Using Simultaneous Prompting Procedure to Promote Recall of Multiplication Facts by Middle School Students with Cognitive Impairment

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Abstract: This study examined effectiveness of simultaneous prompting system in teaching students with cognitive impairment to automate recall of multiplication facts. A multiple probes design with multiple sets of math facts and replicated across multiple subjects was used to assess effectiveness of simultaneous prompting on recall of basic multiplication facts. Two students with mild cognitive impairment at middle school level completed this intervention to recall 30 math multiplication facts between 0-12. Data collected over a period of approximately three and a half months indicated maintenance and generalization of the skill across materials, settings, and people.

From the six overarching principles of National Council of Teachers of Mathematics (NCTM, 2000) the first, ‘equity’ principle states ‘excellence in mathematics education requires equity—high expectations and strong support for all student’ (p. 12) and the ‘teaching principle’ emphasizes that ‘effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well’. Learning mathematical concepts and skills may be particularly difficult for students with cognitive impairments. However, these skills are essential for achieving an acceptable level of independence in adult life. According to Vaughn, Bos, and Schumm (2007) a central topic in education is mathematics instruction. The authors highlighted importance of teaching and learning basic math facts and expressed concern that a lack of knowledge of basic math facts is a common impediment to learning higher-level math for all students including students with disabilities. Due to this lack of knowledge of math facts students may learn neither math computation nor higher-order mathematics (p 399). McCallum, Skinner, Turner and Saecker (2006) cited various studies (Cates & Rhymer; Deno & Murkin; Haring & Eaton; Shapiro; Ysseldyke, Thill, Pohl, & Bolt) that emphasized importance of automaticity (arriving at answers accurately and rapidly) over and above understanding basic math facts such as multiplication facts.

Wolery, Ault, and Doyle (cited in Morse & Schuster, 2004) emphasized teachers’ responsibility in producing learning and a need to be experts at presenting instruction. Three essential conditions for students’ acquisition of a behavior or a skill described included students attending to relevant stimulus, teachers providing information about how to perform target behavior, and finally, providing feedback about the correctness of the response. Instructional antecedents (Snell & Brown, 2006) are planned and incidental stimuli used in learning situation in antecedent teaching methods used by teachers to teach skills and behaviors to students with cognitive impairment. Snell and Brown described prompting as a major category of antecedent strategies teachers can use to successfully teach various skills and behaviors to students with cognitive impairment. Response prompts are actions taken by a
teacher before a student responds (or after an error) to increase the probability of a correct response (Snell & Brown, p. 136). These prompts minimize errors during instruction and can be used singularly, in combination, or as a part of a prompting system. Prompting systems recommended and cited in successful studies include constant time delay, progressive time delay, system of least prompts, most-to-least prompts hierarchy, and simultaneous prompts (Kennedy & Horn, 2004; Snell & Brown; Westling & Fox, 2004; Wolery, Ault, & Doyle, 1992).

There are several reasons that simultaneous prompting is preferable to other response prompting procedures such as constant time delay, progressive time delay, and system of least prompts. Primarily, simultaneous prompting is more efficient for the classroom teacher to set up and implement. Unlike a system of least prompts, simultaneous prompting does not require the instructor to set up a hierarchy of prompts. Simultaneous prompting also requires fewer prerequisite skills unlike the wait response that is necessary with time delay interventions. Also, simultaneous prompting uses a controlling prompt that reduces instructional time and the quantity of student error (Singleton, Schuster, Morse, & Collins, 1999). It is similar to antecedent prompt and test in that zero second time delay trials are used throughout all training sessions. Daily probe sessions are conducted to determine if the student can respond to the discriminant stimuli without prompting. Two features of simultaneous prompting are unique. First, probe sessions are always conducted immediately before training sessions and second, a controlling prompt is used throughout the training sessions (Gibson & Schuster, 1992).

Morse and Schuster (2004) conducted a review of published literature pertaining to use of simultaneous prompting system that reported a total of 18 studies conducted between 1992 and 2002 that used the procedure successfully to teach various skills. Participants in 17 studies included individuals with mild, moderate and/or moderate to severe cognitive impairment, developmental delays, and one with learning disabilities and mild cognitive impairment. Within the last five years other studies (Akmanoglu & Batu, 2005; Akmanoglu-Uludag & Batu, 2005; Gursel, Tekin-Iftar, & Bozkurt, 2006; Tekin-Iftar, Acar, & Kurt, 2003) used simultaneous prompting procedure with students with autism and cognitive impairment.

The majority of research reported between 1992 and 2005 pertaining to use of simultaneous prompting system focused on teaching discreet or chained tasks to preschoolers and elementary aged children with four reporting studies with high school students, and two with adults. Only two studies (Fickel, Schuster, & Collins, 199; Gursel et al., 2006) had participants from middle school level. These studies successfully taught skills and behaviors that included receptively and/or expressively identifying various vocabulary, occupations, signs; object identification; identification of relatives; identification of maps, river, countries; and various discrete skills such as making juice, and construction of shipping boxes. Only three studies used simultaneous prompting to teach skills involving numbers and/or mathematics; Bikren (2005) taught telling time in hours, halves and quarters to a high school age students, Akamanoglu and Batu (2004) taught 6 and 17 year old students with autism to point to numerals, and Gursel et al. (2006) taught a group five middle school age students to name various mathematical symbols.

In light of the efficiency and effectiveness of simultaneous prompting in studies that have been conducted and potential benefit for the students, more research is warranted. Little has been written to date on effects of using simultaneous prompting to help junior high students with cognitive impairment to automate the recall of math facts. This study was conducted to determine if simultaneous prompting procedures could teach junior high students with mild cognitive impairment to automate the recall of multiplication facts. Progress of two students was compared to better measure effectiveness and efficiency of simultaneous prompting in the acquisition, maintenance, and generalization of the target behavior and to rule out the influence of other factors.

Specifically, this study addressed the following research questions: (1) Is simultaneous prompting effective in teaching two students with mild cognitive impairment automate the
recall of multiplication fact? (2) Will the two students with cognitive impairment be able to maintain the skill of recalling multiplication facts over time? (3) Will the two students with mild cognitive impairments be able to generalize the skill of recalling multiplication facts across other settings, materials, and people?

Method

Participants

This study was conducted with two students with cognitive impairment (CI) one male and one female enrolled in a public junior/senior high school serving students from 7th to 12th grades. Participants spent mornings in a special self-contained classroom for students with cognitive impairment. During mornings students received instruction in core subject areas of math, language arts, and geography from an instructor majoring in instruction of students with cognitive impairment. There were typically seven other students in the room at the same time as the participants. Students were both approximately 14 years and 10 months of age at the beginning of this study. A psychologist had diagnosed both participants as having intellectual disabilities. Student A (male, Caucasian) was not on any medication. Student B (female, black) took prescribed medication for a seizure disorder related to her cerebral palsy.

Student A, an eighth grader had a full scale I.Q. of 62 and excellent adaptive behavior skills that allowed him to pass through the school system until the seventh grade before he was diagnosed as having a mild cognitive impairment. He had a pleasant personality, and made friends easily. His major weakness was making decisions under pressure. He often got in trouble for not thinking before acting. In the areas of transition and vocational skills, student A had good skills. He displayed strong work habits learned on his family farm. Student A also had a strong grasp of basic science concepts and safety procedures. He did household chores at home, but would benefit from life skills classes on money, budgeting, renting, using credit, and consumer rights and responsibilities. Physically, student A was in good health and physical condition. In math, student A showed emergent competence in basic operations. He was strong in numbers and counting. His areas of weakness were remembering multiplication facts and calculating elapsed time.

Student B was a seventh grader with strong verbal skills in reading, listening, and speaking and had a full scale I.Q. of 49. She was especially weak in math with a grade level equivalent of 2-9 (2 year 9 months). It was necessary to modify classroom instruction in division to meet her needs. She was new to the school system as her adoptive parents moved from New Orleans. Her areas of weakness in language were in reading and listening comprehension. Her writing was very disorganized and she had a weak understanding of written language concepts. Student B had a very outgoing personality and made friends easily but she sometimes alienated her peers by being too clingy. She was competent in completing household chores and had acquired some independent living skills. She would benefit from life skill classes, and was weak in basic science and safety concepts. Student B had many ties to the community through her involvement with her church youth group. This provided her many opportunities to engage in recreational activities with her peers. She also participated in the school choir and art classes. In math, student B was strong in numbers and counting, and could do basic operations. Her areas of weakness were abstract concepts like elapsed time, money, and multiplication facts. According to the available records the student was diagnosed at an early age with mild to moderate cognitive impairment and cerebral palsy with a double hemiplegics pattern. She also had a shunt due to a hydrocephalic condition at birth, as well as other orthopedic impairments.

Screening

Though strengths and weaknesses of the students varied greatly based on their individual circumstances, they both had similar skills in math. They also had similar prior learning experiences since they both came from the same upper-elementary school before coming to the Junior./Senior High School. Both students had learned their multiplication tables through rote memorization. Both students had strengths in verbal receptive language,
and had mastered the majority of their multiplication tables using rote memorization. Therefore, the simultaneous prompting technique would work well for both students.

For this simultaneous prompting project, we worked with these students with cognitive impairment to help them automate recall of multiplication facts. The math class as a whole was working on long division involving decimals, and these two students were having particular difficulty. It took them a long time to recall multiplication facts and they often had to work out the problem using repeated subtraction instead of simply recalling the multiplication fact and reversing it. Also, learning their multiplication facts was a priority goal on both students IEP(s), as well as, being a survival skill for life.

The second author who was the classroom teacher working with the participants at the Junior/Senior High School and also a graduate student at a large Midwestern university had adequate knowledge of simultaneous prompting system and conducted all experimental sessions and collected data under the supervision of university professor, the first author. The first author who initiated this project also conducted inter-rater reliability checks, procedural reliability checks, and guided the second author throughout the duration of the study including analysis of data and interpretation of results.

Setting

All sessions in this research project were carried out in the students’ normal morning placement. This was a room at the south end of the building located next to the rear entrance of the school. Most days students came to this room directly upon entering school. The room had three large windows that faced west and allowed for substantial natural lighting. There were also three strips of fluorescent lighting spaced evenly across the ceiling that were typically in use during the time that students were present for instruction. Tables were arranged in two long rows facing south toward the blackboard where most direct instruction took place. Occasionally, tables were arranged in a horseshoe formation also facing the board. Students were adaptable and accepting of either arrangement. The room had nondescript walls, floor, and ceiling, but bright, cheerful decorations and displays of student work that made it a pleasant, welcoming atmosphere. The room was relatively quiet, but sometimes noise from the adjacent classroom filtered through.

During all baseline and training sessions the teacher sat across from the student at one of the students’ tables. All probes were conducted in a 1:1 ratio. The other students in the room did quiet seatwork during the probe sessions. All students worked with flashcards sometime during the day, so this was an accepted and normal occurrence that did not stigmatize participants.

Materials

The primary instructional materials for this study were flash cards constructed on 3x5” note cards, all of which were handwritten in the same size by the same person for consistency. Other materials consisted of baseline data sheets, daily full-probe session data sheets, daily training session data sheets, and maintenance data sheets. All sheets were color coded (blue for the male student, and pink for the female student) and tabbed for easy reference and use in a three-ring binder. The only other required instrument was a sharpened pencil.

Experimental Design

A multiple probes design with multiple sets of math facts and replicated across the multiple subjects was used to assess the effectiveness of simultaneous prompting on the recall of basic multiplication facts. The dependent variable in this research was number of correct responses given to the previously unknown multiplication facts. The independent variable for this study was the simultaneous prompting procedure. The independent variable was introduced using one multiplication set at a time. Experimental control was established through sequential introduction of the teaching set and introduction of the independent variable in time lagged fashion (Tawney & Gast as cited in Birkan, 2005; Tekin- Iftar et al., 2003; Tekin & Kircaali-Iftar as cited in Akamanoglu & Batu, 2004)
General Procedure

The goal of this research project was to see if simultaneous prompting would be effective in teaching students with cognitive impairment to automate the recall of multiplication facts from 0-12. Both students who participated in this research had a firm grasp of 114 of the 144 multiplications facts from 0-12. The remaining 30 facts had not been learned, were learned incorrectly, or were not practiced enough to be maintained. These 30 multiplication facts were written on 3x5” note cards, all of which were handwritten in the same size by the same person for consistency.

Through using the intervention of simultaneous prompting, it was the aim of this project to provide an opportunity for errorless learning of these facts by providing the correct response immediately during training sessions, before the student made an incorrect response. Showing the student a flash card with the targeted multiplication fact on it, asking for an answer, and immediately providing the student with the correct response would accomplish this.

Experimental procedure consisted of full-probe (baseline), daily probe, training, maintenance, and generalization phases. During training sessions five flashcards were presented, one at a time. When the student had mastered these five facts, they moved on to the next set of five. Students demonstrated mastery of a set by responding correctly to those facts 100% of the time in at least two consecutive daily-probe sessions. The project took approximately three-and-half months to complete including baseline data collection.

Generalization was assessed in the classroom setting, as well as others. In the normal course of the math class conducted in this room, the students had multiple opportunities to demonstrate generalization. Data were collected on the students’ ability to recall and use the targeted multiplication facts when working long division problems. Also, a direct comparison of students’ performance on routine progress monitoring probes before and after the intervention was assessed. Finally, observations and antidotal data were collected from students’ general education classrooms on their ability to recall and use the targeted multiplication facts.

Task Selection

To initiate this project it was necessary to determine exactly which multiplication facts students had committed to memory and which they had not. To accomplish this task each student was shown a series of flashcards representing all multiplication facts from zero through twelve. Each student participated in these sessions individually. The classroom instructor, who was also the student researcher, conducted each probe session. At the beginning of each baseline session the attention of students was secured by asking them if they were ready to begin. When they responded with an affirmative the task direction was presented. “When I show you each flashcard, please say the correct answer. If you do not know the answer, it is O.K. I will wait four seconds then show you the next flashcard. Do you understand?” When students responded in the affirmative, the session began. Each flashcard was presented one at a time in random order. Students had four seconds to produce the correct response to each flashcard.

As students progressed through all flashcards, the researcher discreetly put the cards that the student responded to incorrectly or did not respond to in four seconds (4s schedule), into a separate pile to be recorded later. At the end of each session, students were thanked for their participation and praised for their effort as a form of reinforcement. The students consistently responded incorrectly, or not at all, to between 30 to 47 of the multiplication facts. To simplify the execution of the study, the 30 incorrect multiplication facts that the students had in common were selected. The 30 multiplication facts were then broken down into 6 sets of 5 each (see Table 1).

Full-probe Session (Baseline Data)

Once the thirty target facts and the sets were decided, three baseline/full-probe probe sessions were conducted each day for five days for student A, and three baseline probe sessions were conducted each day for eight days for student B until a stable baseline score was obtained. The full-probe sessions for baseline were conducted exactly as above following the 4s schedule. All 30 flashcards were presented one at a time in random order. Students had
four seconds to produce the correct response to each flashcard. As students progressed through the flashcards, the researcher recorded ‘X’ for an incorrect response or no response within 4 seconds, and a checkmark for a correct response on the full-probe data sheet. Three trials were conducted during each full-probe session and the percentage of correct responses was calculated. At end of these sessions students were thanked for their attention and cooperation.

**Daily-probe Session**

The daily-probe gave a chance for participants to respond independently to stimulus cards with target math facts by sets and helped collect the study data. The reason for having daily probe sessions was that while using simultaneous prompting, correct answer or the controlling prompt is provided simultaneously when the stimulus cards are presented, the students do not have a chance to respond independently and as such, it is not possible to test student’s achievement of the skill and collect data. A Daily-probe session was conducted each school day, prior to each training session. The daily-robe session was conducted exactly like the full-probe baseline sessions. The only difference was that these sessions were conducted for each of the five sets instead of presenting all 30 facts randomly.

Each student participated in the daily-probe sessions individually. The classroom teacher, who is also the student researcher, conducted each probe session. At the beginning of each daily-probe session the attention of the students was secured by asking them if they were ready to begin. When they responded with an affirmative, the task direction was presented as “When I show you each flashcard, please say the correct answer. If you do not know the answer, it is O.K. I will wait four seconds then show you the next flashcard. Do you understand?” When the students responded in the affirmative, the daily-probe session began. Each of the 30 flashcards was presented one at a time, in random order. Students had four seconds to produce a response to each flashcard. As students progressed through the flashcards, the researcher recorded ‘X’ for an incorrect response or no response within 4 s, and a checkmark for a correct response on the daily-probe data sheet. Three trials were conducted during each daily-probe session and the percentage of correct responses was calculated. The overall percentage of correct responses of each trial was averaged for each day to see if the criterion for mastery had been met. Mastery criterion was defined as 100% accuracy of the facts currently being taught (or taught previously in prior sets). At the end of each daily-probe session, students were thanked for their participation and praised for their effort as a form of reinforcement. Student A reached mastery criterion in the 18th daily probe session. Student B reached mastery level in the 24th daily probe session.

**Training Session**

Immediately following each daily-probe session, a training session was conducted on one set of five multiplication facts. During training sessions the five flashcards were presented, one at a time. Each student participated in the training sessions individually. During the training session direction and the controlling prompt (correct answer) were both delivered simultaneously (0s delay). Each training ses-

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**TABLE 1**

<table>
<thead>
<tr>
<th>Multiplication Facts Sets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set 1</strong></td>
</tr>
<tr>
<td>9 × 4</td>
</tr>
<tr>
<td>6 × 9</td>
</tr>
<tr>
<td>8 × 8</td>
</tr>
<tr>
<td>7 × 9</td>
</tr>
<tr>
<td>4 × 8</td>
</tr>
</tbody>
</table>
session had a total of five trials with a 4s interval between each trial. At the beginning of each training session, the attention of the students was secured by telling them we were going to learn some multiplication facts and asking them if they were ready to begin. When they responded with an affirmative the task direction was presented. “I will first show you a flashcard and also tell you the answer and you will listen. Then, when I ask you what the answer is, you will repeat”. When students responded in the affirmative, the training session began. Each of the five flashcards in the given set was presented one at a time, in random order. Students had four seconds to produce the correct response to each flashcard when the student was asked to give the multiplication fact before proceeding to the next training trial. At the end of each training session, that lasted between 3-5 minutes students were thanked for their participation and praised for their effort as a form of reinforcement. Training sessions continued until students reached a 100% correct responding on three consecutive days during the daily-probe sessions.

When the student mastered the five facts in the set, they moved on to the next set of five. The number of sessions it took to master a set of facts varied by student and by difficulty of the facts in each set. Student A, for example, required five training sessions to master the first set of multiplication facts, but then proceeded to learn subsequent sets with a consistently decreasing number of training sessions (Set 1 – 5 training sessions, set 2 - 4 training sessions, sets 3 through 6 – 2 training sessions each). Student B, on the other hand, had a more varied learning pattern. She required 5 training sessions to learn set 1, 7 training sessions for set 2, 3 training sessions for set 3, 2 training sessions each for sets 4 and 5, and 4 training sessions for set 6. Students demonstrated mastery of a set by responding correctly to those facts 100% of the time in at least two consecutive daily-probe sessions.

Student A required a total of 18 training sessions to master all 30-multiplication facts to criterion level. Student B required a total of 24 training sessions to master all 30-multiplication facts (See Table 2).

**Maintenance**

Maintenance probe sessions were built into the study by using a multiple probe design (Birkan, 2005). Conducting the daily-probe sessions with all 30 facts in sets of five prior to each training session not only helped collect the study data but also helped with maintenance of the learned facts. Continuing the daily probe sessions for several days after the last set of facts had been mastered and the training sessions had ceased assessed maintenance of the 30 multiplication facts. Maintenance probe sessions were conducted exactly like the daily-probe sessions, except that they were no longer followed by training sessions. Each student participated in the maintenance probe sessions individually. All 30 flashcards in sets of five was presented one at a time, in random order. Students had four seconds to produce the correct response to each flashcard. As the students progressed through the flashcards, the researcher recorded ‘X’ for an incorrect response or no response within 4

**TABLE 2**

Participants’ Instructional Data

<table>
<thead>
<tr>
<th>Student A</th>
<th>Baseline Data (Full Probe)</th>
<th>Sessions 5</th>
<th>% Errors (Average) 98.6%</th>
<th>Time 1 hr 15 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Probe</td>
<td>Sessions 18</td>
<td>% Errors (Average) 15.2%</td>
<td>Time 1 hr 30 min</td>
<td></td>
</tr>
<tr>
<td>Training Session</td>
<td>Sessions 18</td>
<td>% Errors (Average) 8.6%</td>
<td>Time 3 hr 0 min</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Sessions 13</td>
<td>% Errors (Average) 0.15%</td>
<td>Time 1 hr 15 min</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Student B</th>
<th>Baseline Data (Full Probe)</th>
<th>Sessions 8</th>
<th>% Errors (Average) 100%</th>
<th>Time 1 hr 25 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Probe</td>
<td>Sessions 24</td>
<td>% Errors (Average) 26.4%</td>
<td>Time 1 hr 35 min</td>
<td></td>
</tr>
<tr>
<td>Training Session</td>
<td>Sessions 24</td>
<td>% Errors (Average) 17.6%</td>
<td>Time 3 hr 15 min</td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>Sessions 4</td>
<td>% Errors (Average) 0.0%</td>
<td>Time 1 hr 15 min</td>
<td></td>
</tr>
</tbody>
</table>

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seconds, and a checkmark for a correct response on the maintenance probe data sheet. Three trials were conducted during each maintenance probe session and the percentage of correct responses was calculated. Overall percentage of correct responses of each trial was averaged for each day to see if the criterion for mastery was maintained. At the end of each probe session, students were thanked for their participation and praised for their effort as a form of reinforcement.

Maintenance probes for Student A were performed for 10 consecutive sessions after training sessions ended, then at one-week intervals for three weeks. Student A maintained 100% accuracy through all 13 maintenance probe sessions. Maintenance Probes for Student B were performed the day after training sessions ended and at one-week intervals for three weeks. Student B maintained 100% accuracy through all 4 maintenance sessions. Maintenance probes were continued longer for Student A (13 sessions altogether) to give Student B time to reach mastery, so both students could begin the generalization process together. Student B required 6 more training sessions than Student A. Also Student B began training 3 days later than Student A, due to the delayed start model of the experiment that required three additional days of baseline for Student B.

**Generalization**

Both students demonstrated generalization of the multiplication facts learned in the training sessions by completing a two-minute timed multiplication test in their normal math class. Six other students also took the timed tests at the same time as Student A and B, since this is a normal part of the regular math class. The timed tests were presented on 8.5 x 11” paper with seven single digit multiplication problem presented vertically in each row. There were six rows of problem on each paper. Three timed tests were given to each student to assess generalization. Generalization sessions took place in the morning on three consecutive school days, following the last maintenance probes for both students. The test was conducted by a paraeducator that was not part of the simultaneous prompting training. Also, the timed test included all multiplication facts, not just those taught in the simultaneous prompting training sessions. Both students achieved 100% accuracy on this timed test, thus demonstrating generalization across format, setting, and personnel.

Furthermore, students dramatically improved the number of correct digits per two-minute timed test after this experiment. Prior to this experiment, Student A averaged 38 correct digits per two minutes on the weekly curriculum based measurement (CBM) math probes of multiplication facts. However during the generalization sessions Student A averaged 47 digits correct per two-minutes. Student B averaged 22 correct digits per two-minute CBM probe prior to the experiment, but averaged 34.3 correct digits per two minutes during the generalization sessions. Evidence of generalization of the skill was also observed in the areas of science and long division, where students’ speed and accuracy in using multiplication facts to solve problems had noticeably improved.

**Reliability**

Throughout the baseline, training, and maintenance sessions the first author (principal investigator and university professor) supervising this study conducted random inter rater reliability checks and procedural reliability checks. Procedural reliability checks were conducted to see that appropriate procedure including administering the instruction, collecting and recording the data were in place. Steps recommended and used in previous studies (Akmanoglu & Batu, 2005) included (1) controlling the materials, (2) attention securing, (3) delivering the task directions, (4) delivering the controlling prompt, (5) correct response time, (6) giving appropriate response, and (7) correct inter-trial interval. These observations resulted in procedural reliability score above 90%. The interrater reliability checks obtained by dividing number of agreements divided by number of agreements plus disagreements and multiplied by hundred (Akmanoglu & Batu, 2005) resulted in 100% inter rater reliability.

**Social Validity**

Understanding basic math facts, ability to accurately respond to basic math facts, and an
ability to rapidly arrive at correct answers is a prerequisite to understanding and carrying out higher order mathematical computations. This was a skill that everyone else in the math class was working on and these two students had particular difficulty with. Also, learning their multiplication facts was a priority goal on both students IEP(s), as well as, being a survival skill for life.

Results

Results (see Figure 1 & Figure 2) and maintenance and generalization data revealed that this intervention involving using simultaneous prompting was successful. Both students had learned to automate recall of multiplication facts and maintained the skill learned and were able to generalize across setting, material, and people. Table 2 lists participants’ data indicating number of sessions and average % errors that decreased to near errorless phase. Student A had a total of 55 sessions over a total time of seven hours for intervention to be successful and student B the intervention had involved 56 sessions over a total time of seven hours and 30 minutes. Students A and B continued to be monitored for the remaining six weeks of the school year. They maintained their skills at 100%, and continued to improve their speed and consequently their scores on the two-minute CBM probes. Further monitoring at the beginning of the next school year will test retention over the summer months. The same simultaneous prompting procedure will be employed to reteach any skills that were lost during that time period.

Discussion

The No Child Left Behind Act (NCLB) of 2001 requires that all students should be included and make adequate yearly progress in high-stakes assessments, regardless of disability. Added to this is the provision of access to general curriculum promoted by the reauthorization of Individual with Disabilities Act (IDEA) in 1997 and again, in 2004. To create this access to general education mathematics curriculum teachers need to use effective, near errorless strategies that promote success in and motivation to learn basic math concepts that lead to success in higher order mathematics skills.

This study successfully taught two middle school age students with cognitive impairments to automate recall of multiplication facts that they were able to generalize in other settings, with other materials, and with people.
ple. Morse and Schuster (2004) in their literature review and other recent studies (Akmanoglu & Batu, 2004; Akmanoglu-Uludag & Batu, 2005; Birkan, 2005; Gursel et al., 2006; Tekin-Iftar et al., 2003) reported successful use of simultaneous prompting in teaching various discrete chained tasks and learning receptive and expressive vocabulary in content areas. Limited research is reported however, using this procedure in teaching mathematical concepts.

More research is needed to examine effectiveness of simultaneous prompting system in teaching other essential mathematical concepts and areas highlighted in the NCTM (2000) standards that include various concepts under number operations, algebra, geometry, measurement, data analysis and probability, representation, connections, problem solving, and communications. This study had a limitation in terms of sample size of only two participants and it may need to be replicated with a small group of students in a similar setting of resource room as well as, in inclusion setting in general education classrooms given a steady move towards inclusive setting for students with cognitive impairments and other disabilities. More studies also need to be conducted with students with different disabilities and also with students without disabilities. Lastly, although simultaneous prompting has many reported (see Singleton et al., 1999) advantages over other prompting systems such as constant time delay that have been used in general education classrooms (see McCallum et al., 2006) there is a need to conduct more comparative studies using constant time delay and prompting procedures (such as progressive time delay and system of least prompts).

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