavioral Developmental Cusp*

   When acquired, a person comes into contact with new environments, contingencies, or stimulus controls and increases a person’s repertoire and can lead to the acquisition of other cusps (Rosales-Ruiz, & Baer, 1997). Crawling and walking are examples of behavior developmental cusps. Through the actions of crawling and walking a person comes into contact with opportunities that are easier to accomplish and more complex behaviors can be attained. With the attainment of the cusp, a person learns faster and without the attainment of the cusp, further development is delayed (Greer & Speckman, 2009).

4. *Capability*
A verbal developmental capability that once acquired allows students to learn in ways in which they could not learn before. Naming is one example of a verbal developmental cusp and capability that once acquired allows students to learn language incidentally (Greer & Speckman, 2009). One who has the Naming capability is able to emit a response in the absence of direct instruction and that this capability is innate or biological and is present around the age of two. So for example, when a mother points to a bird in the sky while both she and the child are looking at the bird and the mother says, “bird”, and without reinforcing the child for saying bird, the child will then be able to later on identify a bird as both a listener and speaker is the Naming capability is present (Horne and Lowe, 1996).

5. *Conditioned Reinforcement*

A stimulus that has been paired with another conditioned or unconditioned reinforcer and that now also functions as a reinforcer (Cooper, et. al., 2007).

6. *Consequence*

A consequence is a stimulus change in the environment, which is observed following a particular behavior of interest (Cooper, et. al., 2007). A teacher presents the vocal antecedent, “What is 2 + 2?” (antecedent), the student responds with, “4” (behavior of interest), and the teacher responds with, “You are correct!” (consequence).

7. *Contingency*

A contingency is a dependent relationship between operant behavior, or learned behavior and the surrounding antecedent and consequent variables in the environment (Cooper, et. al., 2007). Upon a student completing a worksheet he earns free time on the
computer. Earning free time on the computer is contingent upon completing the assignment and a contingency put into place by the classroom teacher.

8. **Direct Instruction**

   Carefully and logically sequenced, scripted curricula that presents tested lessons with guided practice and immediate feedback to the learner in small increments (SRA McGraw Hill, 2009). *Project Follow Through*, a study sponsored by the United States Office of Education and implemented by independent Universities and institutions in 1968 studies the effects of a variety methods on the reading outcomes of students grades kindergarten through grade three from low-income communities (Stallings, & Kaskowitz, 1974). Reading approaches derived from various theoretical approaches that ranged from direct instruction and behaviorism to Piaget and cognitive approaches were implemented (Meyer, Gersten, & Gutkin, 1983). Following the completion of the longitudinal study, the direct instruction method yielded the greatest student outcomes (Shepard, 2012). This model of instruction has been demonstrated as a highly effective model of instruction for students from low-income communities (Gersten, Carnine, Zreof, & Cronin, 1986).

9. **Extinction**

   Previously reinforced behavior that is no longer reinforced (Cooper, et. al., 2007). For example, a student calls out to obtain teacher attention during classroom instruction. The teacher delivering attention to the student, while the student is emitting the behavior reinforces the behavior of calling out. The teacher reinforces this behavior by calling on the student to respond to the antecedent or directing the student to raise his hand. The principle of extinction is implemented when the teacher no longer delivers attention to the student while he is calling out.
10. **Operant**

   Behavior evoked in the environment as a function of the consequences immediately following the behavior and a stimulus that sets the occasion upon which the behavior will occur. Operant behaviors are elicited with the surrounding controlling variables in the environment that have previous been present (Skinner, 1938).

11. **Personalized System of Instruction**

   A go at your own pace approach to learning and individualized instruction in which instructors plan and organize the curriculum and present lectures. Instructors act as facilitators and proctors in this type of instructional model. They provide immediate written feedback to students. Students must achieve mastery level criterion following each unit before moving on to the next set of instructional objectives. Students who are taught through a Personalized System of Instruction (PSI) model have greater achievement gains. The five components of PSI model of instruction includes: (a) individualized pacing, (b) mastery learning of each unit, (c) lectures and demonstrations as a source of motivation, (d) written teacher and student communication, and (e) the use of proctors (Keller, 1968).

12. **Precision Teaching**

   A method of monitoring responses of individual learners and is most effective when implemented in combination with direct instruction. Behaviors of learners are graphed on a standard celeration chart. Frequencies of behaviors are recorded on a semi-logarithmic graph. Frequencies of behaviors emitted are plotted along the y-axis of the graph and time is plotted along on the x-axis of the graph. Frequencies of behaviors emitted once per day up to 1,000 per minute can be graphed. This method of data
analysis was first implemented in special education classrooms in 1965 and became more widely implemented in a number of educational institutions during the 1970’s (Lindsley, 1991).

13. Reinforcement

A stimulus that immediately follows a behavior and increases the probability of that behavior emitted in the future (Cooper, et. al., 2007). A student raises his hand and calls out during class when the teacher presents a question. The teacher calls on the student immediately following the student raising his hand and not when he calls out. Calling on the student when he raises his hand reinforces the probability of the student raising his hand in the future.

14. Repertoire

A set of acquired behaviors by an individual emitted during certain environmental conditions (Greer & Ross, 2008). A student emitted zero correct responses on a math objective, solving 2-digit by 1-digit long division problems, on a pre-unit assessment. Learn units were delivered and mastery criterion was met during the lesson. A post-unit assessment was conducted in which the student emitted zero incorrect responses. The student now has a repertoire for solving 2-digit by 1-digit long division problems.

15. Stimulus

Single or multiple physical events or the relation between specific events that can be described as descriptive or functional classes (Catania, 2007).

16. Tact

A verbal operant identified by Skinner (1957) in which the presence of a stimulus evokes a response that is reinforced through generalized reinforcement. The term tact is
shortened for the word, “contact”, having contact with a stimulus in the environment. A child looks up at the sky, points, and says, “airplane” and immediately turns his head towards his mother. His mother says, “Yes, that is an airplane” and the boy smiles.

17. **Tactic (Behavior Change Tactic)**

A scientifically tested procedure to change behavior based on one or more than one principles of behavior. The procedure has demonstrated effective behavior change across subjects, settings, and behaviors (Cooper, et. al. 2007). Multiple exemplar instruction across response topographies is a behavior change tactic that has been implemented to induce certain higher order operants, developmental cusps and capabilities such as Naming and observational learning, and as a general teaching tactic for learners struggling to acquire a particular skill. Multiple exemplar instruction is presented across various response topographies (Davies-Lackey, 2005; Greer, Stolfi, Chavez-Brown, & Rivera-Valdez, 2005; Greer, Yuan, & Gautreaux, 2005).

18. **Teacher Performance Rate and Accuracy Scale**

An observation procedure on the rate of teacher instructional presentations to student(s), the response(s) of the student(s), and feedback delivered by the teacher following the response(s) of the student(s). A study conducted compared the use of a Teacher Performance Rate and Accuracy Scale (TPRA) on teacher effectiveness and student learning (Ingham & Greer, 1992). The results indicated that when the TPRA was implemented teacher effectiveness and student learning outcomes increased (Selinske, Greer, & Lodhi, 1991; Ingham & Greer, 1992; Ross, Singer-Dudek, & Greer, 2005).

19. **Token (Classroom Point)**
A stimulus used as a generalized conditioned reinforcer, that can be delivered following a behavior desired for increase, which can be exchanged for a variety of unconditioned or conditioned reinforcers (Cooper, et. al., 2007). Students in a classroom emit correct responses and engage in appropriate behaviors (i.e. raise hand, complete assignments, deliver assistance to peers) and are delivered a token or classroom point. The teacher may say, “yes, thank you for raising your hand, please give yourself a classroom point on your data sheet.” Upon students earning a predetermined number of tokens or points, student may turn in their points for a back up reinforcer such as reading a book, a snack, or a game with a peer.

20. Vocal Praise (Social Approval)

A conditioned reinforcer spoken aloud by a teacher or peer to increase a desired behavior (Greer, 2002). Students in a classroom emit correct responses and engage in appropriate behaviors (i.e. raise hand, complete assignments, deliver assistance to peers) and are delivered vocal praise. The teacher may say, “thank you for raising your hand, great job.”

21. Vicarious Reinforcement

A student observes another person emitting a behavior and receiving reinforcement upon engaging in the behavior. The student then performs the same behavior in order to gain access to reinforcement (Bandura, 1965).
Appendix B

Pictures of the Classroom Setting

![Classroom Setting Image 1](image1)

![Classroom Setting Image 2](image2)

![Classroom Setting Image 3](image3)
Appendix C

Picture of the Experimental Setting
Appendix D

Data Collection Form Used in Experiment 1 and in Experiment 2

Observer: _____________ Date: ______
Teacher/Student: __________________
LTO: ___________________________
STO: ___________________________
Elapsed Time: ____________________
Reliability: _______________________

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Student %: ___
Student Rate +: ___ Student Rate -: ___

Observer: _____________ Date: ______
Teacher/Student: __________________
LTO: ___________________________
STO: ___________________________
Elapsed Time: ____________________
Reliability: _______________________

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Teacher +: ___ Teacher -: ___ TRA: ___
Student +: ___ Student -: ___
Student %: ___
Student Rate +: ___ Student Rate -: ___
# Appendix E

## Student Data Sheet

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Appendix F

Pre-experimental Screening Assessment Used in Experiment 1

Name: _________________________________________  Date: __________________

Directions: Find the length of the arc given the formula: \( L = \frac{n^\circ}{360^\circ} \times 2\pi r \)
where: \( \pi = 3.14 \)

1. 

2. 

3. 

Diagram 1:

Diagram 2:

Diagram 3:
Directions: Calculate the compound interest given the formula: \( I = Prt \)

1. What is the compound interest on $890.00 at 12.5% for 10 years?

2. What is the compound interest on $520.00 at 17.5% for 15 years?

3. What is the compound interest on $1,200.00 at 13% for 22 years?

4. What is the compound interest on $750.00 at 15% for 8 years?

5. What is the compound interest on $2,000.00 at 10.5% for 5 years?
Directions: Solve for permutation given the formula: \( P(n, r) = \frac{n!}{(n-r)!} \)

1. A coach wants to choose 5 players from 12 different teams. How many different ways can he choose these players?

2. Nine people applied for a 7-person committee. How many ways can the jobs be the committee form?

3. Erin was asked to choose 4 paintings from a collection of 8 and hang them on a wall in a row. How many different ways could the wall be decorated?

4. Five people walk into a fast food restaurant at the same time. How many different ways can the first 3 people stand in a line?

5. A baby plays with 10 blocks numbered 1-10. How many different ways can the baby play with the first 4 blocks?
Directions: Find sine, cosine, and tangent of a triangle given the formulas:

\[
\begin{align*}
\text{sine} &= \frac{\text{opposite}}{\text{hypotenuse}} \\
\text{cosine} &= \frac{\text{adjacent}}{\text{hypotenuse}} \\
\text{tangent} &= \frac{\text{opposite}}{\text{adjacent}}
\end{align*}
\]

1. Given triangle ABC, solve for sine, cosine, and tangent of angle A.

2. Given triangle ABC, solve for sine, cosine, and tangent of angle B.

3. Given triangle ABC, solve for sine, cosine, and tangent of angle C.
4. Given triangle ABC, solve for sine, cosine, and tangent of angle A.

5. Given triangle ABC, solve for sine, cosine, and tangent of angle C.
Appendix G

An example of a learn unit presented for a correct response during the reinforcement condition for each objective presented in Experiment 1.

Objective: Find the length of an arc

1. Attention of the students is obtained.  Experimenter \( S^d \)

2. Experimenter draws a circle on the board, writes the length of the radius (12), angle measure (45), \( \pi = 3.14 \) and the formula \( L = \frac{n°}{360°} \times (2\pi)(r) \), on the board and responds by saying, “Find the length of the arc.”  Experimenter behavior  Non-target peer \( S^d \)

3. Non-target peer responds correctly.  Non-target peer behavior  Experimenter consequence  Experimenter \( S^d \)

4. Experimenter points to the equation to solve for the reflex on the non-target peer’s board and responds by saying, “Yes, (non-target peer) you subtracted the angle measure from the number of degrees in a circle in step 1, you calculated the reflex measure of the angle, “360° – 45° = 315°.”  Non-target peer consequence  Experimenter behavior

5. Completion of the learn unit.  Experimenter consequence

6. Attention of the students is obtained.  Experimenter \( S^d \)

7. Experimenter points to the formula on the non-target peer’s board to find the reflex.  Experimenter behavior  Non-target peer \( S^d \)

8. Non-target peer responds by looking at the board.  Non-target peer behavior  Experimenter consequence  Experimenter \( S^d \)

9. Experimenter responds by saying, “Yes, (non-target peer) in step 2, you inserted your numerical values into the formula, \( L = \frac{315°}{360°} \times 2(3.14)(12) \).”  Non-target peer consequence  Experimenter behavior

10. Completion of the learn unit.  Experimenter consequence

11. Attention of the student is obtained.  Experimenter \( S^d \)

12. Experimenter points to the variables in the equation on the non-target peer’s board.  Experimenter behavior  Non-target peer \( S^d \)

13. Non-target peer responds by looking at the board.  Non-target peer behavior  Experimenter consequence  Experimenter \( S^d \)

14. Experimenter responds by saying, “Yes, (non-target peer) in step 3, you began to solve by dividing your fraction, \( \frac{315°}{360°} = .875 \)”  Non-target peer consequence  Experimenter behavior
15. Completion of the learn unit.
   Experimenter consequence

16. Attention of the student is obtained.
   Experimenter $S^d$

17. Experimenter points to the equation on the non-target peer’s board in which the non-target peer solved the fraction on the board.
   Experimenter behavior
   Non-target peer $S^d$

18. Non-target peer responds by looking at the board.
   Non-target peer behavior
   Experimenter consequence
   Experimenter $S^d$

19. Experimenter responds by saying, “Yes, (non-target peer) in step 4, you multiplied the first two factors, .875 x 2 = 1.75.”
   Non-target peer consequence
   Experimenter behavior

20. Completion of the learn unit.
   Experimenter consequence

21. Attention of the student is obtained.
   Experimenter $S^d$

22. Experimenter points to the equation on the non-target peer’s board in which the non-target peer multiplied the ratio by the diameter.
   Experimenter behavior
   Non-target peer $S^d$

23. Non-target peer responds by looking at the board.
   Non-target peer behavior
   Experimenter consequence
   Experimenter $S^d$

24. Experimenter responds by saying, “Yes, (non-target peer) in step 5, you completed solving the equation by multiplying the remaining factors, 1.75 x (3.14)(12) = 65.94 cm.”
   Non-target peer consequence
   Experimenter behavior

25. Experimenter records the non-target peer’s response.

26. Completion of the learn unit.
   Experimenter consequence
Objective: Solve using permutations

1. Attention of the students is obtained. Experimenter $S^d$

2. Experimenter writes the problem, “Jason was asked to choose 4 frames from a box of 8 and hang them on the wall. How many different ways can Jason hang the frames on the wall?” And the formula, $P(n, k) = \frac{n!}{(n-k)!}$, on the board, reads the problem and responds by saying, “Solve the problem on the board.” Experimenter behavior Non-target peer $S^d$


4. Experimenter points to the equation on the non-target peer’s board and responds by saying, “Yes (non-target peer) in step 1, you replaced the variables in the given formula, $P(n, k) = \frac{n!}{(n-k)!}$, $n = 5, r = 3.$” Non-target peer consequence Experimenter behavior

5. Completion of the learn unit. Experimenter consequence

6. Attention of the students is obtained. Experimenter $S^d$

7. Experimenter points to the expanded factorial on the non-target peer’s board. Experimenter behavior Non-target peer $S^d$

8. Non-target peer responds by looking at the board. Non-target peer behavior Experimenter consequence Experimenter $S^d$

9. Experimenter responds by saying, “Yes, (non-target peer) in step 2, you expanded the factorial $5 \times 4 \times 3 \times 2 \times 1.$” Non-target peer consequence Experimenter behavior

10. Completion of the learn unit. Experimenter consequence

11. Attention of the students is obtained. Experimenter $S^d$

12. Experimenter points to the denominator on the non-target peer’s board. Experimenter behavior Non-target peer $S^d$

13. Non-target peer responds by looking at the board. Non-target peer behavior Experimenter consequence Experimenter $S^d$

14. Experimenter responds by saying, “Yes, (non-target peer) in step 3, you solved the denominator by subtracting, $5 - 3 = 2.$” Non-target peer consequence Experimenter behavior

15. Completion of the learn unit. Experimenter consequence

16. Attention of the students is obtained. Experimenter $S^d$
17. Experimenter points to the equation on the non-target peer’s board.

18. Non-target peer responds by looking at the board.

19. Experimenter responds by saying, “Yes, (non-target peer) in step 4, you simplified the fraction by crossing off the like factor, 2 in the numerator and in the denominator.”

20. Completion of the learn unit.

21. Attention of the students is obtained.

22. Experimenter points to the equation on the non-target peer’s board.

23. Non-target peer responds by looking at the board.

24. Experimenter responds by saying, “Yes, (non-target peer) in step 5, you multiplied the remaining products, $5 \times 4 \times 3 = 60.$”

25. Experimenter records the non-target peer’s response.

26. Completion of the learn unit.
Objective: Calculate interest

1. Attention of the students is obtained.  

2. Experimenter writes the problem, “What is the compound interest on $890.00 at 12.5% for 10 days?” And the formula, \( I = Prt \), on the board, reads the problem and responds by saying, “Calculate the interest.”


4. Experimenter points to the equation to convert the percent to a decimal on the non-target peer’s board and responds by saying, “Yes (non-target peer) in step 1, you converted the percent to a decimal, 12.5% converted to .125.”

5. Completion of the learn unit.

6. Attention of the students is obtained.

7. Experimenter points to the formula on the non-target peer’s board to calculate the interest.

8. Non-target peer responds by looking at the board.

9. Experimenter responds by saying, “Yes, (non-target peer) in step 2, you replaced the variables in the given formula, \( I = 890(.125)(10) \).”

10. Completion of the learn unit.

11. Attention of the students is obtained.

12. Experimenter points to the equation on the non-target peer’s board in which the non-target peer multiplied the principle times the interest.

13. Non-target peer responds by looking at the board.

14. Experimenter responds by saying, “Yes, (non-target peer) in step 3, you solved by multiplying the principle times the interest \( 890(.125) = 111.25 \).”

15. Completion of the learn unit.

16. Attention of the students is obtained.

17. Experimenter points to the equation on the non-target peer’s board in which the non-target peer added the
interest to the principle amount.

18. Non-target peer responds by looking at the board.  
Non-target peer behavior  
Experimenter consequence  
Experimenter $S^d$

19. Experimenter responds by saying, “Yes, (non-target peer) in step 4, you solved by multiplying the product times the time, $111.25 \times 10 = 1,112.5$.”  
Non-target peer consequence  
Experimenter behavior

20. Completion of the learn unit.  
Experimenter consequence

21. Attention of the students is obtained.  
Experimenter $S^d$

22. Experimenter points to the equation on the non-target peer’s board in which the student added the interest to the principle amount.  
Experimenter behavior  
Non-target peer $S^d$

23. Non-target peer responds by looking at the board.  
Non-target peer behavior  
Experimenter consequence  
Experimenter $S^d$

24. Experimenter responds by saying, “Yes, (non-target peer) in step 5, you added the interest to the principle amount $1,112.5 + 890 = 2,002.5$.”  
Non-target peer consequence

25. Experimenter records the non-target peer’s response.  
Experimenter consequence

26. Completion of the learn unit.  
Experimenter consequence
Objective: Find sine, cosine, and tangent of a triangle

1. Attention of the students is obtained. Experiment S
d

2. Experimenter draws a triangle with a length for each side (10, 5 and 8) and three equations for sine (opposite/hypotenuse), cosine (adjacent/hypotenuse), and tangent (opposite/adjacent) on the board and responds by saying, “Find sine, cosine, and tangent.”

d

4. Experimenter points to the triangle labeled sine, cosine, and tangent on the non-target peer’s board and responds by saying, “Yes, (non-target peer) in step 1, you labeled the triangle: hypotenuse, opposite, and adjacent.”

5. Completion of the learn unit. Experiment S
d

6. Attention of the students is obtained. Experiment S
d

7. Experimenter points to the formula on the non-target peer’s board required to solve for sine. Experiment S
d

8. Non-target peer responds by looking at the board. Non-target peer S
d

9. Experimenter responds by saying, “Yes, (non-target peer) in step 2, you solved for sine by dividing 10/5 = 2, opposite divided by hypotenuse.” Non-target peer S
d

10. Completion of the learn unit. Experiment S
d

11. Attention of the students is obtained. Experiment S
d

12. Experimenter points to the formula on the non-target peer’s board required to solve for cosine. Experiment S
d

13. Non-target peer responds by looking at the board. Non-target peer S
d

14. Experimenter responds by saying, “Yes, (non-target peer) in step 3, you solved for cosine by dividing 8/5 = 1.6 adjacent divided by hypotenuse.” Non-target peer S
d

15. Completion of the learn unit. Experiment S
d

16. Attention of the students is obtained. Experiment S
d

17. Experimenter points to the formula on the non-target peer’s board required to solve for tangent. Experiment S
d
18. Non-target peer responds by looking at the board.

19. Experimenter responds by saying, “Yes, (non-target peer) in step 4, you solved for tangent by dividing 10/8 = 1.25, opposite divided by adjacent.”

20. Experimenter records the non-target peer’s response.

21. *Completion of the learn unit.*

Non-target peer behavior
Experimenter consequence
Experimenter $S^d$

Non-target peer consequence

Experimenter consequence
Appendix H

*An example of a learn unit presented for an incorrect response during the correction condition for each objective presented in Experiment 1.*

**Objective: Finding the length of an arc**

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Attention of the students is obtained.</td>
</tr>
<tr>
<td>2.</td>
<td>Experimenter draws a circle on the board, writes the length of the radius (12), angle measure (45°), Pi = 3.14 and the formula, ( L = \frac{n°}{360°} \times (2)\Pi(r) ) on the board and responds by saying, “Find the length of the arc.”</td>
</tr>
<tr>
<td>4.</td>
<td>Experimenter points to the formula on the instructor board and responds by saying, “(Non-target peer) let’s review steps on the board together. Take a look at the formula, ( L = \frac{n°}{360°} \times (2)\Pi(r) ).” Experimenter points to the equation and calculates the reflex of the angle on the instructor board and responds by saying, “<strong>Step 1</strong>, let’s calculate the reflex measure of the angle and subtract the angle measure from the number of degrees in a circle, ( 360° - 45° = 315° ).”</td>
</tr>
<tr>
<td>5.</td>
<td>Non-target peer calculates the angle of the arc, ( 360° - 45° = 315° ) on his dry erase board.</td>
</tr>
<tr>
<td>6.</td>
<td><strong>Completion of the learn unit.</strong></td>
</tr>
<tr>
<td>7.</td>
<td>Attention of the students is obtained.</td>
</tr>
<tr>
<td>8.</td>
<td>Experimenter points to the formula and inserts the numerical values into the formula on the instructor board.</td>
</tr>
<tr>
<td>9.</td>
<td>Non-target peer responds by looking at the board and writes the formula, ( L = \frac{315°}{360°} \times 2(3.14)(12) ) on his dry erase board.</td>
</tr>
<tr>
<td>10.</td>
<td>Experimenter responds by saying, “<strong>Step 2</strong>, we will begin to solve. First we are going to insert the numerical values into the formula, ( L = \frac{315°}{360°} \times 2(3.14)(12) ).”</td>
</tr>
<tr>
<td>11.</td>
<td><strong>Completion of the learn unit.</strong></td>
</tr>
<tr>
<td>12.</td>
<td>Attention of the students is obtained.</td>
</tr>
<tr>
<td>13.</td>
<td>Experimenter points to the formula, divides the fraction on the instructor board and responds by saying, “<strong>Step 3</strong>, we will begin to solve by dividing our fraction ( 315°/360° = .875 ).”</td>
</tr>
</tbody>
</table>
14. Non-target peer divides the fraction 
$315^\circ/360^\circ = .875$ on his dry erase board.

15. *Completion of the learn unit.*

16. Attention of the students is obtained.

16. Experimenter points to the formula, multiplies the first
2 factors on the instructor board and responds by saying,
“**Step 4**, we are going to multiply the first 2 factors,
$.875 \times 2 = 1.75.$”

17. Non-target peer multiplies the factors
$.875 \times 2 = 1.75$ on his dry erase board.

18. *Completion of the learn unit.*

19. Attention of the students is obtained.

20. Experimenter points to the formula, multiplies the
remaining factors on the instructor board and responds
by saying, “**Step 5**, we are going to multiply the remaining
factors $1.75 \times (3.14)(12) = 65.94$ cm.”

21. Non-target peer multiplies the factors
$1.75 \times (3.14)(12) = 65.94$ cm on his dry erase board.

22. Experimenter records the Non-target peer's
response.

23. *Completion of the learn unit.*
Objective: Solve using permutations

1. Attention of the students is obtained.

2. Experimenter writes the problem, “Jason was asked to choose 4 frames from a box of 8 and hang them on the wall. How many different ways can Jason hang the frames on the wall?” And the formula, \( P(n, k) = \frac{n!}{(n-k)!} \), on the board, reads the problem and responds by saying, “Solve the problem on the board.”


4. Experimenter points to the instructor board and responds by saying, “(Non-target peer) let’s review the steps on the board together. Take a look at the formula, \( P(n, k) = \frac{n!}{(n-k)!} \) Step 1, we replace the variables in the given formula, \( P(n, k) = \frac{n!}{(n-k)!} \), \( n = 5 \) and \( r = 3 \), \( P(5, 3, ) = \frac{5!}{(5-3)!} \).”

5. Non-target peer writes down the formula \( P(5, 3) = \frac{5!}{(5-3)!} \) on his dry erase board.

6. Completion of the learn unit.

7. Attention of the students is obtained.

8. Experimenter points to the formula, replaces the variables in the formula on the instructor board.

9. Non-target peer responds by looking at the board and writes inserts the variables into the formula, \( P(n, k) = \frac{n!}{(n-k)!} \), \( n = 5 \) and \( r = 3 \), \( P(5, 3, ) = \frac{5!}{(5-3)!} \) on his dry erase board.

10. Experimenter responds by saying, “Step 1, we will begin to solve. First we are going to expand our factorial, \( 5 \times 4 \times 3 \times 2 \times 1 \).”

11. Completion of the learn unit.

12. Attention of the students is obtained.

13. Experimenter points to the formula, expands the factorial on the instructor board.

14. Non-target peer looks at the board and expands the factorials, \( 5 \times 4 \times 3 \times 2 \times 1 \) on his dry erase board.

15. Experimenter responds by saying, “Step 2, we will begin to solve. First we are going to expand our factorial, \( 5 \times 4 \times 3 \times 2 \times 1 \).”
16. *Completion of the learn unit.*

17. Attention of the students is obtained.

18. Experimenter points to the formula and subtracts the denominator on the instructor board.

19. The non-target peer responds by looking at the board and subtracts $5 - 3 = 2$ on his dry erase board.

20. The experimenter responds by saying, “**Step 3,** we solve the denominator by subtracting, $5 - 3 = 2.$”

21. *Completion of the learn unit.*

22. Attention of the students is obtained.

23. Experimenter points to the formula and simplifies the fraction by crossing off the like factor, 2 on the instructor board.

24. Non-target peer looks at the board and simplifies the fraction by crossing off the number 2 in the numerator and in the denominator on his dry erase board.

25. Experimenter responds by saying, “**Step 4,** we simplify the fraction by crossing of the like factor, 2 in the numerator and in the denominator.”

26. *Completion of the learn unit.*

27. Attention of the students is obtained.

28. Experimenter points to the formula and multiplies the remaining products on the instructor board.

29. Non-target peer responds by looking at the board and multiplies the products, $5 \times 4 \times 3 = 60$ on his dry erase board.

30. Experimenter responds by saying, “**Step 5,** we multiply the remaining products, $5 \times 4 \times 3 = 60.$”

31. Experimenter records the non-target peer’s response.

32. *Completion of the learn unit.*
Objective: Calculate interest

1. Attention of the students is obtained. Experiment S\textsuperscript{d}

2. Experimenter writes the problem, “What is the compound interest on $890.00 at 12.5% for 10 days?” And the formula, \( I = Prt, \) on the board, reads the problem and responds by saying, “Calculate the interest.” Experimenter behavior

3. Non-target peer responds incorrectly. Non-target peer S\textsuperscript{d}

4. Experimenter responds by saying, “(Non-target peer) let’s review the steps on the board together. Take a look at the formula, \( I = Prt. \)” Experimenter converts the percent to a decimal on the instructor board and responds by saying, “\textbf{Step 1}, we convert the percent to a decimal by moving the decimal over 2 places, 12.5% converts to .125.” Non-target peer consequence

5. Non-target peer converts the percent to a decimal, 12.5% converts to .125 on his dry erase board.

6. 

7. Attention of the students is obtained. Experiment S\textsuperscript{d}

8. Experimenter points to the formula and replaces the variables in the given formula on the instructor board. Non-target peer S\textsuperscript{d}

9. Non-target peer responds by looking at the board and replaces the variables in the formula, \( I = 890(.125)(10) \) on his dry erase board. Non-target peer behavior

10. The experimenter responds by saying, “\textbf{Step 2}, we are going to replace the variables in the given formula, \( I = 890(.125)(10) \)” Non-target peer consequence

11. 

12. Attention of the students is obtained. Experiment S\textsuperscript{d}

13. Experimenter points to the formula and multiplies the principle times the interest on the instructor board. Experiment S\textsuperscript{d}

14. The non-target peer responds by looking at the board and multiplies the principle times the interest, \( 890 \times .125 = 111.25 \) on his dry erase board. Non-target peer behavior

15. Experimenter responds by saying, “\textbf{Step 3}, we solve by multiplying the principle times the interest, \( 890 \times .125 = 111.25 \)” Non-target peer consequence

16. 

17. Experiment S\textsuperscript{d}
17. Attention of the students is obtained. Experimenter S^d

18. Experimenter points to the formula and multiples the principle times the time on the instructor board. Experimenter behavior
Non-target peer S^d

19. The non-target peer responds by looking at the board and multiplies the principle times the interest, $111.25 \times 10 = 1,111.25$ on his dry erase board. Non-target peer behavior
Experimenter consequence
Experimenter S^d

20. Experimenter responds by saying, “Step 4, we solve by multiplying the principle times the time in years, $111.25 \times 10 = 1,111.25$.” Non-target peer consequence
Experimenter behavior

21. Completion of the learn unit. Experimenter consequence

22. Attention of the students is obtained. Experimenter S^d

23. Experimenter points to the formula and adds the principle to the total amount on the instructor board. Experimenter behavior
Non-target peer S^d

24. Non-target peer responds by looking at the board and adds the interest to the total amount, $1,112.5 + 890 = 2,002.5$ on his dry erase board. Non-target peer behavior
Experimenter consequence
Experimenter S^d

25. Experimenter responds by saying, “Step 5, we solve by adding the interest to the total amount, $1,112.5 + 890 = 2002.5$” Non-target peer consequence
Experimenter behavior

26. The experimenter records the non-target peer’s response.

27. Completion of the learn unit. Experimenter consequence
Objectives: Find sine, cosine, and tangent of a triangle

1. Attention of the students is obtained.

2. Experimenter draws a triangle with a length for each side (10, 5, and 8) and three equations for sine (opposite/hypotenuse), cosine (adjacent/hypotenuse), and tangent (opposite/adjacent) on the board. The experimenter responds by saying, “Find sine, cosine, and tangent.”


4. Experimenter responds by saying, “(Non-target peer) let’s review the steps on the board together. Take a look at the formulas, sine = opposite/hypotenuse, cosine = adjacent/hypotenuse, and tangent = opposite/adjacent.” The experimenter points to the triangle, labels the triangle, opposite, adjacent, and hypotenuse on the instructor board, and responds by saying, “Step 1, we label the triangle opposite, adjacent, and hypotenuse.”

5. The non-target peer writes down the corrected step on his dry erase board.

6. Completion of the learn unit.

7. Attention of the student is obtained.

8. Experimenter points to the formula for sine on the instructor board and divides opposite by hypotenuse.

9. Non-target peer responds by looking at the board and writes down 10/5 = 2 on his dry erase board.

10. Experimenter responds by saying, “Step 2, we will begin to solve. First we are going to solve for sine by dividing opposite by hypotenuse, 10/5 = 2.”

11. Completion of the learn unit.

12. Attention of the student is obtained.

13. Experimenter points to the formula for cosine on the instructor board and divides adjacent by hypotenuse.

14. Non-target peer responds by looking at the board and writes down 8/5 = 1.6 on his dry erase board.

15. Experimenter responds by saying “Step 3, we will begin to solve. First we are going to solve for cosine by dividing adjacent over the hypotenuse, 8/5 = 1.6.”

Non-target peer behavior
Experimenter consequence
Experimenter S

Non-target peer behavior
Experimenter consequence
Experimenter S

Non-target peer behavior
Experimenter consequence
Experimenter S

Non-target peer behavior
Experimenter consequence
Experimenter S

Non-target peer behavior
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Non-target peer behavior
Experimenter consequence
Experimenter S

Non-target peer behavior
Experimenter consequence
Experimenter S
<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.</td>
<td><em>Completion of the learn unit.</em></td>
</tr>
<tr>
<td>17.</td>
<td>Attention of the student is obtained.</td>
</tr>
<tr>
<td>18.</td>
<td>Experimenter points to the formula for tangent on the instructor board and divides opposite by adjacent.</td>
</tr>
<tr>
<td>19.</td>
<td>Experimenter responds by saying “<strong>Step 4</strong>, we will begin to solve. First we are going to solve for tangent by dividing opposite by the adjacent, (10/8 = 1.25).”</td>
</tr>
<tr>
<td>20.</td>
<td>The non-target peer responds by looking at the board and writes down (10/8 = 1.25) on his dry erase board.</td>
</tr>
<tr>
<td>21.</td>
<td>The experimenter records the non-target peer’s response.</td>
</tr>
<tr>
<td>22.</td>
<td><em>Completion of the learn unit.</em></td>
</tr>
</tbody>
</table>
Appendix I

*Pre-experimental Screening Assessment Used in Experiment 2*

Name: _____________________________________________ Date: __________

Directions: Find the volume given the formula: \( V = \frac{1}{3} \) (area of the base) (height)

1.

![Diagram 1](image)

2.

![Diagram 2](image)

3.

![Diagram 3](image)
4.

5.
Directions: Find the slope of each line given the formula: m = \( y_2 - y_1 / x_2 - x_1 \)

1. 

2. 

3.
4.

5.
Directions: Find sine, cosine, and tangent of each triangle given the formulas:

Sine = opposite/hypotenuse

Tangent = opposite/adjacent

Cosine = adjacent/hypotenuse

1. Given triangle ABC, solve for sine, cosine, and tangent of angle A.

2. Given triangle ABC, solve for sine, cosine, and tangent of angle B.

3. Given triangle ABC, solve for sine, cosine, and tangent of angle C.
4. Given triangle ABC, solve for sine, cosine, and tangent of angle A.

5. Given triangle ABC, solve for sine, cosine, and tangent of angle C.
Directions: Solve for permutation given the formula: \( P(n, r) = \frac{n!}{(n-r)!} \)

1. A coach wants to choose 5 players from 12 different teams. How many different ways can he choose these players?

2. Nine people applied for a 7-person committee. How many ways can the jobs be the committee form?

3. Erin was asked to choose 4 paintings from a collection of 8 and hang them on a wall in a row. How many different ways could the wall be decorated?

4. Five people walk into a fast food restaurant at the same time. How many different ways can the first 3 people stand in a line?

5. A baby plays with 10 blocks numbered 1-10. How many different ways can the baby play with the first 4 blocks?
Directions: Solve.

1. \((56 \div 8) + 2 + (88 \div 4) - 1 =

2. \((5 - 3) \times (54 \div 9 \times 2 + 4) =

3. \((7 + 3 + 6) \div (48 \div 6) =

4. \(8 \times 4 + (36 \div 9) + 5 + 2 =

5. \((9 - 4) \times 56 \div 8 \times (5 - 2) =

Directions: Find the length of the arc given the formula: \( L = \frac{n^\circ}{360^\circ} \times 2\pi r \)
\( \pi = 3.14 \)

1.

2.

3.
Appendix J

An example of a learn unit presented for a correct response during the reinforcement condition for each additional objective presented in Experiment 2 that was not presented in Experiment 1.

Objective: Find the volume of a prism.

1. Attention of the students is obtained.

2. Experimenter draws a prism on the board, writes the length, width, and height of the prism, and formula, \( V = \frac{1}{3}(\text{area of base})(\text{height}) \), board and responds by saying, “Find the volume of the prism.”


4. Experimenter points to the equation to solve for the area of the base on the non-target peer’s board and responds by saying “Yes, (non-target peer) in step 1, you calculated the area of the base, multiplying base times height, \( 8 \times 7 = 56 \).”

5. Completion of the learn unit.

6. Attention of the students is obtained.

7. Experimenter points to the formula required to find the reflex on the non-target peer’s board.

8. Non-target peer responds by looking at the board.

9. The experimenter responds by saying, “Yes, (non-target peer) in step 2, you inserted your dimensions into the formula, \( V = \frac{1}{3}(56)(3) \).”

10. Completion of the learn unit.

11. Attention of the students is obtained.

12. Experimenter points to the variables in the equations on the non-target peer’s board.

13. Non-target peer responds by looking at the board.

14. Experimenter responds by saying “Yes, (non-target peer) in step 3, you multiplied the area of the base times height, \( 56 \times 3 = 168 \).”

15. Completion of the learn unit.
16. Attention of the students is obtained.

17. Experimenter points to the equation in which the non-target peer solved the fraction on the non-target peer’s board.

18. Non-target peer responds by looking at the board.

19. Experimenter responds by saying, “Yes, (non-target peer) in step 4, you multiplied 1/3 times the product of the area of the base times height, 168, 1/3 x 168 = 56.”

20. Completion of the learn unit.

21. Attention of the students is obtained.

22. Experimenter points to the equation on the non-target peer’s board in which the non-target peer multiplied the ratio by the diameter.

23. Non-target peer responds by looking at the board.

24. Experimenter responds by saying, “Yes, (non-target peer) in step 5, you cubed your answer 56^3.”

25. Experimenter records the Non-target peer’s response.

26. Completion of the learn unit.
Objective: Find the slope of a line.

1. Attention of the students is obtained. Experimenter S

2. Experimenter draws a coordinate grid and the formula, $y_2 - y_1/x_2 - x_1$, on the board and responds by saying, “Find the slope of the line.” Experimenter behavior


4. Experimenter points to the radius and the formula to solve for the diameter on the non-target peer’s board and responds by saying, “Yes, (non-target peer) in step 1, you selected data points for the ‘y’ variables, 5 and 4.” Non-target peer S

5. Completion of the learn unit. Experimenter S

6. Attention of the students is obtained. Experimenter S

7. Experimenter points to the formula required to find the reflex on the non-target peer’s board. Experimenter behavior

8. Non-target peer responds by looking at the board. Non-target peer S

9. Experimenter responds by saying, “Yes, (non-target peer) in step 2, you selected data points for the ‘x’ variables, 10 and 6.” Non-target peer S

10. Completion of the learn unit. Experimenter S

11. Attention of the students is obtained. Experimenter S

12. Experimenter points to the variables in the equation on the non-target peer’s board. Experimenter behavior

13. Non-target peer responds by looking at the board. Non-target peer S

14. Experimenter responds by saying, “Yes, (non-target peer) in step 3, you inserted the variables into the equation, $5 - 4/10 - 6$.” Non-target peer S

15. Completion of the learn unit. Experimenter S

16. Attention of the students is obtained. Experimenter S

17. Experimenter points to the equation in which the non-target peer solved the fraction on the non-target peer’s board. Experimenter behavior

Non-target peer S
18. Non-target peer responds by looking at the board. | Non-target peer behavior
Experimenter consequence
Experimenter S^d

19. Experimenter responds by saying, “Yes, (non-target peer) in **step 4**, you solved the numerator by subtracting ‘y_1 - y_2’, 5 - 4 = 1.” | Non-target peer consequence
Experimenter behavior

20. **Completion of the learn unit.** | Experimenter consequence

21. Attention of the students is obtained. | Experimenter S^d

22. Experimenter points to the equation in which the non-target peer multiplied the ratio by the diameter on the non-target peer’s board. | Non-target peer behavior
Experimenter consequence
Experimenter S^d

23. Non-target peer responds by looking at the board. | Non-target peer consequence
Experimenter behavior

24. Experimenter responds by saying, “Yes, (non-target peer) in **step 5**, you solved the denominator by subtracting ‘x_1 - x_2’, 10 - 6 = 4”.

25. Experimenter records the Non-target peer’s response. | Experimenter consequence

26. **Completion of the learn unit.** | Experimenter consequence
Objective: Solve using order of operations.

1. Attention of the students is obtained.
   Experimenter $S^d$

2. Experimenter writes the equation, $8^2 x (36/9) + 5 - 2 = \text{on the board and responds by saying, ”solve the equation.”}$
   Experimenter behavior
   Non-target peer $S^d$

3. Non-target peer responds correctly solves the equation.
   Non-target peer behavior
   Experimenter consequence
   Experimenter $S^d$

4. Experimenter points to the equation on the non-target peer’s board and responds by saying, “Yes, (non-target peer) in step 1, you solved the part of the equation that was in between the parenthesis, $36/9 = 4.$”
   Non-target peer consequence
   Experimenter behavior

5. Completion of the learn unit.
   Experimenter consequence

6. Attention of the students is obtained.
   Experimenter $S^d$

7. Experimenter points to the equation on the non-target peer’s board.
   Experimenter behavior
   Non-target peer $S^d$

8. Non-target peer responds by looking at the board.
   Non-target peer behavior
   Experimenter consequence
   Experimenter $S^d$

9. Experimenter responds by saying, “Yes, (non-target peer) in step 2, you solved for the exponents, $8^2 = 64.$”
   Non-target peer consequence
   Experimenter behavior

10. Completion of the learn unit.
    Experimenter consequence

11. Attention of the students is obtained.
    Experimenter $S^d$

12. Experimenter points to the variables in the equation on the non-target peer’s board.
    Experimenter behavior
    Non-target peer $S^d$

13. Non-target peer responds by looking at the board.
    Non-target peer behavior
    Experimenter consequence
    Experimenter $S^d$

14. Experimenter responds by saying, “Yes, (non-target peer) in step 3, you solved multiplication or division, left to right, $64 \times 4 = 256.$”
    Non-target peer consequence
    Experimenter behavior

15. Completion of the learn unit.
    Experimenter consequence

16. Attention of the students is obtained.
    Experimenter $S^d$

17. Experimenter points to the addition equation on the non-target peer’s board.
    Experimenter behavior
    Non-target peer $S^d$

18. Non-target peer responds by looking at the board.
    Non-target peer behavior
    Experimenter consequence
<table>
<thead>
<tr>
<th>Step</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.</td>
<td>Experimenter responds by saying, “Yes, (non-target peer) in step 4, you solved addition or subtraction, left to right, $256 + 5 = 261$.”</td>
</tr>
<tr>
<td>20.</td>
<td>Completion of the learn unit.</td>
</tr>
<tr>
<td>21.</td>
<td>Attention of the students is obtained.</td>
</tr>
<tr>
<td>22.</td>
<td>Experimenter points to the addition equation on the non-target peer’s board.</td>
</tr>
<tr>
<td>23.</td>
<td>Non-target peer responds by looking at the board.</td>
</tr>
<tr>
<td>24.</td>
<td>Experimenter responds by saying, “Yes, (non-target peer) in step 5, you solved addition or subtraction again, left to right, $261 - 2 = 259$.”</td>
</tr>
<tr>
<td>25.</td>
<td>Experimenter records the non-target peer’s response.</td>
</tr>
<tr>
<td>26.</td>
<td>Completion of the learn unit.</td>
</tr>
</tbody>
</table>
Appendix K

An example of a learn unit presented for an incorrect response during the correction condition for each additional objective presented in Experiment 2 that was not presented in Experiment 1.

Objective: Find the volume of a prism.

1. Attention of the students is obtained. Experimenter $S^d$
2. Experimenter draws a prism on the board, writes the length, width, and height of the prism, and formula, $V = \frac{1}{3}(\text{area of base})(\text{height})$ on the board and responds by saying, “Find the volume of the prism.” Experimenter behavior Non-target peer $S^d$
4. Experimenter points to the instructor board and responds by saying, “(Non-target peer) let’s review the steps on the board together. Take a look at the formula, $V=\frac{1}{3}(\text{area of the base})(\text{height}).$” Experimenter points to the instructor board, multiplies the base times the height to find the area, and responds by saying, **“Step 1, we find the area of the base by multiplying base times height, $8 \times 7 = 56.$”** Non-target peer consequence Experimenter behavior Non-target peer $S^d$
5. Non-target peer multiplies the base times height, $8 \times 7 = 56$ on his dry erase board. Non-target peer behavior
6. **Completion of the learn unit.** Experimenter consequence
7. Attention of the students is obtained. Experimenter $S^d$
8. Experimenter points to the instructor board and inserts the dimensions into the equation. Experimenter behavior Non-target peer $S^d$
9. The non-target peer responds by looking at the board and writes the dimensions into the formula $V = \frac{1}{3}(56)(3)$ on his dry erase board. Non-target peer behavior Experimenter consequence Experimenter $S^d$
10. Experimenter responds by saying, **“Step 2, we insert our dimensions into our formula, $V = \frac{1}{3}(56)(3).$”** Non-target peer consequence Experimenter behavior
11. **Completion of the learn unit.** Experimenter consequence
12. Attention of the students is obtained. Experimenter $S^d$
13. Experimenter points to the instructor board and multiplies the area of the base times the height. Experimenter behavior Non-target peer $S^d$
14. Non-target peer responds by looking at the board and multiplies the base times the height, $56 \times 3 = 168$ and writes the corrected steps on his dry erase board. Non-target peer behavior Experimenter consequence Experimenter $S^d$
15. Experimenter responds by saying, **“Step 3, we multiply** Non-target peer consequence
the area of the base times the height, 56 x 3 = 168.”

16. **Completion of the learn unit.**

17. Attention of the students is obtained.

18. Experimenter points to the instructor board and multiplies the area and 1/3.

19. Non-target peer responds by looking at the board and multiplies the product of the base times the height, 168 times 1/3 and writes the corrected step on his dry erase board.

20. Experimenter responds by saying, **“Step 4, we multiply the area 168 times 1/3.”**

21. **Completion of the learn unit.**

22. Attention of the students is obtained.

23. Experimenter points to the instructor board and cubes the answer.

24. Non-target peer responds by looking at the board and cubes his answer 56, and writes the corrected step on his dry erase board.

25. Experimenter responds by saying, **“Step 5, we cubed our answer, 56.”**

26. The experimenter records the non-target peer’s response.

27. **Completion of the learn unit.**
Objective: Find the slope of a line.

1. Attention of the students is obtained. Experimenter S\textsuperscript{d}

2. Experimenter draws a coordinate grid, a line on the coordinate grid, and the formula, \(y_2-y_1/x_2-x_1\) on the board and responds by saying, “Find the slope of the line.” Experimenter behavior Non-target peer S\textsuperscript{d}

3. Non-target peer responds incorrectly. Non-target peer behavior Experimenter S\textsuperscript{d}

4. Experimenter responds by saying, “(Non-target peer) let’s review the steps on the board together. Take a look at the formula, \(y_2-y_1/x_2-x_1\).” Experimenter points to the line on the coordinate grid on the instructor board, selects the ‘y’ data points, and responds by saying, “\textbf{Step 1}, select the data points for the ‘y’ variables, 5 and 4.” Non-target peer consequence Experimenter behavior Non-target peer S\textsuperscript{d}

5. The non-target peer writes the correct ‘y’ variables on his dry erase board. Experimenter consequence

6. \textit{Completion of the learn unit.} Experimenter S\textsuperscript{d}

7. Attention of the students is obtained. Experimenter S\textsuperscript{d}

8. Experimenter points to the line on the coordinate grid on the instructor board and selects the data points for the ‘x’ variables. Experimenter behavior Non-target peer S\textsuperscript{d}

9. Non-target peer responds by looking at the board and writes the correct ‘x’ variables on his dry erase board. Non-target peer behavior Experimenter S\textsuperscript{d}

10. Experimenter responds by saying, “\textbf{Step 2}, select the data points for the ‘x’ variables, 10 and 6”. Non-target peer consequence Experimenter behavior

11. \textit{Completion of the learn unit.} Experimenter S\textsuperscript{d}

12. Attention of the students is obtained. Experimenter S\textsuperscript{d}

13. Experimenter points to the selected ‘x’ and ‘y’ variables on the instructor board and inserts the variables into the equation. Experimenter behavior Non-target peer S\textsuperscript{d}

14. Non-target peer responds by looking at the board and inserts the variables into the equation on his dry erase board. Non-target peer behavior Experimenter S\textsuperscript{d}

15. Experimenter responds by saying, “\textbf{Step 3}, insert the selected ‘x’ and ‘y’ variables into the equation.” Non-target peer consequence Experimenter behavior

16. \textit{Completion of the learn unit.} Experimenter S\textsuperscript{d}
17. Attention of the students is obtained.

18. Experimenter points to the instructor board and solves the numerator by subtracting $5 - 4 = 1$.

19. The non-target peer responds by looking at the board and subtracts the ‘$y$’ variables, $5 - 4 = 1$ on his dry erase board.

20. Experimenter responds by saying “**Step 4**, solve the numerator by subtracting $y_2 - y_1$, $5 - 4 = 1$”

21. *Completion of the learn unit.*

22. Attention of the students is obtained.

23. Experimenter points to the instructor board and solves the denominator by subtracting $10 - 6 = 4$.

24. Non-target peer responds by looking at the board and subtracts the ‘$x$’ variables, $10 - 6 = 4$ on his dry erase board.

25. Experimenter responds by saying, “**Step 5**, solve the denominator by subtracting $x_2 - x_1$, $10 - 6 = 4$.”

26. The experimenter records the non-target peer’s response.

27. *Completion of the learn unit.*
Objective: Solve using order of operations.

1. Attention of the students is obtained. Experimenter S

2. Experimenter writes the equation, \(8^2 \times (36/9) + 5 \times -2 = \) on the board, reads the problem and responds by saying, “Solve the equation.” Experimenter behavior Non-target peer S


4. Experimenter points to the algorithm on the instructor board and, responds by saying, “(Non-target peer) let’s review the steps on the board together. Take a look at the algorithm, we solve using PEMDAS, first parentheses, second exponents, third and fourth multiplication and division, left to right and finally addition and subtraction, left to right.” Experimenter points to the parenthesis on the instructor board, solves 36/9 = 4, and responds by saying, “**Step 1**, we solve the part of the equation between the parenthesis, 36/9 = 4.” Non-target peer consequence Experimenter behavior Non-target peer S

5. Non-target peer divides 36/9 = 4 on his dry erase board. Non-target peer behavior

6. **Completion of the learn unit.** Experimenter consequence

7. Attention of the students is obtained. Experimenter S

8. Experimenter points to the exponents on the instructor board and solves \(8^2 = 64\). Experimenter behavior Non-target peer S

9. Non-target peer responds by looking at the board and solves \(8^2 = 64\) on his dry erase board. Non-target peer behavior Experimenter consequence Experimenter S

10. Experimenter responds by saying, “**Step 2**, we solve for exponents, \(8^2 = 64\).” Non-target peer consequence Experimenter behavior

11. **Completion of the learn unit.** Experimenter consequence

12. Attention of the students is obtained. Experimenter S

13. Experimenter points to the multiplication problem on the instructor board and solves 64 x 4 = 256. Experimenter behavior Non-target peer S

14. Non-target peer responds by looking at the board and multiplies 64 x 4 = 256 on his dry erase board. Non-target peer behavior Experimenter consequence Experimenter S

15. Experimenter responds by saying, “**Step 3**, we solve multiplication and division left to right 64 x 4 = 256.” Non-target peer consequence Experimenter behavior

16. **Completion of the learn unit.** Experimenter consequence
17. Attention of the students is obtained.

18. Experimenter points to the addition problem on the instructor board and adds 256 + 5 = 261.

19. Non-target peer responds by looking at the board and adds 256 + 5 = 261 on his dry erase board.

20. Experimenter responds by saying, “Step 4, we solve for addition and subtraction left to right 256 + 5 = 261.”

21. Completion of the learn unit.

22. Attention of the students is obtained.

23. Experimenter points to the addition equation on the instructor board and subtracts 261 – 2 = 259.

24. Non-target peer responds by looking at the board and subtracts 261 – 2 = 259 on his dry erase board.

25. Experimenter responds by saying, “Step 5, we solve addition or subtraction again, left to right, 261 – 2 = 259.”

26. Experimenter records the non-target peer’s response.

27. Completion of the learn unit.