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The Effects of Peer Mediated Instruction to Teach Math Skills to Middle School Students

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THE EFFECTS OF PEER MEDIATED INSTRUCTION TO TEACH MATH SKILLS TO MIDDLE SCHOOL STUDENTS

THESIS

A thesis submitted in partial fulfillment of the
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By

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ABSTRACT OF THESIS

THE EFFECTS OF PEER MEDIATED INSTRUCTION TO TEACH MATH SKILLS TO MIDDLE SCHOOL STUDENTS

The purpose of this study was to determine if there was a functional relation between a peer-delivered modified system of least prompts procedure (SLP) and an increase in level and trend of performance on finding the area of polygons or finding the volume of cylinders, spheres, and cones, and could the peer tutor reliably implement the modified SLP procedure with middle school students with mild to severe disabilities. A multiple probe days across participants design was used. Results from this study show that there was a functional relation across students in which students were able to make progress on academic math skills when taught by a peer tutor using the modified SLP procedure. The peer tutor was able to reliably implement the procedure to multiple students. Limitations and implications for practice are discussed.

KEYWORDS: Mild and severe disabilities, system of least prompts, peer mediated instruction, academic math skills, middle school

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Section 1: Introduction

Peer tutoring can be an effective way to teach students with moderate and severe disabilities (MSD) academic, functional, and social skills. Peer tutoring is a method in which a student provides instruction to another student by implementing a structured, pre-developed strategy provided by the classroom teacher. The term "peer tutor" may consist of different types of students tutoring other students in various settings, including students with disabilities serving as the peer tutors to other students with disabilities (Telecsan, Slaton, & Stevens, 1999; Utley et al., 2001), students without disabilities serving as the peer tutors to students with disabilities in a self-contained environment (Collins, Branson, & Hall, 1995; Godsey, Schuster, Lingo, Collins & Kleinert, 2008; Miracle, Collins, Schuster, & Grisham-Brown, 2001; Tekin-Iftar, 2003), students without disabilities serving as the peer tutors to students with disabilities in a general classroom setting (Collins, Branson, Hall, & Rankin, 2001; Gilberts, Agran, Hughes, & Wehmeyer, 2001; Hudson, Browder, & Jimenez, 2014; Jimenez, Browder, Spooner, & Dibiase, 2012; Wolery, Werts, Snyder, & Caldwell, 1994), class wide peer tutoring (CWPT) in which peers with or without disabilities tutor one another (Hughes & Fredrick, 2006, Utley et al., 2001), and a non-disabled sibling serving as a tutor to a sibling with a disability (Tekin & Kircaali-Iftar, 2002). In a search of the literature from 1990-2014, 13 research studies were identified that used peer tutoring to teach students with disabilities using a variety of procedures. A search of literature was conducted through EBSCO host, ERIC, and Google Scholar using a combination of the following keywords: *peer tutoring*, *peer teaching*, *peer-delivered instruction*, *peer support*, *constant time delay*, *chained tasks*, *disabilities*, *and moderate and severe disabilities*. The search resulted in full text articles

from the years 1994-2014. Thirteen single subject research studies included in this review contained (a) response prompting procedures; (b) peer tutoring; (c) CWPT; (d) high rates of procedural fidelity; (e) students with learning disabilities; (f) mild, moderate, or severe disabilities; and/or (g) results showing social or academic progress made as a result of peer tutoring.

The constant time delay (CTD) procedure was implemented the most frequently to teach students with moderate and severe disabilities or learning disabilities. According to Wolery et al. (1994), CTD is a near-errorless teaching strategy that systematically transfers stimulus control from a prompt to the natural discriminative stimulus. After the delivery of the task direction, a controlling prompt is provided to ensure that the student will respond correctly. The controlling prompt is then faded by inserting a predetermined time interval. Constant time delay is generally easy to implement, results in low student error rate, and requires little teacher preparation time (Stevens & Schuster, 1988). In addition, it allows for frequent opportunities for students to respond, provides learners with instructive feedback, and fades a controlling prompt (Telecsan et al., 1999). Researchers have taught a variety of both academic (Collins et al., 2001; Gilberts et al., 2001; Hudson et al., 2014; Hughes and Fredrick, 2006; Jimenez et al., 2012; Miracle et al., 2001; Tekin & Kircaali-Iftar, 2002; Telecsan et al., 1999; Utley et al., 2001; Wolery et al., 1994) and functional skills (Collins et al., 1995; Godsey et al., 2008; Tekin-Iftar, 2003) through the use of peer tutoring and the CTD procedure.

Constant time delay was used in four studies to teach discrete academic skills including: teaching sight words and spelling in an inclusive setting (Wolery et al., 1994), sight word identification in a self-contained classroom (Miracle et al., 2001), written

spelling words in a resource room (Telecsan et al., 1999), and science vocabulary, with the use of a graphic organizer, to teach science concepts in an inclusive science classroom (Jimenez et al., 2012) to students with moderate and severe disabilities. Constant time delay also was used in conjunction with the simultaneous prompting (SP) procedure to teach students with mild and moderate disabilities animal identification in a 1:1 setting (Tekin & Kircaali-Iftar, 2002). In one study, peers implemented CTD during CWPT to teach students with learning disabilities vocabulary words and their definitions in an inclusive setting (Hughes & Fredrick, 2006).

Wolery et al. (1994) used 13 typically developing peer tutors and the CTD procedure to teach three students with moderate to severe disabilities sight word reading and spelling in two inclusive classrooms. Results indicated that it was effective for peers to implement the CTD procedure to teach students the targeted skills. Peers implemented the procedure with a high degree of procedural fidelity. Similarly, Miracle et al. (2001) and Telecsan et al. (1999) conducted studies in which peers implemented the CTD procedure to teach sight words and written spelling words, respectively. Miracle et al. examined the differential effectiveness of peer implementation of the CTD procedure versus teacher implementation of the procedure to teach 4 high school students with MSD to read sight words. Five peer tutors without disabilities implemented the procedure to teach sight words to the students. Alternatively, the teacher implemented the same procedure with students using a different set of sight words. Results indicated that, while both peer and teacher delivered instruction were effective, teacher delivered instruction was slightly more efficient. This could have been possible due to the amount of experience the teacher had administering the procedure compared to the amount of the

peers' experience. Different teaching styles also were documented in this study, which may have affected the results. However, peers were able to administer the procedure with a high degree of procedural fidelity, and the students were able to reach criterion with peer-delivered instruction. Telecsan et al. implemented a study similar to those conducted by Wolery et al. and Miracle et al. in that it involved peers using the CTD procedure to teach other students written spelling words. However, this study involved 6 students with learning disabilities working with one another using the CTD procedure. Prior to intervention, the classroom teacher taught a seven-step procedure to learn CTD. Students were required to meet criterion using the procedure before intervention began. Results showed that students with learning disabilities were able to learn the CTD procedure and effectively implement the procedure with one another to teach and learn written spelling words. A high degree of procedural fidelity was maintained. Most importantly, this study showed that it is possible for peers with disabilities to effectively learn and implement learning strategies with other peers with disabilities. The last study reviewed that specifically addressed an academic discrete task, sight word vocabulary, CTD, and peer tutoring was conducted by Jimenez et al. (2012). In this study, CTD was embedded by non-disabled peers into an inquiry-based science lesson to teach students with moderate and severe disabilities to use a KWHL chart, learn science vocabulary words and science pictures, match words to pictures, and learn two science concept statements. Six students without disabilities served as peer tutors to students with moderate disabilities in a sixth grade inclusive science class. Results showed that students with disabilities were able to learn the targeted science content as a direct result of the embedded CTD procedures implemented by non-disabled peers. Peers attended a

1-hour training session prior to instruction. All peers were able to implement the procedure with a high degree of procedural reliability.

Two additional studies used the CTD procedure to teach academic skills including animal identification (Tekin & Kircaali-Iftar, 2002) and vocabulary words (Hughes & Fredrick, 2006). These studies differ from the aforementioned studies in that they both attempted to combine the CTD procedure with additional procedures or strategies. Tekin and Kircaali-Iftar (2002) compared the effectiveness and efficiency of two procedures, the CTD procedure and the SP procedure to teach animal identification to students with mild to moderate intellectual disabilities. Another difference in this study was that the peer tutors in this study were actually the non-disabled siblings of the tutees. Results showed that, in comparing the use of these two response prompting procedures, both were equally effective in teaching the targeted skill; however, SP was more efficient in terms of percentage of errors and CTD was more efficient in number of sessions to criterion. The sibling peers were able to implement both strategies with high rates of procedural fidelity. At the conclusion of the study, siblings indicated that they enjoyed being peer tutors and enjoyed the interactions that developed during the study. In a study by Hughes and Fredrick (2006), researchers combined the CWPT with the CTD procedure to teach students with and without disabilities vocabulary words and their definitions. Class wide peer tutoring allowed all members of the class to work in pairs and form two teams (Hughes & Fredrick, 2006). This study included three students with learning disabilities and 16 students without disabilities. The study took place in an inclusive sixth grade language arts class. With the CWPT procedure, students were paired into groups of two, and in one case, a group of three due to an odd number of

students. Teams were formed by pairing students with strong academic skills with students with weaker academic skills. Students with learning disabilities were not paired up with one another. Before intervention began, all students received training on the peer tutoring program and the CTD procedure. Upon intervention, procedures were implemented by students with disabilities and without disabilities with a high degree of treatment integrity. Results showed that all students were able to correctly implement the procedure to peers. Both students with disabilities and without disabilities were able to learn the vocabulary words through the use of peer-mediated instruction and CTD. Two out of the three students with learning disabilities were able to master three sets of words and maintain that knowledge over time. At the end of the study, all peers indicated that they enjoyed using the CTD procedure as well as the CWPT method. In a social validity survey at the end of the study, students indicated that they learned more when using the CWPT method than during traditional instruction.

Functional skills were also taught through the use of peer-directed instruction and the CTD procedure. Collins et al. (1995) taught 26 peer tutors at the high school level to use the CTD procedure to teach four students with moderate disabilities to read labels of cooking products. Students were taught to locate the word on the package, read the word, and were provided incidental information by the peer at the end of each trial. While all students knew at least some of the words during baseline, students were able to increase their ability to read and define words located on cooking products as well as generalize the skill to new brands. Peers were able to implement the CTD procedure, but did have procedural errors in delivery of praise after correct responses. In addition, researchers noted that social relationships developed between the peers and students. Godsey et al.

(2008) also used peer tutoring and CTD to teach a functional skill. Students were taught by peers to prepare foods using picture recipes. This study was noteworthy because it was one of two studies found involving peer tutors teaching a chained task. Most of the studies that have been conducted with peer tutors involved teaching discrete tasks that are academic or functional. In Godsey et al., 11 peer tutors without disabilities worked with 4 students with moderate to severe disabilities. Each student with a disability was paired with two non-disabled peers. During each session, one peer tutor acted as the instructor and one peer tutor collected the data. Peers implemented the CTD procedure to teach students to prepare a meal using a picture recipe. Results showed that the CTD procedure was effective for peers to teach a chained task to students with disabilities. Peers maintained a high rate of procedural fidelity. While the students in this study were able to implement the procedure with a high rate of fidelity, teachers or researchers may be hesitant to use peer tutors to teach chained tasks because chained tasks are more complex and could compromise procedural fidelity.

Another response prompting procedure used in conjunction with peer tutoring was the system of least prompts (SLP). This procedure allows "the learner to perform a behavior independently, before delivering prompts, starting with the least intrusive prompt, and working through a hierarchy from least to most intrusive until the learner can perform the response correctly and independently" (Collins, 2012, p. 40). Two studies involved the use of peer tutors using SLP to teach academic skills to students with moderate to severe disabilities including teaching students to write personal letters (Collins et al., 2001) and teaching correct comprehension responses (Hudson et al., 2014).

Collins et al. (2001) used peer tutors to teach a chained academic task; however, it was the only study to date that included peer tutors teaching a chained academic skill using the SLP procedure. Within this study, four students without disabilities at the secondary level taught students with moderate to severe disabilities to write letters within a general education composition class. Peers assisted students with spelling while the teacher used the SLP procedure to assist students in writing letters. Throughout the study, researchers found that students were spending too much time waiting for the teacher to provide assistance. Therefore, peers were trained to deliver prompts to the student using the SLP procedure. Results from this study found that students were able to reach criterion for writing letters and peers were able to effectively implement the SLP procedure. Peers and the teacher were able to implement the procedure with an acceptable rate of procedural fidelity, although there were early sessions in which the peer delivered the prompt rather than waiting for the teacher to deliver the initial prompt and the peer failed to consistently deliver praise for all correct responses. A more recent study conducted by Hudson et al. (2014) involved peers using the SLP procedure to help elementary students answer comprehension questions about an adapted grade-level science read-aloud using a response board. Students also were taught to self-monitor their independent correct responses. Three students with moderate intellectual disabilities and two peer tutors from a general education class participated in the study. Additionally, all fourth grade science students were offered an opportunity to complete a survey before and after the study. Results found that students were able to improve their independent listening comprehension responses, self-monitor their responses, and determine the amount of support needed from their peers. Peers also were able to

implement the SLP procedure reliably into the general education classroom activities. Peers indicated they enjoyed peer tutoring and other students indicated that they were more likely to interact students with disabilities.

In this search of the literature, one study was found to have utilized peer tutoring with the response prompting procedure, simultaneous prompting to teach discrete functional skills. "The SP procedure uses a 0-second delay interval only until learners reach criterion; there is no increase in the delay interval across sessions" (Collins, 2012, p. 58). This study involved peers implementing SP to teach students to read community signs (Tekin-Iftar, 2003). In this study, four non-disabled peers worked with four peers with moderate and severe disabilities. The targeted skill was taught 1:1 in a counselor's office. Results indicated that SP administered by peer tutors was effective in teaching students with moderate and severe disabilities to read community signs. Peers were able to implement the procedure with a high degree of fidelity. Both peers and tutees enjoyed the study.

One study used a non-specified response prompting procedure to teach body parts and functions to students in a self-contained classroom (Utley et al., 2001). Utley et al. (2001) conducted a study involving five students, all with developmental disabilities, implementing a response prompting procedure to teach safety facts to each other. Targeted skills in this study included body parts, body functions, poisons, drugs and their effects, and dangerous situations. Students reciprocally taught each other within a self-contained classroom using CWPT. Results of this study showed it was effective for peers to implement the procedure to learn body parts and functions. Students implemented the procedure with a high rate of procedural fidelity. In addition, students showed greater

pre-to post-test gains during the CWPT condition than during a traditional teaching method.

Last, students were taught to self-monitor academic survival skills in the general education classroom (Gilberts et al., 2001). This study involved five non-disabled peers teaching self-monitoring strategies to five students with severe disabilities in a general classroom setting (Gilberts et al., 2001). Students taught peers to self-monitor what were considered academic classroom survival skills. These skills were chosen based on level of importance and were skills that teachers believed promoted classroom participation. According to the authors, survival skills included items such as being in seat when the bell rings or having materials prepared. Results showed an increase in occurrence of survival skills and class participation for students with disabilities.

Each of these studies adds to the literature demonstrating the effectiveness of peer tutoring. Peer tutoring can be beneficial to the peer without disabilities, the peer with disabilities, and the teacher. Several studies discussed the positive effects of peer tutoring on the behaviors and attitudes of the students with disabilities (Collins et al., 2001; Gilberts et al., 2001; Godsey et al., 2008). Peer tutor instruction may be preferable to students with disabilities because it may be perceived as more enjoyable and less stigmatizing than instruction from an adult, especially if it is paired with opportunities to develop social relationships (Godsey et al., 2008). Students in this population may have less natural opportunities to develop social relationships when compared to their same age peers. Peer tutoring could be an enjoyable, educational and social experience for both the peer tutor and the tutee and might be an opportunity for a friendship to form that might not have otherwise formed. Several studies discussed the enjoyment of students

with and without disabilities participating in peer tutoring programs (Godsey et al., 2008; Hughes & Fredrick, 2006; Tekin-Iftar, 2003; Tekin & Kircaali-Iftar, 2002; Utley et al., 2001) and also noted their increased focused behavior (Hughes & Fredrick, 2006). In addition, peer tutors without disabilities may be highly motivating for students with disabilities. Students with disabilities may be more eager to work with a peer tutor than an adult teacher (Gilberts et al., 2001). Peer tutoring also can be a benefit to teachers as well. In the Godsey et al. (2008) study, results showed the importance and value of peer tutors being used to deliver instruction. It is difficult for teachers to meet the individual needs of all students, especially in a general education classroom setting. The involvement of peer tutors to teach students certain skills can take demands off of teachers and open them up for other opportunities (Gilberts et al., 2001; Godsey et al., 2008).

While there are many advantages to peer tutoring, some studies suggested cautions about using peer tutors. Jimenez et al. (2012) warned against relying solely on peer-delivered instruction. If some students fall behind or are not learning the material at the same pace as others, then the teacher might have to provide additional support that the peer tutor would not be able to provide. The studies presented in this literature review demonstrated that all peer tutors were able to implement procedures with high degrees of procedural reliability; however, high rates of procedural reliability may not always be the case. Differences in peer delivery of instruction and teacher delivery of instruction may affect delivery of the teaching procedure to the students. In addition, peer tutors may not be naturally as relaxed or as fluent as the classroom teacher when administering instruction (Miracle et al., 2001).

According to the review of the literature evaluating the effects of peer tutoring, one variable that could make peer tutoring more effective would be peer tutor training (Stenhoff & Lignugaris/Kraft, 2007). Stenhoff and Lignugaris/Kraft stated that "teachers should train peer tutors to implement instructional methods (e.g., delivering praise, error corrections, monitoring tutee progress) while tutoring and, in future studies should report the training provided in combination with tutor training, teachers should monitor tutors' behaviors while they are tutoring to correct and reinforce the behaviors that were taught to tutors during training" (2007, p. 27). Of the studies reviewed in the current literature review, all of the students in a peer tutor role received some form of training; however, training sessions were conducted differently in each study and some were not described in as much detail as others. In studies where procedural reliability did not reach 100%, it was typically due to errors in which the peer tutor did not provide descriptive verbal praise after correct responses (Godsey et al., 2008). Researchers should be more diligent in ensuring appropriate and consistent tutoring and follow-up for peer tutors who are providing instruction to students with moderate and severe disabilities.

This review of literature shows a variety of skills and locations in which peer tutoring can be used. Teachers can use peer tutors to teach academic, functional, or social skills to students with moderate and severe disabilities. Learning environments may include the general education classroom, a self-contained classroom, a one-on-one setting in the home, or in a more natural setting. A majority of the studies in this review focused on teaching discrete academic or functional skills. A very limited number of studies exist that include peers teaching chained academic tasks. Peer tutors can be students with disabilities or students without disabilities. Research has shown that

students with and without disabilities can be taught how to implement response prompting procedures to teach a variety of skills. The literature suggests that students without disabilities who tutor students with disabilities have increased expectations of students with disabilities and are more aware of the needs of people with disabilities (Copeland et al., 2004). Advantages for students with disabilities interacting with peers include improved behavior, an increase in social interactions, and an increase in classroom participation. Teachers can benefit from the use of peer tutors as well by freeing up instructional time for teachers, allowing them to provide more individualized instruction time for other students. One thing that can be improved upon is ensuring that peers are receiving appropriate training and that those skills are being maintained throughout the studies. In order to ensure peer tutors are implementing procedures correctly, teachers need to provide appropriate training in addition to follow up training to monitor peer tutors delivery of instruction. Future research is needed in the areas of peer tutor training, peer tutors teaching using a variety of procedures, and teaching a variety of skills including chained tasks with academic skills.

Section 2: Research Question

The literature lacks adequate research in the area of the use of peer tutors to teach chained academic tasks. This study investigated whether or not a modified SLP procedure was an effective strategy to teach academic tasks to students with disabilities and whether peer tutors without disabilities were able to reliably implement this procedure when teaching students with disabilities.

This study attempted to answer the following research questions:

1. *Experimental Question:* Is there a functional relation between a peer-delivered modified system of least prompts procedure and an increase in level and trend of performance on finding the area of polygons or finding the volume of cylinders, spheres, and cones with middle school students with mild to severe disabilities?
2. *Descriptive Question:* Can a peer tutor reliably implement the modified SLP procedure when teaching middle school students with mild to severe disabilities to find the area of polygons or to find the volume of cylinders, spheres, and cones?

Section 3: Method

Participants

Students with disabilities. Four participants with mild to severe disabilities participated in this study. Requirements for participating in this study included infrequent absences, parent permission to participate in the study, and student assent. At least one of the students in the study had previously been taught a math skill through peer mediated instruction using the SLP prompting procedure within this classroom setting. All students were able to use a calculator, write numerical answers independently or choose answers using a multiple choice format. Specific academic skills chosen for this study were based on standards that students are assessed on for the Kentucky Alternate Assessment Program (Alternate K-PREP). Students chosen for this study were sixth and eighth graders, ranging in age from 11-14 years. All students in this study received services in the special education classroom for students with moderate to severe disabilities. Students participated in reading, writing, and math instruction in the special education classroom and participated in inclusive classroom settings for social studies, science, and two elective classes. Students also received instruction within the community setting. Some students had worked with various peer tutors for 2 years prior to the beginning of the study and some students have worked with the peers for only a few weeks prior to the study.

John was a 14-year-old male student in the eighth grade with a mild mental disability. He received special education services within the self-contained classroom for approximately 40% of his school day. He was social with peers within the resource classroom and outside of the resource classroom. He was able to maintain friendships

with peers outside of the classroom. His strengths were in the areas of math and reading. He was able to solve basic addition and subtraction problems without a calculator and was working on solving multi-digit addition or subtraction problems with regrouping, without a calculator. He was quick to learn more advanced math problems involving algebra or geometry when the problems are task analyzed and he received verbal or model prompting and had the opportunity for repeated practice. He was able to count money and was working on telling time using an analog clock. He was able to read basic sight words within a text and small, simple reading passages. He was able to answer basic recall questions and could summarize small reading passages. He had difficulty writing about a topic and using correct letter formation and size when writing. He worked best 1:1 or in a small group setting. Results of the *Woodcock-Johnson Tests of Achievement – 3rd Edition* (WJ-III Ach.) completed in 2012 indicated John's overall scores in the areas of basic reading, reading fluency, math calculation, math reasoning, math fluency and written expression all fell in the low-very low range. In 2009, he was assessed using the *Wechsler Intelligence Scale for Children – Fourth Edition* (WISC-IV) and obtained a full Scale IQ of 62.

Mary was a 14-year-old female student in the eighth grade with a mild mental disability, the Kentucky classification for Mild Intellectual Disability. She received services in the self-contained classroom for approximately 40% of her school day. She was a shy student and required prompting to engage in social interactions. Her strengths were in the areas of reading and math. She could read fluently, but had difficulty with comprehending or summarizing passages she had just read. In the area of math, she was able to independently solve multi-digit addition and subtraction problems, with

regrouping, without a calculator. She was able to count money and tell time using an analog clock. She was able to solve more complex problems involving algebra or geometry when the problems were task analyzed or when she received verbal or model prompting and repeated practice. Mary worked best 1:1 or in a small group setting. Results of the *Wechsler Intelligence Scale for Children – Fourth Edition* (WISC-IV), administered in 2012 indicated that she obtained a full scale IQ of 55 and fell in the extremely low range.

Joseph was a14-year-old male student in the eighth grade with a functional mental disability. He received special education services in the self-contained classroom for 100% of his school day. He was non-verbal and used some sign language, gestures, and pictures to communicate his wants and needs. His receptive communication was more advanced than his expressive communication. He was able to follow 1-2 step directions with little to no prompting and enjoyed social interaction with peers and adults. He was able to point to basic sight words on an index card, sign basic sight words, count with 1:1 correspondence, identify numbers, shapes and colors, and solve basic addition and subtraction problems on a calculator, with prompting. He required hand over hand assistance to write his name. He was able to make a choice by pointing to an answer when presented with a multiple choice question. No formal academic standardized testing was able to be conducted with Joseph. Results of the *Vineland Adaptive Behavior Scales – 2nd Edition* completed in 2008 showed his adaptive skills in the areas of communication, daily living, and socialization were all in the low range. In 2009, the *Gilliam Autism Rating Scale* (GARS) indicated his ratings resulted in an Autism Quotient of 118 (89th percentile).

Tyler was a 12-year-old male student in the sixth grade with a mild mental disability. He was social with peers and adults within the resource classroom and outside of the classroom. His strengths were in the areas of social interaction and reading with picture supported text. He was unable to consistently recognize numbers, letters, basic sight words, coins, and coin values. He was able to solve basic one digit addition or subtraction problems with a calculator. He required multiple prompts to solve more complex math problems involving algebra or geometry. He spent approximately 50% of his school day in the special education classroom and 50% of his day in general education science, social studies, art, and gym with support from an instructional assistant. He worked best in small group instruction or 1:1 with an adult or peer. Results of the *Woodcock-Johnson Tests of Achievement – 4th Edition* (WJ-IV Achievement), administered in 2014 showed significant deficits in reading, writing, and math, with standard scores at or below the 1st percentile. Results of the *Adaptive Behavior Assessment System – 2nd Edition* (ABAS – 2nd Edition) indicated a General Adaptive Composite score of 59. In 2011, he was assessed using the *Wechsler Intelligence Scale for Children – Fourth Edition* (WISC-IV) and obtained a full scale IQ of 40.

Students without disabilities. One eighth grade student without disabilities was selected by the classroom teacher to be a peer tutor for this study for sixth, seventh, and eighth grade students with disabilities. The peer was enrolled in the gifted and talented program and had prior experience with implementing SLP to teach a math skill to a student with a disability. Requirements for the peer tutor to participate in the study included passing grades in all classes, an interest in participation, parent permission to

participate in the study, and infrequent absences throughout the school year, as well as completing and passing three training sessions prior to the study.

Setting and Materials

This study took place in a middle school special education classroom in a rural school district in central Kentucky. The peer tutor implemented instruction and collected data, one-on-one, at least once per day, with each student. Sessions were conducted at a kidney shaped desk in the back of the classroom. Other students worked on assigned tasks with the instructional assistants in the front of the room.

Materials used during this study for students John and Mary included a set of nine individual worksheets which consisted of three worksheets for each shape: cone, cylinder, and sphere (see Appendix A). Materials for Tyler included a set of nine individual work sheets (see Appendix B). Additional materials for each student included a corresponding data sheet for each student (see Appendix C and Appendix D), a scientific calculator for the eighth grade students, a basic calculator for the sixth grade student, a cue card with formulas for John and Mary (see Appendix E), and pencils. Materials used during this study for Joseph included two separate worksheets with Velcro manipulatives including answer choices and a 'box' (see Appendix F), cue cards with formulas and Velcro manipulatives (see Appendix G), a scientific calculator, and data sheets (see Appendix H). The student at the sixth grade level found the area of polygons by composing them into rectangles or decomposing them into other shapes in the context of solving real-world problems. Specifically, the student was given a word problem with a diagram and asked to determine the total area of the shapes in the word problem. The task analysis for the sixth grade student contained 22 steps. Students at the eighth grade

level solved real-world problems involving cylinders and spheres when presented with a volume formula. Specifically, they were given a word problem with a diagram and asked to find the volume of the shape in the word problem. The peer tutor was provided with the appropriate task analyses for each student. For students John and Mary, the task analyses for finding the volume of a sphere and a cylinder contained 10 steps and 9 steps, respectively. For Joseph, the task analyses for finding the volume of a sphere and a cylinder contained 20 and 15 steps, respectively. Generalization worksheets were formatted the same for the eighth grade students, however, they contained a cone shape (see Appendix I). The task analysis for the cone was the same as the task analysis for the sphere (see Appendix J).

Data Collection

Data were collected on a separate data sheet for each student. Sample data sheets can be found in Appendices C, D, and H. The prompt hierarchy for this study included (I) independent response, (V) verbal prompt, (M) model prompt, and (P) physical prompt. The peer tutor recorded the least intrusive prompt needed to complete each step of the task analysis. Possible student responses included correct response, incorrect response, or no response. A correct response was defined as the student independently completing the step correctly after the peer delivered the specific task direction. An incorrect response was defined as the student making an error while completing the step either before or after the peer delivered the specific task direction. Errors could include students taking too long to respond, writing answers incorrectly, copying down the problem, the formula, or the information from the calculator incorrectly, pushing the incorrect button on the calculator, performing the steps out of order, etc. No response

was defined as the student not initiating a response during the specified time interval. More specific information about possible student responses is listed in the SLP procedures section. The student had 5 s to initiate a response once the peer delivered the step and 10 s to complete the step after initiation. For example, if the student was given the step "Divide the shape into two separate shapes," and the student did not respond within 5 s, then the peer delivered the next prompt in the hierarchy. The least intrusive prompt on the prompt hierarchy after independent response was a verbal prompt. The peer then delivered the verbal prompt, "Draw a line to make the shape into two separate shapes." If the student was able to complete the step with a verbal prompt within 5 s, then a "V" was recorded next to that step under the corresponding date on the data sheet. If the student still required prompting, then the peer delivered a more intrusive prompt on the prompt hierarchy. The next prompt on the hierarchy was a model prompt. The peer modeled the step on his own copy of the work sheet and the model prompt was paired with verbal directions. If the student completed the step with this type of prompt, then an "M" was recorded next to that step under the corresponding date on the data sheet. If the student continued to require prompting, the peer delivered the most intrusive prompt on the prompt hierarchy, a physical prompt. The peer physically prompted the student to complete the step correctly. A "P" was recorded next to that step under the corresponding date on the data sheet.

In addition to recording student responses on the data sheet, the peer also recorded his initials, the date, and totaled up the number of correct responses for each prompt level, as well as the percentage of correct responses from each prompt level. Data for baseline were collected and recorded by the teacher as described in the baseline

procedures. Data for intervention were recorded by the peer upon the completion of each step. Data were graphed for independent correct responses by the classroom teacher. The classroom teacher collected interobserver agreement. The instructional assistant who has worked in the classroom for several years collected procedural fidelity simultaneously.

Peer Tutor Training

The peer tutor used in this study had prior experience with using the SLP prompting procedure to teach a math skill. However, he received formal training prior to beginning the study to ensure proper use of the teaching procedure. Training required a minimum of four sessions which reviewed the modified SLP prompting procedure and allowed the peer to practice teaching a skill to an instructional assistant using the procedure, and teaching a skill to a student, under the supervision of the teacher. Sessions lasted approximately 30 minutes and some sessions consisted of multiple trials over the course of several days. During the first training session, the instructor introduced the study topic to the peer and discussed how the skill would be taught to the students using the modified SLP procedure. The teacher then showed the student several video examples of others using the SLP procedure to teach various skills. Video examples included demonstrations of the use of the SLP procedure that were procedurally accurate or inaccurate. This facilitated discussion about appropriate and inappropriate ways to implement the procedure. The peer also looked at examples of data sheets during this training session. The second part of the training consisted of the teacher guiding the peer through modeling and verbal cues to teach both a functional and academic skill to an instructional assistant. With guidance from the teacher, the peer practiced teaching the

instructional assistant how to cook Ramen Noodles and how to write his name. This training opportunity allowed the teacher to model to the peer how the procedure should be implemented. The teacher gave an example to the peer of what he should do and say to begin the session. The session began and the peer began implementing the SLP procedure with some modeling and verbal prompting from the teacher to show the peer what to do as needed. This training session was informal in that it allowed for the teacher and peer to interact throughout the session. If the teacher noticed the peer making errors then the teacher could intervene to show the peer by modeling to the peer what the process should look like or verbally telling the peer tutor what he should do differently. The peer also used this opportunity to begin to practice collecting data during implementation. During the third training session, the peer again had the opportunity to practice teaching both academic and functional skills by implementing the procedure with another peer tutor in the classroom and with a student in the classroom. The student that the peer tutor worked with during the training session, Joseph, was not originally part of the study, but was added to the study after the peer training sessions. During this part of the training process, the teacher was sitting with the peer to model or verbally help the peer as needed. The final training session consisted of the peer using the modified SLP prompting procedure to teach the math skill used in the study to the instructional assistant. This gave the peer the opportunity to ask questions and become familiar with how to implement the procedure using the specific materials before beginning the study. The peer was required to achieve 100% criterion on the accurate implementation of the procedures and the accurate scoring of the instructional assistant's response before being allowed to implement the procedure during the actual study. Within 3 trials the peer

reached 100% criterion on accurate implementation. The steps for accurate implementation and accurate scoring included (a) the peer tutor asked student to put name and date; (b) the peer tutor secured learner's attention ("Are you ready?"); (c) the peer tutor waited for student response; (d) the peer read directions and problem to the student; (e) the peer delivered first step of task analysis; (f) the peer waited a pre-determined amount of seconds for the learner to respond (5 s for initiation, 10 s for completion of step); (g) the peer delivered the appropriate prompt in the prompt hierarchy; (h) the peer recorded student response on data sheet; (i) the peer provided verbal praise for the correct response; and (j) the peer ended the session with verbal praise. If there were significant errors (i.e., peer moved on without the student completing the step correctly) during intervention or the peer failed to correctly implement the procedure, then the classroom teacher conducted re-training sessions identical to the training session in which the peer taught an instructional assistant the math skill using the modified SLP procedure. The peer was required to implement the procedure with 100% reliability. After initial errors were made during the first several sessions of intervention and the peer had received re-training, future intervention sessions ended with the teacher conducting informal debriefing sessions with the peer to discuss specific areas of the session that were implemented successfully and specific areas that needed improvement. The peer could also use this opportunity to share concerns or ask questions.

Baseline Procedure

Baseline procedures occurred for six consecutive sessions, or until data were stable for each student. During the baseline condition, students were presented with their

task in the form of a worksheet. The teacher was sitting across from the students for each baseline session. The teacher instructed the students to put their name and date on the worksheet. The teacher provided assistance to those students who needed help with putting the date on the worksheet. One student was not able to put his date on his worksheet. His date was recorded by the teacher on the data sheet for each session. To prevent students from becoming upset or frustrated, the teacher reminded students before the task began that this was a new skill and it was ok if they did not know how to do the task and also reminded them to do their best. The teacher then read the directions aloud to the student and the student was given 30 s to initiate the task. This was a single opportunity probe in which the students had one chance to correctly complete the task. If a mistake was made then the session would end immediately. Students had the opportunity to perform the task correctly by completing the worksheet independently without making any errors. Had the students done this they would have received general verbal praise for completing the math assignment correctly and independently and would not have needed further instruction in this area. Students also could respond incorrectly if he or she did it topographically wrong, completed a step out of order, or took too long to do a step. If an error was made, then the session stopped immediately. Students could also have no response in which the student did nothing after the teacher read the directions. No prompting or feedback was provided during baseline sessions. Only one math problem was on each worksheet during the baseline condition. At the end of the session, regardless of the students' responses, the teacher delivered general verbal praise such as "Good work today!" or "Great job!" The teacher collected the work and students put away their materials.

Modified System of Least Prompts Procedure

Intervention began after six sessions of baseline and when data were stable for each student. At the beginning of each student's session, the teacher gave verbal directions for the student to get ready for math. Each student was instructed to go to the table at the back of the classroom for math. The teacher made sure necessary materials which included a worksheet, a calculator, a pencil, and any formulas that correspond to the student's assignments were available and ready at the back table before instruction began. Once a student was at the table, the teacher asked the peer and the student to write their names and date on the worksheet. Then, the attentional cue, "Are you ready?" was delivered by the peer. The peer waited for the attentional response, which was an indication from the student that he or she was ready (e.g., "Yes," head nod, signing "yes"). Once the student's attention was secured, the peer gave the general task direction, "Read or listen to the question. Use the correct volume formula and a calculator to solve the problem" to the eighth grade students. For the sixth grade student, once the student's attention was secured, the peer read the word problem to the student and provided the general task direction, "Determine the area of the polygon below." For both grade levels, the peer read the directions and the word problem to the students. Once the directions and the word problem were read, the peer verbally provided specific task directions for each step as listed in the task analysis. The first step of the task analysis for all of the eighth grade students was "Point to the formula." The first step of the task analysis for the sixth grade student was "Divide the shape into two separate shapes." Upon delivery of the first step, John, Mary and Tyler, were given a 5 s interval to initiate a response. Once the response was initiated, these students had 10 s to

complete the step. Joseph had 20 s to initiate and complete the step. A response was considered correct if the student performed the step independently, without any additional verbal, model, or physical prompting. If the student responded correctly during the 5 s interval or completed the step correctly during the 10 s interval, then the peer recorded the student's response onto the data sheet as described above. Specific verbal praise, such as "Good, you drew a line to divide the shape into two shapes" was delivered upon all correct responses. A response was considered to be incorrect if the student made an error while completing the step. No response was considered if the student did not initiate a response during the 5 s time interval. If the student responded incorrectly or did not respond during the specified time interval, then the peer delivered the next least intrusive prompt in the prompt hierarchy. For example, if the peer said "Divide the shape into two separate shapes," and the student did not respond, then the peer delivered the verbal prompt, which was the first prompt on the prompt hierarchy. For the verbal prompt, the peer could say "Draw a line to divide the shape into two separate shapes." If the student responded correctly to the verbal prompt, then a "V" was recorded next to the corresponding step under the corresponding date on the data sheet, followed by specific verbal praise. If the student responded incorrectly or did not respond within the 5 s interval or complete the step within 10 s, then the next prompt level, a model prompt, was delivered to the student. In this case, the peer modeled the step for the student by drawing a line on a separate but identical worksheet and paired a verbal direction with the model. Then, the peer verbally repeated the step to the student. If the student responded correctly to the model prompt, then an "M" was recorded next to the corresponding step under the corresponding date on the data sheet followed by specific verbal praise. If the

student responded incorrectly, did not respond at all during the 5 s interval, or failed to complete the step within 10 s, then the next prompt level, a physical prompt, was delivered to the student. In this case, the peer would physically prompt the student, using hand-over-hand to complete the step as well as pair the verbal direction with the physical prompt. A "P" was recorded next to the corresponding step under the corresponding date on the data sheet, followed by specific verbal praise. Praise statements were not delivered for incorrect responses; however, if a student made an error, the peer tutor would interrupt the student immediately by saying "Nice try" and deliver the next prompt. The peer continued prompting the student using the modified SLP procedure so that they were able to move on to the next step. Intervention sessions were conducted up to two times per day. During each intervention session, the worksheet rotated and students were presented with a different but similar worksheet.

Maintenance Procedure

Once students met criterion at 100% of steps completed independently for two sessions, the peer conducted maintenance sessions once per week for the remainder of the school year. Maintenance sessions were conducted similar to baseline sessions. The peer read the worksheet's directions and the word problem to the student but did not provide prompting or reinforcement during the session.

Generalization Procedure

The use of multiple formats of each worksheet during intervention helped to facilitate some generalization across materials. During intervention, students at the eighth grade level were taught to find the volume of a cylinder and sphere. For post-generalization purposes, the eighth grade students were presented with a novel word

problem that asked them to find the volume of a cone. At the sixth grade level, during intervention, the student was presented with a variety of different worksheets containing 2-D polygons. For post-generalization purposes, the sixth grade worksheet would have also been a novel word problem involving finding the area of polygons, but the diagram on the worksheet would have included a blue print for a house floor plan, or a back yard diagram. Generalization sessions were conducted by trained instructional assistants and the classroom teacher. One generalization session was conducted in a separate classroom.

Experimental Design

A multiple probe days across participants design was used to determine the effectiveness of peers using the modified SLP procedure to teach academic math skills to students with disabilities. Baseline sessions were conducted with each student at the same time. Once a stable baseline was established for all participants, intervention began with the first student, John. Criterion was 50% above the students' baseline scores for two consecutive sessions to move on to intervention with the second student. When John was at 50% above baseline for steps in the task analysis completed independently for 2 consecutive sessions, students Mary, Tyler, and Joseph were probed again, with probe sessions being identical to the baseline condition. After the probe session, John continued with intervention and the second student, Mary, began intervention and continued until reaching criterion, 50% above baseline for two consecutive sessions. Once the Mary met criterion, Tyler and Joseph were probed again. This process continued until all students were participating in intervention. Criterion for mastery was 100% of steps completed independently for 2 consecutive sessions.

Social Validity

Throughout the peer tutor training sessions, the peer was asked informal questions to determine his perceptions of working with students with disabilities. The peer had opportunities to ask questions and discuss his thoughts on the benefits of peer tutoring and what he thought would happen during the study and after the study. A more formal survey with similar questions was conducted with the peer tutor (see Appendix K) and the students with disabilities (see Appendix L and Appendix M) at the end of the study to determine their thoughts on working with one another and using the modified SLP procedure. There were two versions of the student survey. One version was for students John and Mary who were able to answer multiple choice questions and short answer questions in standard format. The second version was for both Tyler and Joseph who were able to answer multiple choice questions with picture supported text.

Reliability

Peer training procedural fidelity. Procedural fidelity data were collected by an instructional assistant on the teacher training the peer tutor prior to the study. Procedural fidelity during the teacher training session was measured on the behaviors of: (a) teacher introduced peer to SLP procedure, (b) teacher presented video examples to peer, (c) teacher guided peer in teaching functional skill and/or academic skill to an instructional assistant, (d) teacher guided peer in teaching a functional and/or academic skill to another peer or student using the modified SLP procedure, and (e) teacher had peer test out using the modified SLP procedure with 100% accuracy.

Procedural fidelity of peer. Procedural fidelity data were also collected by the classroom teacher during the fourth peer training session when the peer was required to

test out using the modified SLP procedure with 100% accuracy. Procedural fidelity on the peer teaching the instructional assistant using the modified SLP procedure was measured on the behaviors of: (a) peer asked student to put name and date, (b) peer secured learner attention, (c) peer waited for student response, (d) peer read directions and problem to the student, (e) peer delivered first step of task analysis, (f) peer waited pre-determined amount of seconds for learner to respond, (g) peer delivered appropriate prompt in the prompt hierarchy, (h) peer recorded student response on data sheet, (i) peer provided verbal praise for the correct response, and (j) peer ended the session with verbal praise.

Interobserver agreement reliability. Interobserver agreement data were collected by an instructional assistant during the baseline/probe conditions and by the classroom teacher during intervention and maintenance conditions. The point-by-point method was used to calculate interobserver agreement by taking the number of agreements divided by the agreements plus the disagreements and multiplying by 100 (Gast & Ledford, 2014).

Procedural fidelity. Procedural fidelity data also were collected by the instructional assistant simultaneously during baseline, during intervention, and during maintenance conditions. Procedural fidelity during baseline was measured on (a) teacher direction to begin math, (b) teacher instruction to put name and date on paper, (c) delivery of attentional cue, (d) wait time for attentional response, (e) reading directions/problem to student, (f) stopping student when error was made, and (g) praising student for working on math. During intervention, the teacher told the students that it was time for math and to go to the back table. The teacher also instructed both peer and

student to put their name and date on their paper. After these directions were given, procedural fidelity during intervention was measured on (a) peer secured learner attention, (b) peer waited for student response, (c) peer read directions and problem to the student, (d) peer delivered first step of task analysis, (e) peer waited pre-determined amount of seconds for learner to respond, (f) peer delivered appropriate prompt in the prompt hierarchy, (g) peer recorded student response on data sheet, (h) peer provided verbal praise for the correct response, and (i) peer ended the session with verbal praise.

Section 4: Results

Reliability Data

Procedural reliability data on the classroom teacher training the peer on the use of the modified SLP procedure and on the peer testing out using the modified SLP procedure were collected for 100% of sessions. The training procedure was implemented reliably on all behaviors for 100% of training sessions. Procedural reliability data were collected by an instructional assistant for 86% of all baseline/probe sessions and 68% of all intervention sessions across students. The procedure was implemented reliably for an average of 98% (range = 71% to 100%) for all baseline/probe sessions across students. The procedure was implemented reliably for an average of 97.5% (range of 88% to 100%) for all intervention sessions across students. Procedural errors most often occurred when the peer failed to deliver the appropriate prompt in the prompt hierarchy.

Interobserver agreement data were collected by an instructional assistant for 86% of all baseline/probe sessions with interobserver agreement between the classroom teacher and the instructional assistant being 100%. IOA data were collected by the classroom teacher for 98% of all intervention and maintenance sessions with a mean agreement of 96% (range of 80-100%).

Baseline

John was the only student out of the four students to score above a 0% during the baseline condition. For three of the six baseline sessions, John completed the first step of the task analysis independently by pointing to the formula that matched his worksheet. This was the only step that he could perform. Baseline data for John, Mary, Tyler, and

Joseph remained stable (i.e., 0%) throughout the baseline condition. Mary, Tyler, and Joseph, did not respond or responded incorrectly during baseline sessions.

Modified System of Least Prompts

All students made progress after receiving intervention from the peer tutor. John and Mary reached mastery and were able to generalize the skill across materials and people. Mary was able to maintain the skill after intervention had stopped for two sessions at three days after intervention and at one week after intervention. Tyler made significant progress but was unable to continue due to the end of the school year. Joseph made slow progress with only four sessions. Student results are shown in Figure 1.

John was the first student to receive intervention. After the first session of intervention with peer delivered instruction, John's percentage of correct responses increased from a mean of 5% during the six baseline sessions to 44% on the first session of intervention. It took 34 sessions of intervention to reach a criterion of 100% accuracy for 2 consecutive sessions. The student frequently required many model and verbal prompts for steps 3 and 4 of the task analysis (rewrite the formula, replacing the pi, radius, and height if necessary, and use a calculator to solve the exponent). Most of John's errors throughout intervention seemed to come from careless handwriting errors or trying to get through the worksheet too fast and typing things into the calculator too quickly. Beginning around session 23, the teacher began giving a verbal reminder before the start of each session, reminding the student to take his time. This seemed to help the student to slow down and improve handwriting. Fourteen sessions were required before the student reached 50% above his baseline score for two consecutive sessions to

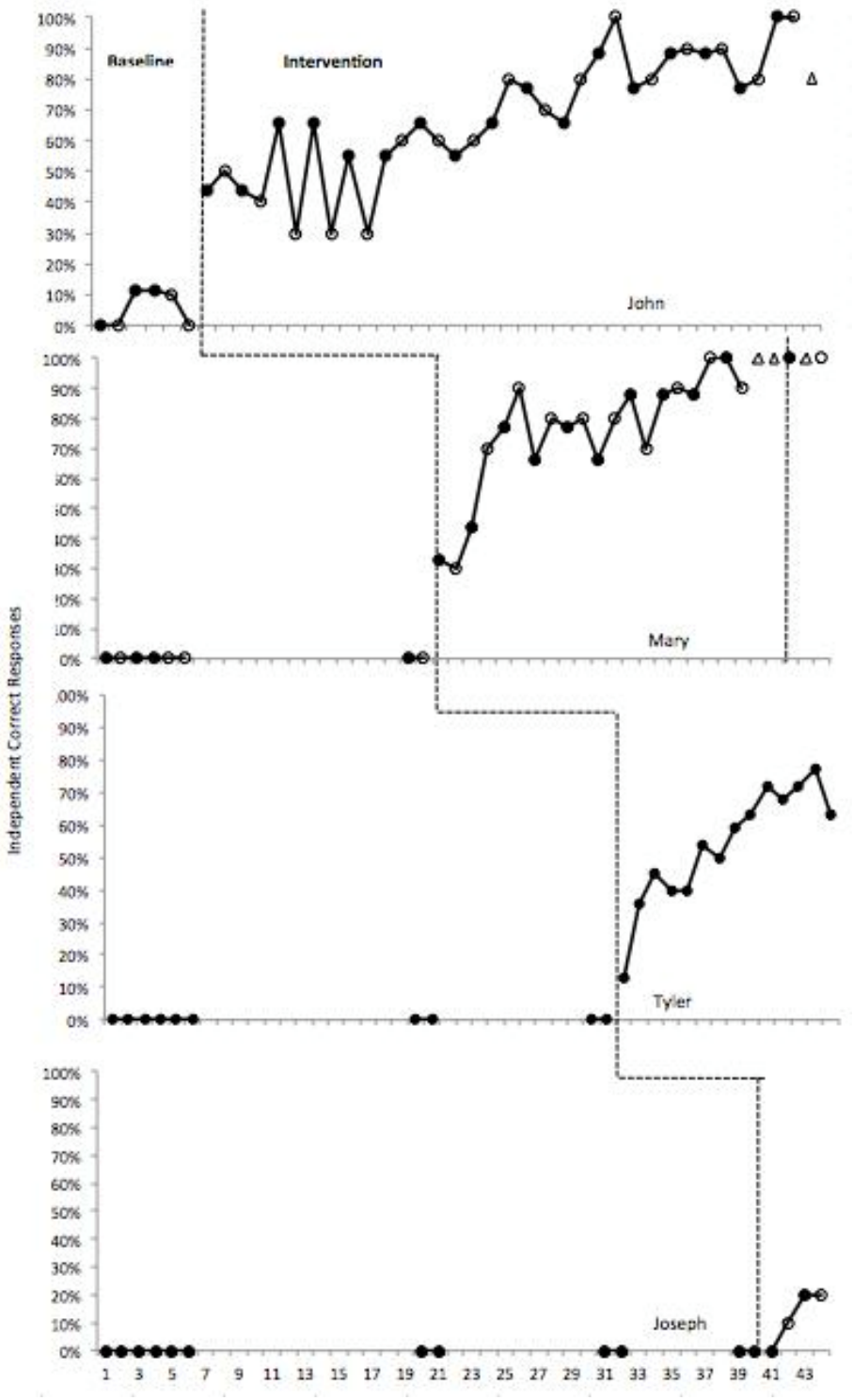


Figure 1: Student Graphs of Percentage Independent Correct responses. Key: 8th grade students: closed, filled circle = independent correct responses for cylinder; closed, unfilled circle = independent correct responses for sphere; triangle = generalization Key: 6th grade student: closed, filled circle = independent correct responses.

allow the other three students to be probed again and intervention began with student 2, Mary.

Mary's percentage of correct responses increased from 0% during all baseline and probe sessions to 33% after the first session of intervention with the peer tutor. It took Mary 20 sessions of intervention to reach the criterion of 100% accuracy for two consecutive sessions. Five sessions were required for Mary to reach 50% above her baseline score for two consecutive sessions to allow the other two students to be probed again and intervention began with student 3, Tyler.

Tyler's percentage of correct responses increased from 0% during all baseline and probe sessions to 13% after the first session of intervention with the peer tutor. Due to the end of the school year, Tyler did not reach criterion of 100% for 2 consecutive sessions, however, he did make progress. Unlike the skill that John and Mary were learning (finding the volume of a cylinder and sphere), Tyler was learning a different math standard; he was learning how to find the area of polygons by decomposing them into other shapes. This was a new skill for the peer tutor to teach, but one that he had the opportunity to practice with before beginning intervention with Tyler. Tyler required more physical and model prompts than John or Mary. He also required behavioral reinforcement from the classroom teacher. Any teacher interventions during this condition related to behavior management, including encouragement, reinforcement (reminding the student what he was working for, reminders to stay on task), and reminders to put the calculator down when it was not needed. The calculator was eventually moved away from the student during the steps that it was not needed and replaced when it was needed so as not to distract the student. The student showed

aversion toward the instructional assistant collecting IOA data, often refusing to work when the instructional assistant was nearby. An alternate instructional assistant, when available, collected IOA data. Tyler had 14 sessions of intervention with his highest percentage during intervention being 77%. Seven sessions were required for Tyler to reach 50% above his baseline score for two consecutive sessions to allow the last student to be probed again and intervention to begin student 4, Joseph.

Joseph made slower progress than the other three students in the study. Due to the end of the school year he only had 4 sessions of intervention. From his baseline scores of 0% he progressed slowly during his intervention sessions to 20% for his last two sessions. He required much more physical prompting to complete the tasks and required a longer response time for each step. Joseph, like Tyler, needed frequent behavior redirection and behavior reinforcements from the classroom teacher.

Maintenance and Generalization

Only one student, Mary, made it to the maintenance phase of the study. She demonstrated that she was able to maintain the skill at 100% for two sessions, five days apart. More maintenance sessions were not able to be conducted due to the end of the school year. Mary had three opportunities to generalize the skill she learned to new word problems with a new shape, a cone. She also worked with a different person on each occasion. She scored 100% for each generalization session. John also had an opportunity to practice generalizing the skill across materials and people. He was presented with a new word problem, with a new shape (cone) and worked with an instructional assistant. John scored 80% during his generalization session. Due to the end of the school year, maintenance sessions were not able to be conducted with John.

Social Validity Results

Each of the students took a survey at the end of the study. Table 1 shows the results from the student survey given at the end of the study. The student survey asked the following questions: (1) Do you like to work with your peers? (2) Do you like the way you learned? (3) Was this an important skill for you to learn? (4) Was the peer tutor helpful? and question 5 was a short answer question for John and Mary, "When will you use this skill in the real world?" and multiple choice for Tyler and Joseph, "Will you use this skill in the real world?" Results of the student survey indicate that half of the students like to work with their peers and the other half of the students liked to work with their peers sometimes. Two of the students liked the way they learned, one student did not like the way he learned and one student sometimes liked the way he learned. Three students agreed that this was an important skill for them to learn, one student circled that it was not an important skill to learn. Two students indicated that the peer tutor was helpful; one student responded that the peer tutor was not helpful, and one student replied that the peer tutor was sometimes helpful. Two students responded that they would use this skill again in high school, one student circled that he would use this skill in real life and the other student circled that sometimes this skill would be used in real life. One student taking the survey was notorious throughout the school year for always choosing the last answer choice when presented with questions in the multiple choice format. This student selected the last answer choice for each question on the survey as well. The two students who were most successful in this study were the students who chose that they liked to work with the peers, liked the way they learned; felt that it was an important skill to learn and that the peer tutor was helpful. The peer tutor also took a survey at the end

Table 1: Student Survey Results

		Yes	No	Sometimes	I don't know
1. Do you like to work with your peers?		2	0	2	
2. Do you like the way you learned?		2	1	1	
3. Was this an important skill for you to learn?		3	1		
4. Was the peer tutor helpful?		2	1	1	0
5. When will you need to use this math skill in real life?	2 – "In high school."				
OR					
5. Will you use this skill in real life?		1	0	1	

of the study. The peer tutor survey asked the following questions: (1) Do you like being a peer tutor?, (2) Was this an important skill for these students to learn?, (3) Do you think the students you worked with learned the math?, (4) Was it good to use a peer tutor to teach this skill?, and (5) Was it easy to help the students with the math worksheet using this method? There was also a comments section in which the peer tutor could write additional information if needed. Results from the peer survey indicated that the peer liked being a peer tutor, it was an important skill for these students to learn, the students learned the material, it was good to use a peer tutor to teach the math skill, and

sometimes it was easy to help the student with the math worksheet using the modified SLP procedure. The peer did not add any additional comments.

Section 5: Discussion

One purpose of this study was to determine if there was a functional relation between a peer-delivered system of least prompts procedure and an increase in level and trend of academic performance of math skills with middle school students with mild to severe disabilities. Three of the four students made immediate progress after implementing the peer delivered instruction using the modified SLP procedure. John made progress from a mean baseline percentage of 5% to a mean of 66% correct independent responses during intervention. He reached mastery after 34 sessions of intervention. Mary made progress from a mean baseline percentage of 0% to a mean of 75% correct independent responses during intervention. Mary reached mastery after 20 sessions of intervention. Tyler made progress from a mean baseline percentage of 0% to a mean of 54% correct independent responses during 14 intervention sessions. Tyler did not continue with intervention due to the end of the school year. Joseph made minimal progress from a mean baseline percentage of 0% to a mean of 12% during four intervention sessions. Joseph did not continue with intervention sessions due to the end of the school year. John's data had a variable trend that began accelerating. All other students' data showed an accelerating trend once in intervention. The other purpose of this study was to determine if the peer tutor could reliably implement the modified SLP procedure when teaching middle school students with mild to severe disabilities to find the area of polygons or to find the volume of cylinders, spheres, and cones. Based on interobserver agreement data and procedural reliability data, the peer was able to implement the procedure reliably at 97.5% and the interobserver agreement was 96%. This study adds to the literature to suggest that peers are able to reliably implement a

modified SLP procedure with students to teach chained academic skills and that the students are able to learn an academic skill from a peer through the use of the modified SLP procedure.

Limitations and implications for future research. One limitation was that only 1 peer tutor was used in this study. Using one peer tutor placed a lot of responsibility on the peer and although he was able to implement it with a high degree of procedural reliability, it is unknown if multiple peers would have also been able to implement the procedure reliably. Future research could include the use of multiple peer tutors, one peer tutor per student, or perhaps rotating peer tutors, to determine if multiple peer tutors could implement the SLP procedure reliably.

A second limitation of this study was that the peer required retraining after the first few sessions of intervention. Although the peer's procedural reliability was within acceptable limits, he made multiple errors during the first session. During the first session of intervention with John, there were two occurrences of teacher intervention. It was necessary for the teacher to intervene for several reasons. On these occurrences, the peer had moved on without the student correctly completing the step. The teacher directed the peer to model the steps for the student. After the first session, which had two teacher interventions, the teacher conducted retraining sessions with the peer. The retraining sessions consisted of the peer teaching the math skill to the instructional assistant just as he had done in the original training session. There were a total of five retraining sessions before the student implemented the procedure with 100% accuracy with the instructional assistant. Future instances in which the teacher had to intervene or when there were small mistakes made by the peer, the teacher would meet to debrief with the peer after the

session ended to discuss things to do differently or things to change in order to implement the procedure correctly. The teacher intervened for a total of four times during the intervention condition with John: twice when the peer moved on without the student completing the step correctly, once when the peer had the wrong data sheet, and one other occasion. Although some teacher intervention was required, the peer improved his reliability throughout the study. During the beginning sessions of the study, the peer seemed nervous while conducting the procedure. He would often look at the classroom teacher if he was unsure of what to do, or wait for prompting from the teacher on what to do next. Typically, the teacher provided a gesture or verbally prompted the peer on what to do next and these concerns would be discussed during debriefing sessions one-on-one with the peer after the instructional session ended. It took the peer several sessions to become comfortable with implementing the procedure in a real classroom scenario and becoming familiar with appropriate ways to provide model and verbal prompts and to become comfortable with stopping a student from making a mistake. There was one occurrence during intervention with John when the peer should have provided a physical prompt but felt uncomfortable in doing so and therefore modeled the step again for the student. There were several additional occurrences throughout intervention, across students, when the peer should have provided a model, but instead gave a second verbal prompt, or when the peer recorded a "+" as if it were an independent response when it should have been a "V" because a verbal prompt was needed. When the intervention condition began with Mary, the peer was more comfortable in implementing the procedure and more knowledgeable of the math content. The teacher only had to intervene twice: once due to peer and student error and once to tell the student to put the

calculator on the table so the peer could see her calculator responses. In the future, a more specific procedural reliability datasheet would have reflected peer errors more accurately. In addition, more training sessions should be offered to the peer in which the peer trains by teaching a similar skill to another student in order to make the training sessions more real-world.

A third limitation in this study was the way in which the baseline sessions were conducted. During the baseline sessions, the teacher only read the directions and the word problem to the student. The specific task directions were not presented to the student. In addition, these sessions were single opportunity probes in which the student only had one opportunity to complete the task correctly. As soon as the student made an error, the session ended immediately. It is difficult to determine if the students would have been able to complete more steps independently had the baseline sessions been conducted differently. Had the students been provided with multiple opportunity probes, a more accurate baseline could have been obtained. Future research could consider offering multiple opportunity probes during the baseline condition, however it is important to note that due to the complexity of the skills being taught, the single opportunity probe was chosen to lessen the frustration of the students during baseline and so as not to inadvertently teach the skills during baseline.

A fourth limitation was the low range procedural reliability during the baseline condition. The bottom range could be due to one teacher error during one session of baseline in which the teacher failed to deliver the attentional cue, “Are you ready?” and wait for the attentional response from the student. However, it is possible that the student was already attending.

A fifth limitation was that due to the end of the school year, two students did not have the chance to reach mastery and two students had very few opportunities to practice generalization and/or maintenance of the skill they learned. Data were collected with students until the end of the school year. At the end of the year, two students, Tyler and Joseph, were still in the intervention phase of the study. Although both were making progress, it is difficult to determine if they would have also reached criterion and been able to generalize and maintain the skill. Additionally, the students who had reached criterion and were in the maintenance and/or generalization phase of the study, due to the end of the school year, had very few opportunities to generalize the skill across settings, materials, or people and very few or no opportunities to practice maintenance. In future research, generalization of math skills across settings, materials, and people could be assessed. With proper training and teacher willingness, math skills could be taught in the general education classroom where other students are also learning the same skills or within the community. Students could use different materials, such as a variety of worksheets, manipulatives, or even use technology such as a Smart Board or iPad to complete their math. Students could work with a variety of peers or adults across settings. Working with other peers could encourage social relationships and increase awareness about student abilities.

A sixth limitation was that during baseline and probe sessions, Joseph's baseline data were collected on a data sheet for finding the volume of a cylinder. Due to teacher error, the shape that Joseph was presented with, sphere or cylinder was not specifically documented during the baseline or probe sessions. It is difficult to determine if Joseph was only presented with a cylinder during baseline and probe sessions or if the sphere

was also rotated in as well. Joseph was presented with both the sphere and the cylinder during the modified SLP procedure according to data that were collected on separate, shape specific data sheets. In future research, all data sheets should be shape specific and documentation of which shape the student is presented with for each session should be noted if not able to be noted on individual worksheets.

One final limitation was that the students and peers were given a survey at the end of the study but due to teacher error, were not given a survey before the study began. Without a pre-survey, it was difficult to determine if student or peer perceptions had changed over the course of the study. Future research could consider giving peers and students a pre-survey to determine peer and student perceptions. In addition, the results of the social validity survey were likely not valid based on the results. On the student survey, the students may not have been familiar with the term "peer" and therefore may not have answered the questions accurately. Two students completed their survey at the same time while the teacher read each question and answer choice aloud. This may have resulted in the students copying answers from one another and not necessarily reflecting their own thoughts. In the future, the student survey could reflect the specific name of the peer tutor that the student worked with rather than just referring to "peer". This may allow for the student to better understand the questions that are being asked. Additionally, the student surveys should be conducted individually to ensure valid student responses.

Throughout this study a modified SLP procedure was used in which specific task directions were provided as part of the SLP procedure that was implemented with students. After the general task direction (directions and the individual word problem)

was read aloud to the student, the peer then provided a specific task direction ("Point to the formula") for each step of the task analysis for solving the problem, rather than allowing the students the opportunity to complete the first step, independent of the peer's specific task direction. As students began to learn the skill, three of the four students were able to complete steps independently, before the peer delivered the specific task direction. During the generalization and maintenance conditions, which were conducted similarly to baseline, Mary was able to complete all steps independent of the specific task direction for each step. Future research could remove the specific task direction to see if the general task direction was sufficient for the student to complete the step. The specific task direction would then become the verbal prompt if there was no response in 5 s.

The prompt hierarchy used in the modified SLP procedure included verbal, model, and physical prompting; however, the physical prompt was not needed and not necessarily appropriate for students John and Mary. There was one session throughout the study in which the peer tutor should have provided a physical prompt to the student but did not feel comfortable using a physical prompt. It is important to note that while physical prompting may be appropriate for some students, it is not necessarily appropriate for all students. An alternative option for future research could consider using alternate hierarchies for individual students. For example, in this study a more appropriate hierarchy for John and Mary may have been the use of verbal, gesture, and model prompts. Although the students in this study who required physical prompting needed it for mainly hand-over-hand guidance to push the correct button on a calculator, to select the correct answer, or to write the correct answer were used to hand-over-hand

assistance, the idea of a peer providing physical assistance may not be appropriate in all scenarios.

Future research may also consider pairing peers and students with each other based on whom the student and/or peer prefer to be paired with, rather than the teacher selecting who gets paired with whom. Allowing students and peers to select who they will be working with may promote better results. Students may be more motivated to work harder with a certain peer. Peer tutors may interact better with specific students and may prefer to work with certain individuals. These considerations should be taken into account in future research involving peer mediated instruction.

Implications for practice. Results from this study show that students were able to make progress when learning academic math skills being taught by peer tutors using the modified SLP procedure. Each of the students in this study made progress after implementation of intervention by the peer. Learning to find the volume of 2-D shapes and learning to find the area polygons may have a functional application in the community setting, in a job setting, or even in a home setting. Mastering these concepts in middle school may also help the students as they transition to high school and participate in the general education settings. A second implication for practice is that a peer tutor can reliably implement the modified SLP procedure when teaching a math skill to students with mild to severe disabilities. Procedural reliability data show that the procedure was implemented reliably for 97.5% of intervention sessions across students. Interobserver agreement data between the classroom teacher and the peer was 96% across intervention and maintenance sessions. While it can be challenging for peers to

implement the procedure and collect data simultaneously, the peer in this study was able to do both successfully.

This study sought to determine if there was a functional relation between a peer delivered modified SLP procedure and an increase of academic performance with middle school students with mild to severe disabilities. Results from this study show that there was a functional relation across students that showed that students were able to make progress on academic math skills when taught by a peer tutor using the modified system of least prompts procedure. This study also sought to determine if a peer tutor could reliably implement the modified SLP procedure when teaching middle school students with mild to severe disabilities to find the area of polygons or to find the volume of cylinders, spheres, and cones. Data show that a peer tutor was able to reliably implement the procedure with two of the four students reaching criterion and two students making progress toward reaching criterion.

Appendix A

Student Worksheet, John and Mary

Name _____Date _____

Read or listen to the question. Use the correct volume formula and a calculator to solve the problem.

What is the volume of a glass of ice with a radius (r) of 3 and a height (h) of 7?

Appendix B

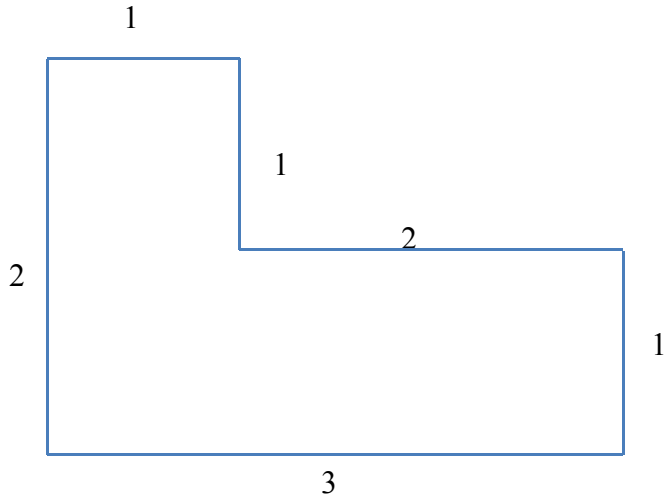
Student Worksheet, Tyler

Cue Card – Area of a rectangle

L  A= Length x Width

W

Fred is combining two picnic tables and needs to make sure he gets a big enough table cloth to cover the tables. To help Fred determine what size his table cloth should be, determine the area of the polygon below.



(___ x ___) + (___ x ___) =
L W L W

Appendix C

Example of Data Sheet for Students John and Mary, Finding the Volume of a Cylinder

Name _____

Objective: Given volume formula, solve real-world problems involving cones, cylinders, and spheres.

Instructional Procedure: System of Least Prompts **Shape:** Cylinder

Prompt Key			
+ = Independent	V = Verbal	M = Model	P = Physical

Instructor Initials:										
Date:										
1. Point to a formula.										
2. Write the formula.										
3. Rewrite the formula, replacing the pi (π), radius (r), and height (h) if necessary.										
4. Use a calculator to solve the exponent and push equals.										
5. Write the answer below the exponent.										
6. Bring everything else down.										
7. Push clear on the calculator.										
8. Multiply the rest of the problem.										
9. Write down the answer with two decimal places.										
# of Independent Correct Responses										
% of Independent Correct Responses										
# of Verbal Prompts										
% of Verbal Prompts										
# of Model Prompts										
% of Model Prompts										
# of Physical Prompts										
% of Physical Prompts										

Appendix D

Data sheet for Tyler, finding the area of polygons

Name _____

Objective: Find the area of polygons by composing into rectangles or decomposing into other shapes.

Instructional Procedure: System of Least Prompts

Prompt Key			
+ = Independent	V = Verbal	M = Model	P = Physical

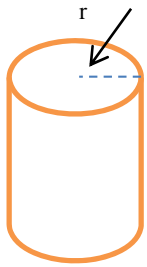
Instructor Initials:										
Date:										
1. Divide the shape into two separate shapes.										
2. Point to the length of one side of the bigger rectangle.										
3. Write the length in the formula below.										
4. Point to the width of one side of the bigger rectangle.										
5. Write the width in the formula below.										
6. Point to the length of one side of the smaller rectangle.										
7. Write the length in the formula below.										
8. Point to the width of one side of the smaller rectangle.										
9. Write the width in the formula below.										
10. Enter the equation from the first set of parentheses into the calculator.										
11. Push equals.										
12. Write the answer below the parentheses.										
13. Bring down the plus sign.										
14. Push clear										
15. Enter the equation from the second set of parentheses into the calculator.										
16. Push equals.										
17. Write the answer below the parentheses.										
18. Bring down the equals sign.										
19. Push clear										
20. Enter the new equation into the calculator.										
21. Push equals.										
22. Write the answer next to the equals sign.										
# of Independent Correct responses (I)										
% of Independent Correct Responses										
# of Verbal Prompts										
% of Verbal Prompts										
# of Model Prompts										
% of Model Prompts										
# of Physical Prompts										
% of Physical Prompts										

Appendix E

Student Formula Sheet for John and Mary

Cylinder Volume

$V = \pi \bullet r^2 \bullet h$



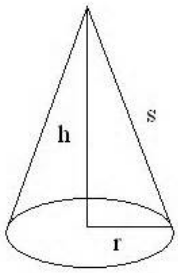
r = radius of base

h = height

$\pi = 3.14$

Cone Volume

$V = \frac{1}{3} \bullet \pi \bullet r^2 \bullet h$



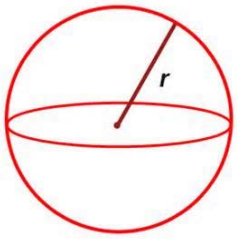
r = radius

h = height

$\pi = 3.14$

Sphere Volume

$V = \frac{4}{3} \bullet \pi \bullet r^3$

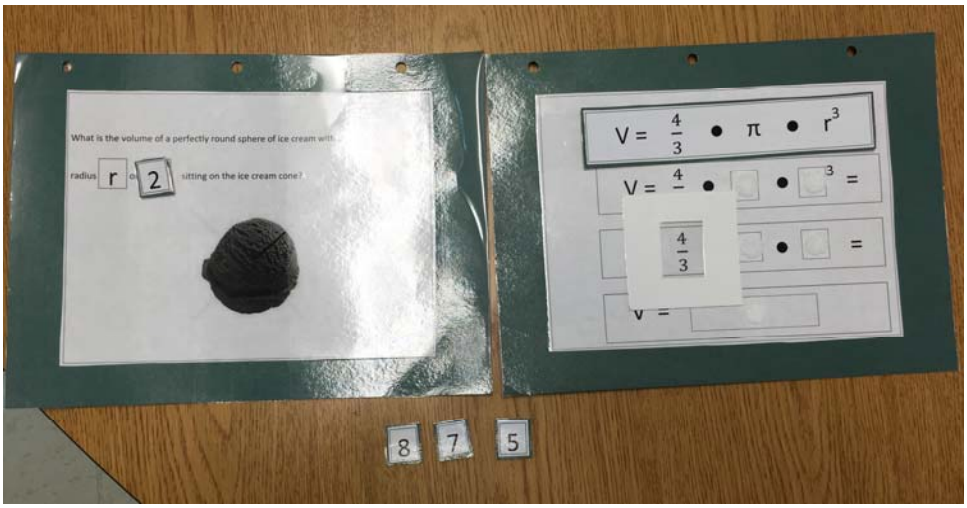


r = radius

$\pi = 3.14$

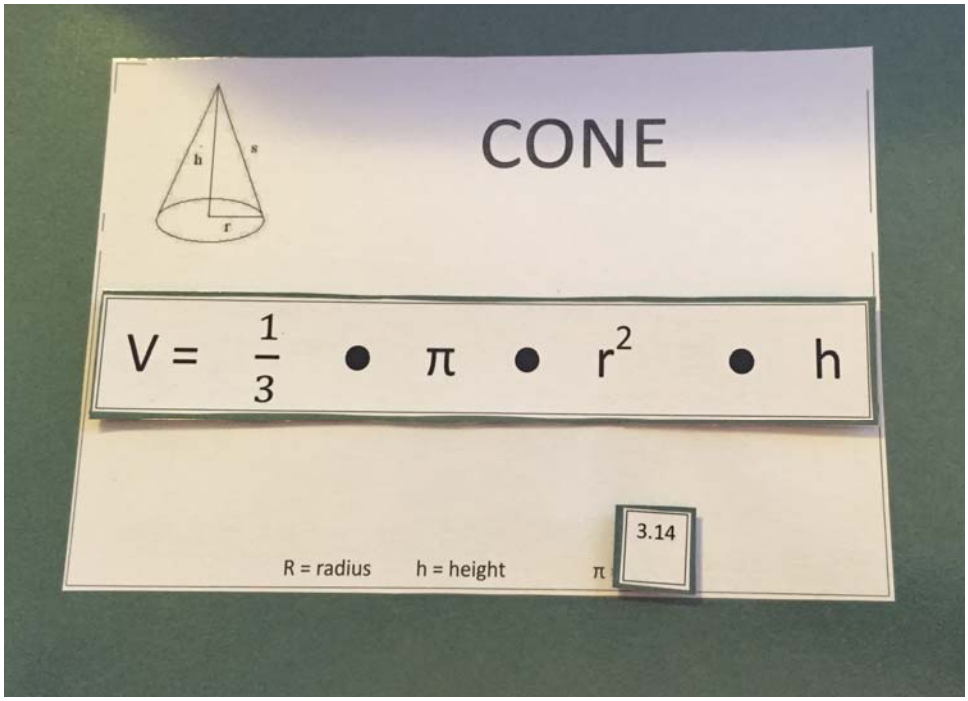
Appendix F

Student word problem with student response sheet and manipulatives, Joseph



Appendix G

Student Formula Example, Joseph



Appendix H

Data sheet example, Joseph

Name _____ Peer _____

Objective: Given volume formula, solve real-world problems involving cones, cylinders, and spheres.

Instructional Procedure: System of Least Prompts **Shape:** Cylinder

Prompt Key			
+ = Independent	V = Verbal	M = Model	P = Physical

Instructor Initials										
Date										
1. Point to formula that matches your problem.										
2. Move formula to worksheet.										
3. Replace radius and/or height and pi.										
4. Put the box around the expression with the exponent										
5. Type base into calculator.										
6. Push 'carrot' button.										
7. Type in the exponent.										
8. Push equals.										
9. Pick up the answer that matches the answer on the calculator. (present 3 answer choices)										
10. Replace answer choice into formula										
11. Move everything else down.										
12. Push clear on the calculator.										
13. Multiply the rest of the problem left to right.										
14. Pick up the answer that matches the answer on the calculator. (present 3 answer choices)										
15. Put answer choice in the box next to V = to solve the problem.										
# of Independent Correct Responses										
% of Independent Correct Responses										
# of Verbal Prompts										
% of Verbal Prompts										
# of Model Prompts										
% of Model Prompts										
# of Physical Prompts										
% of Physical Prompts										

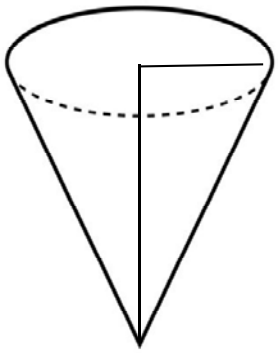
Appendix I

Generalization Worksheet, John and Mary

Name _____ Date_____

Read or listen to the question. Use the correct volume formula and a calculator to solve the problem.

An ice cream cone has a radius (r) of 2 inches and a height (h) of 5 inches. Find the volume of the cone to determine how much ice cream the cone will hold.



Appendix J

Data Sheet Example, John and Mary

Name _____

Objective: Given volume formula, solve real-world problems involving cones, cylinders, and spheres.

Instructional Procedure: System of Least Prompts **Shape:** Cone and Sphere

Prompt Key			
+ = Independent	V = Verbal	M = Model	P = Physical

Instructor Initials:										
Date:										
1. Point to a formula.										
2. Write the formula.										
3. Rewrite the formula, replacing the pi (π), radius (r), and height (h) if necessary.										
4. Use a calculator to solve the exponent and push equals.										
5. Write the answer below the exponent.										
6. Bring everything else down.										
7. Push clear on the calculator.										
8. Convert the fraction into a decimal.										
9. Multiply the rest of the problem.										
10. Write down the answer with two decimal places.										
# of Independent Correct Responses										
% of Independent Correct Responses										
# of Verbal Prompts										
% of Verbal Prompts										
# of Model Prompts										
% of Model Prompts										
# of Physical Prompts										
% of Physical Prompts										

Appendix K

Peer Tutor Survey

1. Do you like being a peer tutor?

   Yes
   No
   Sometimes
   Never

2. Was this an important skill for these students to learn?

   Yes
   No

3. Do you think the student you worked with learned the math?

   Yes
   No
   Sometimes
   Never

4. Was it good to use a peer tutor to teach this skill?

   Yes
   No
   Sometimes
   Never

5. Was it easy to help the student with the math worksheet using this method?

   Yes
   No
   Sometimes
   Never

Comments:

_____
_____
_____

Appendix L

Student Survey

1. Do you like to work with your peers?

   Yes
   No
   Sometimes

2. Do you like the way you learned?

   Yes
   No
   Sometimes

3. Was this an important skill for you to learn?

   Yes
   No

4. Was the peer tutor helpful?

   Yes
   No
   Sometimes
   I don't know

5. When will you need to use this math skill in real-life?

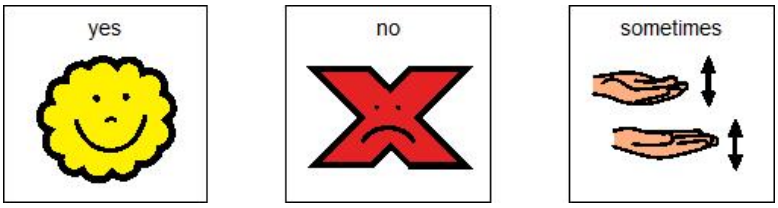
   _____
   _____
   _____

   Comments:
   _____
   _____
   _____

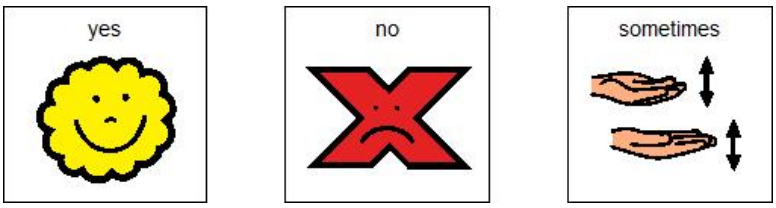
Appendix M

Student Survey

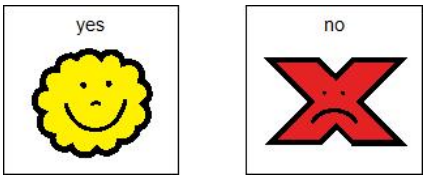
1. Do you like to work with your peers?



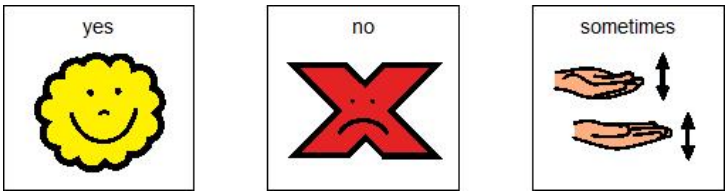
2. Do you like the way you learned?



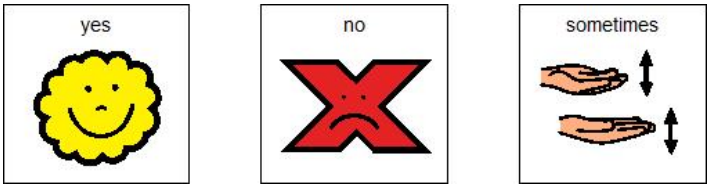
3. Was this an important skill for you to learn?



4. Was the peer tutor helpful?



5. Will you use this skill in real life?



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