Embedded Simultaneous Prompting Procedure to Teach STEM Content to High School Students with Moderate Disabilities in an Inclusive Setting

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Abstract: Effects of an embedded simultaneous prompting procedure to teach STEM (science, technology, engineering, math) content to three secondary students with moderate intellectual disabilities in an inclusive general education classroom were evaluated in the current study. Students learned discrete (i.e., geometric figures, science vocabulary, or use of technology to publish) and chained tasks (i.e., linear equation, Punnett square, or Internet research) from a peer tutor and paraprofessionals. Using a multiple probe across participants design, results showed students reached criterion in two to eight sessions and maintained the skills for one month following intervention. Generalization was also at higher levels than in the baseline condition. In addition, general education students who attended class with the participants expressed positive comments based on the intervention.

The National Science Board has argued that every student in the United States “. . . deserves the opportunity to achieve his or her full potential” (NSF, 2010, p. v). As STEM (science, technology, engineering, math) permeates every aspect of our lives, it is crucial that all students have access to this content. Students benefit from science content by learning about themselves and the natural world; from engaging in technology by learning how to use smart phones, mobile devices, and computers; from engineering concepts by learning how to solve problems; and from math content by learning how to budget their money and determining how much they have for groceries (Science Pioneers, 2013). There is a national emphasis on preparing students for STEM careers; however, all citizens, even those not pursuing STEM careers, should be able to participate in the scientific and technical issues affecting our society (Matthews, 2007).

Common Core State Standards (CCSS) and the Next Generation Science Standards (NGSS) emphasize the importance of high expectations for all students. According to Kleinert, Kearns, and Kennedy (1997), “. . . one of the keys to ensuring high expectations for every child is requiring that all students be included in measures of educational accountability” (p. 88). Based on these assertions, it is likely that assessments for all students, including alternate assessments based on alternate achievement standards (AA-AAS) for students with moderate and severe disabilities (MSD), will be derived from the content recommended in the CCSS and NGSS.

While practices for implementing the AA-AAS vary from state to state, having access to the general education curriculum is key for promoting student progress in content areas. Jackson, Ryndak, and Wehmeyer (2010) argued that the interplay between context of

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instruction and curriculum content is a critical consideration in student learning and progress since students with disabilities who are included in general education contexts are more likely to engage in activities related to grade level standards than students who are in self-contained settings.

Hudson, Browder, and Wood (2013) conducted a literature review to evaluate evidence-based practices for students with MSD in inclusive contexts. Authors found embedded instruction (specifically using constant time delay [CTD]) to be an evidence-based practice. Embedded instruction can be defined as an instructor (teacher, paraprofessional, or peer) distributing trials throughout a lesson or naturally occurring routine in the inclusive classroom. Studies in the review focused on teaching reading and writing skills (e.g., Collins, Hall, Branson, & Holder, 1999), social studies skills (e.g., Collins, Evans, Creech-Galloway, Karl, & Miller, 2007), science skills (e.g., Jimenez, Browder, Spooner, & DiBiase, 2012), and math skills (McDonnell et al., 2006) to students with moderate and severe disabilities within general education classrooms. Hudson et al. (2013) commended researchers for evaluating procedures to teach a range of academic content in general education settings; however, they recommended additional research on strategies to teach complex and chained skills in inclusive environments. Further, only two quality studies in the review used simultaneous prompting (SP), suggesting a need for further research on this strategy in general education settings.

In most of the quality studies reviewed in the Hudson et al. (2013) review, researchers used systematic instruction to teach students core content in general education settings. Methods of systematic instruction include the system of least prompts (SLP), time delay, and simultaneous prompting procedures. Perhaps the easiest and least time consuming method to implement is the SP procedure because the instructor presents the stimulus and the controlling prompt at the same time on each training trial, conducting daily probe trials prior to instructional trials to determine if the student has acquired the target skill (Collins, 2012). Collins et al. (2007) used the SP procedure to teach core content vocabulary to 4 students with MSD at the elementary, middle, and secondary levels, finding the procedure to be effective whether it was delivered in a segregated or an inclusive classroom setting. Riesen, McDonnell, Johnson, Polychronis, and Jameson (2003) and Head, Collins, Schuster, and Ault (2011) compared the efficiency of the CTD and SP procedures in teaching academic content (e.g., science and history vocabulary, state capitols) to middle or high school students with disabilities. In both studies, the researchers found the CTD and SP procedures to be equally effective, but the SP procedure was found to be slightly more efficient (i.e., faster acquisition of skills).

A body of literature has emerged suggesting that, in addition to academic gains, inclusive settings offer the opportunity for positive social effects on students, both with and without disabilities (e.g., Kennedy, Shukla, & Fryxell, 1997). Results have indicated greater social benefits for students who were included full time in general education classrooms. For example, students who were included full time engaged in more frequent interactions with peers without disabilities, more social contacts across a wide range of activities and settings, higher levels of social support behaviors, larger friendship networks, and longer lasting relationships with peers.

While prior research has shown promising effects as a result of teaching in inclusive classrooms, there are several limitations to the research. For example, few studies to date have taught students complex or chained skills in inclusive settings, and no studies exist evaluating STEM-related chained tasks. Hudson et al. (2013) recommended future research using SP in inclusive settings, and despite previous calls for research, sight word identification remains the skill most frequently addressed in these settings. In addition, no research exists on teaching STEM skills identified as part of the AA-AAAS in a general education classroom using an embedded SP procedure. The goal of this study is to evaluate the effects of using an embedded SP procedure to teach STEM-related tasks to students with moderate intellectual disabilities in an inclusive setting.

The current study examined instruction on the state standards related to STEM content on which students taking part in the AA-AAAS were tested. The study occurred in a suburban high school in a southern state, therefore fo-
focusing on the state’s AA-AAS. The special education teacher and the general education teacher collaborated to develop a plan for instruction in the general education classroom to be delivered by a paraprofessional or a peer tutor, which included embedding the SP procedure into the natural routine of the general education classroom. Specifically, the current study focused on the following research questions: (a) Will the embedded SP procedure result in the acquisition of STEM content skills by students with moderate intellectual disabilities in the general education classroom? (b) Will peer tutors and paraprofessionals implement the embedded SP procedure with high levels of procedural fidelity? (c) Will the target students maintain the acquired skills over time? (d) Will the target students generalize the STEM skills to situations that simulate the AA-AAS? and (e) Will inclusion of the target students in the general education classroom result in positive social relationships with their peers without disabilities?

Method

Participants

Students. Three students with moderate intellectual disabilities from a public suburban high school participated in the investigation. The students each attended at least two general education classes (some with support from paraprofessionals or peers) and attended the rest of their classes in a self-contained special education classroom. Reading and math achievement scores are not available, as the teacher who implemented the study is no longer at the school.

Kate was a 17-year-old female with multiple disabilities (i.e., visual impairment, moderate intellectual disability) who received services under the educational classification of functional mental disability (FMD; the state’s term for MSD) and participated in the AA-AAS. As a 10th grader, she was to be tested in math and writing for that school year. Kate had a diagnosis of Cortical Visual Impairment (CVI); she did not benefit from glasses but required preferential seating and enlarged materials. According to the Wechsler Intelligence Scale for Children: 4th Edition (WISC-IV; Wechsler, 2003), Kate’s full scale IQ was 56. Kate could independently add and subtract two digit numbers and could multiply and divide using a calculator. She worked on functional math skills, including counting money and making purchases. Her IEP goals included engaging in appropriate communication with peers and adults, making purchases in the community, identifying the meaning of weekly vocabulary words, answering comprehension questions, writing with correct grammar, using correct punctuation and capitalization, and completing vocational tasks in school and the community. Kate’s long term goal is to work in a restaurant. Prior to the start of the study, Kate attended a general education choir class and Art class.

Ben was a 16-year, 7-month old male with a classification of multiple disabilities (i.e., autism, moderate intellectual disability). He participated in the state’s AA-AAS and, as a 10th grader, was to be tested in math and writing for that school year. According to the WISC-IV, Ben’s IQ was 47. He could write basic sentences and had strong communication skills, although he was often off subject or talked to himself. Ben’s IEP goals included using appropriate language and topic when communicating with peers and adults, making purchases, identifying the meanings of vocabulary words, answering comprehension questions, writing with appropriate grammar mechanics, completing a vocational task, and using appropriate communication skills. Ben has volunteered in a library and his career goal is to work in one upon graduation. Before the study began, Ben was enrolled in a general education computer applications class (the same class used for the study).

Jacob was a 17-year, 8-month old male identified as eligible for services under the category of FMD. He participated in the state’s AA-AAS and, as an 11th grader, was to be tested in science for that school year. According to the Stanford-Binet Intelligence Scale: Fourth Edition (Thorndike, Hagen, & Sattler, 1986), Jacob’s IQ was 53. He had strong basic reading and comprehension skills and wrote legibly, although he had difficulty writing complete sentences. His IEP goals included using age-appropriate language to communicate, budgeting money, identifying the meanings of vocabulary words, answering comprehension questions, writing using correct grammar, and completing vocational tasks. Jacob’s post secondary goal is to
work with animals in some capacity (e.g., animal shelter). Prior to the study, Jacob attended a general education Drama class.

Others. The special education teacher (first author) collected all baseline, probe, and procedural fidelity data. She was a graduate student in special education, with an undergraduate degree in special education - MSD. She had 5 years of experience teaching in self-contained classrooms and had conducted professional development trainings on systematic instruction for the school district.

The special education teacher selected two paraprofessionals to implement the SP procedure within the general education classroom. The first paraprofessional was a 57-year-old female with a Bachelor’s degree in retail management and marketing. She had 5 years of experience in an FMD classroom, had received extensive training in systematic instruction procedures, and regularly collected classroom data. She had 4 years of experience supporting students in an inclusive related arts class, but did not have any experience using systematic instruction in an inclusive setting. In the current study, she attended the Biology class with Jacob. The second paraprofessional was a 45-year old female who was working toward a degree in human services. She had 1 year of experience in an FMD classroom and in supporting students in inclusive settings (i.e., core content and related arts classes). She had minimal training in systematic instruction and data collection procedures, but did not have any experience implementing systematic instructional procedures in these settings. In this study, she implemented the SP procedure with Ben in the Computer Applications class. The special education teacher also selected one peer tutor to serve as an instructor in the general education setting. The peer tutor was 17 years old, was in the 11th grade, and had a 3.3 grade point average. The peer tutor had 1 1/2 years of experience in the special education classroom and had prior experience using a CTD procedure. She had no previous experience supporting students in an inclusive setting, but in the current study, she attended the Algebra class with Kate.

Prerequisite Skills

The students met the following prerequisites: (a) visual acuity to see stimuli, (b) auditory skills to listen to verbal directions, (c) verbal skills to repeat controlling prompt, (d) ability to engage in task for 10 min, (e) participation in the AA-AAS during the current school year, and (f) daily participation in general education classes. The study received the appropriate Institutional Review Board (IRB) approval from all appropriate agencies and participants.

Target Skills

The special education teacher selected the target skills for this investigation based on students’ IEP goals, relationship to post secondary goals, consideration of AA-AAS standards, and were developed in collaboration with the general education teachers. For example, Kate’s target skills of using linear equations and identifying geometric shapes relate to her goal of working in a restaurant (e.g., linear equations may help her determine how much money she will make at the end of the week, her co-workers may use the names of geometric shapes when referring to items used in a restaurant, geometry is beneficial when considering how to fold napkins, cut pies, etc.). Since Ben is interested in working at a library in the future, looking up information on the internet, as well as learning vocabulary words about ways to publish on the internet, would both be integral skills to making his transition from school to post school employment successful. Jacob wants to work with animals in some capacity in the future and was a member of the recycling club at school. These factors were taken into consideration when selecting his goals related to the vocabulary words on homeostasis and Punnett squares. An expert in STEM was consulted to ensure the tasks were aligned to STEM content. Information on the specific targeted discrete and chained skills for each student is listed in Table 1.

Setting

The special education teacher conducted baseline probe, daily probe, maintenance,
and generalization probe sessions in the special education classroom. Instructional sessions occurred in the following general education classrooms: (a) Kate, who was included in a sophomore Algebra class, (b) Ben, who was included in a 10th-12th grade Computer Applications class, and (c) Jacob, who was included in a 11th grade Biology class.

Materials and Equipment

Materials needed to implement the study included (a) 4 × 6-in index cards with target words printed on them, (b) science and math worksheets, (c) calculator for math, (d) data sheets, and (e) task analyses. The math worksheet consisted of two linear equations and enough space under each for the participant to write out the steps to solve the problem. The science worksheet consisted of two blank Punnett Squares and two different genetic combinations (e.g., BB x Bb). Worksheets for the writing/using technology chained task were not used, as the task was completed on the computer.

Data Collection

The special education teacher collected data on two different sets of skills for each student; each set consisted of one chained task and one discrete task. She recorded correct completion of a response with a “+” and incorrect completion of a response with a “−.” Incorrect responses for chained tasks included (a) performing a step incorrectly, (b) performing a step in an incorrect order, (c) not initiating a step within 5 s of the previous step, (d) not completing a step within 20 s, or (e) making no response. Incorrect responses for discrete tasks included (a) stating the wrong word or shape, (b) not stating a word or shape within 5 s of the task direction, or (c) making no response.

TABLE 1
Discrete and Chained Target Skills for Each Student Participant

<table>
<thead>
<tr>
<th>Name</th>
<th>Discrete Skill</th>
<th>Chained Task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kate</td>
<td>Identify Geometric Figures</td>
<td>Solve Linear Equation in One Variable</td>
</tr>
<tr>
<td></td>
<td>1. Cube</td>
<td>1. Write “+” or “=” on each side of equation</td>
</tr>
<tr>
<td></td>
<td>2. Octagon</td>
<td>2. Perform operation</td>
</tr>
<tr>
<td></td>
<td>3. Sphere</td>
<td>3. Write new equation</td>
</tr>
<tr>
<td></td>
<td>4. Cone</td>
<td>4. Write “divide” by multiplier on each side</td>
</tr>
<tr>
<td></td>
<td>5. Pyramid</td>
<td>5. Perform operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Write/state what x equals</td>
</tr>
<tr>
<td>Ben</td>
<td>Using Technology to Publish</td>
<td>Research a Topic on the Internet</td>
</tr>
<tr>
<td></td>
<td>1. Blog – online journal</td>
<td>1. Highlight web address bar</td>
</tr>
<tr>
<td></td>
<td>2. Wiki – website where people can work together to edit or change piece of writing</td>
<td>2. Type <a href="http://www.google.com">www.google.com</a></td>
</tr>
<tr>
<td></td>
<td>3. Scholarly Journal – peer-reviewed periodical containing research</td>
<td>3. Click on google search bar</td>
</tr>
<tr>
<td></td>
<td>4. Chatroom- online conference site</td>
<td>4. Type search word</td>
</tr>
<tr>
<td></td>
<td>5. Facebook – social networking site</td>
<td>5. Press “search or push “enter” key</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Click on website</td>
</tr>
<tr>
<td>Jacob</td>
<td>Identify Meaning of Vocabulary Words</td>
<td>Fill Out Punnett Square</td>
</tr>
<tr>
<td></td>
<td>1. Carrying capacity – maximum population size that environment can sustain</td>
<td>1. Write letters on top of square</td>
</tr>
<tr>
<td></td>
<td>2. Resources – something that satisfies needs of living organism</td>
<td>2. Write letters on side of square</td>
</tr>
<tr>
<td></td>
<td>3. Limiting factors – something that causes population to decrease in size</td>
<td>3. Write letter combination in first block</td>
</tr>
<tr>
<td></td>
<td>5. Species – group of organisms</td>
<td>5. Write letter combination in third block</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. Write letter combination in fourth block</td>
</tr>
</tbody>
</table>
Procedure

Simultaneous prompting training. Prior to beginning instruction, the paraprofessionals and peer tutor received training in the SP procedure from the special education teacher. The 45-min training consisted of an instructional PowerPoint presentation, followed by modeling and individual practice. The PowerPoint included information on the following: (a) systematic instruction, (b) prompting procedures, (c) discrete vs. chained tasks, (d) the target skills for the study, (e) attentional cues and responses, (f) baseline, (g) defining class downtime, (h) giving a task direction, (i) the SP procedure, (j) reliability data, and (k) the students’ working folders. Information on data collection procedures for baseline and test probes was not included since the paraprofessionals and peer tutor would not be delivering any probes. The paraprofessionals and the peer tutor practiced the SP procedure with each other until they reached 100% accuracy for one session, prior to beginning intervention.

Baseline procedures. Baseline condition occurred prior to implementing intervention and lasted for a minimum of 3 days. Sessions occurred in a 1:1 instructional format. Each session consisted of one trial for chained tasks and one trial for each of the discrete tasks. After conducting baseline probe sessions at the beginning of the study for each of the participants, the special education teacher continued conducting baseline probe sessions 1 day per week for each participant and skill not currently in intervention.

The special education teacher sat at a table across from the student. For chained tasks, she gave the task direction and handed the student the worksheet to begin. The teacher read the problem on the worksheet aloud to the student and for the math worksheet she gave the student a calculator to use. She gave the student 5 s to initiate each step and 20 s to complete each step. If the student performed an error, the teacher ended the session (i.e., single opportunity format; Cooper, Heron, & Heward, 2007). She then praised the student for on-task behavior. For discrete tasks, the teacher showed an index card with either a vocabulary word or a picture of a geometric shape. She then provided the task direction and gave the student 5 s to respond. The teacher praised all correct responses and ignored all incorrect responses or failures to respond.

Instructional procedures. All sessions took place 5 days per week. In the SP procedure, daily probe sessions occur prior to daily training sessions. Daily probe session consisted of the same procedures as baseline probe sessions.

A peer tutor or a paraprofessional conducted daily training sessions. Before each student went to the assigned general education class, the special education teacher gave the student a folder with his or her work for the day (i.e., worksheet for chained task, index cards for discrete task) and the task analysis and data sheets for the instructor. In the general education class, the instructor sat next to the student. Kate sat at a desk in the front row of her math class. Ben sat in his regular seat in a computer applications class, and Jacob sat at a table in the front of his biology class. Instruction occurred during class: (a) when the teacher took attendance, (b) during the morning news program, (c) when students started on their homework, or (d) when students did independent seatwork. Although all of the participants participated in the daily instructional activities of the class, supplemental instruction from the peer tutor or paraprofessional was added during these times. To minimize disruptions, instruction for the investigation did not occur while the general education teacher was teaching a lesson or lecturing the class.

During training sessions for both the discrete and the chained skills, the student performed each skill twice, following the same procedure for both types of skills. For example, in teaching the discrete skill, the instructor first delivered an attentional cue (e.g., “Are you ready to begin working on Math?”) and waited for the student’s attentional response (e.g., “Yes, I’m ready to begin.”). Next, the instructor delivered the task direction immediately followed by the controlling prompt (i.e., verbal model). For example, when showing a picture of a cube, the instructor might say, “What shape is this? It’s a cube.” The instructor praised all correct responses and corrected all errors.

The investigators staggered instruction
across students. Kate began instruction first. When she reached one day of 100% correct responses on her discrete task, training sessions began for Ben on both his discrete and chained tasks. When he reached one day of 100% correct responses on his discrete task, training sessions began for Jacob on both his discrete and chained tasks. Training sessions continued to a criterion of 100% during three consecutive probe sessions. After one day of criterion, the instructor faded reinforcement from a continuous reinforcement schedule to a VR3 (variable ratio of 3) schedule.

Maintenance. The special education teacher conducted maintenance probe sessions in the same manner as baseline and daily probe sessions 1 week and 3 weeks after each student reached criterion for their discrete task and for their chained task. She conducted another maintenance probe session 1 month after all 3 students met criterion on both skills.

Generalization procedures. The special education teacher conducted two generalization probe sessions after each student reached criterion on both of his or her target skills. She designed each probe session to assess generalization across persons, settings, and materials. While training sessions occurred in a general education classroom with a peer tutor or paraprofessional using index cards and worksheets, generalization probe sessions occurred in the special education classroom with the special education teacher using materials resembling those used in the state’s AA-AAS and the same format as required for the AA-AAS. During the sessions, the teacher sat across the table from the student with a binder on the table with the generalization probe materials inside. One page with a script and a question faced her. The student had four multiple-choice answers printed on the side facing him or her.

During generalization probe sessions for the geometric shapes, the teacher showed the student a picture of a real-life object (i.e., dice, stop sign, beach ball, party hat, Egyptian ruins) and then asked the student what shape it was. During generalization probe sessions for linear equations, the teacher read a word problem to the student (e.g., “Laura makes $5.00 per hour at her new job with a $2.00 bonus at the end of the week for completing all of her tasks. How many hours did she work if she made $32.00 including the $2.00 bonus?”). She then showed the corresponding linear equation (i.e., “Your equation should look like this: 5x + 2 = 32.”), asking the student to solve for x and giving four possible answers. During generalization probe sessions for writing, the teacher presented various situations where people want to publish items on the Internet and asked which method would be best for each situation (e.g., “Sally wants to make new friends at her school. She decides to join a social networking site. What is an example of this?”). During generalization probe sessions for searching for information on the Internet, the teacher asked for specific steps in the sequence (e.g., “You are researching the various mascots in high schools across the state. What website can you go to in order to look this up? Where do you find the search criteria? If you are looking up the mascot for Central High School, what should you type in the search bar? After you type your word or phrase into the Google search bar, what button should you press? How do you finally get the answer to your search question?”). During generalization probe sessions for Punnett Squares, the teacher showed the student an incomplete Punnett Square and had the student choose what went in the blank. During generalization probe session for biology terms, the teacher asked for the definition of terms within the context of a story (e.g., “The lifeboat on a cruise ship can hold 50 people. The maximum population size that an environment can sustain is referred to as its _____.”).

Experimental Design

Investigators evaluated experimental control using a multiple probe across participants design (MPAP), with concurrent demonstration across two skills per student (Gast & Ledford, 2010). The MPAP was used to minimize student frustration during the baseline phase (over testing) and because students were learning academic skills.

Social Validity

To determine effects on the social relationships between the student participants and the peers in their general education class-
rooms, the teacher conducted a survey at the beginning and conclusion of the investigation. She gave the survey to the general education teacher and students in the Algebra class because it was the only class that did not already have students with moderate intellectual disabilities enrolled in it prior to the investigation. The questions on the survey consisted of the following: (1) Do you know anyone with a disability? If yes, how do you know them? (2) Do you think students from the FMD classroom should attend regular classes? Why or why not? (General education students only) or Prior to this year, have you ever taught someone from a FMD classroom? If yes, how many students? When? (General education teachers only); (3) Do you think students from the FMD classroom should be taught STEM content? Why or why not? (4) What benefits do you think students from the FMD classroom could gain from being in regular classes? (social, academic, communication skills, self-esteem, nothing).

Reliability

A graduate student with a degree in special education collected procedural fidelity (PF) and interobserver agreement (IOA) reliability data during probe sessions. Instructor behaviors included (a) delivering attentional cue, (b) waiting for attentional response, (c) presenting stimulus, (d) ending session following error in chained task or ignoring errors during discrete task, (e) recording data, and (f) praising correct responses and good behavior. The graduate student collected PF and IOA reliability data during 33%, 25%, and 20% of baseline sessions for Kate, Ben, and Jacob, respectively. She collected PF and IOA reliability data during 50% of discrete task test probes for Kate and Ben and 29% for Jacob. She collected reliability data for 30%, 38% and 40% of chained task test probes for Kate, Ben and Jacob, respectively. She collected PF and IOA reliability during 33% of maintenance probe sessions and 50% of generalization probe sessions for all students.

The special education teacher collected PF data during training sessions. During training sessions, instructor behaviors included (a) waiting until it was appropriate to begin training, (b) delivering attentional cue, (c) presenting stimulus, (d) immediately delivering controlling prompt, (e) praising correct responses or correcting errors, and (f) performing task twice. The special education teacher collected reliability data during 33% of Kate’s discrete task training sessions and 20% of her chained task training sessions. She collected PF reliability data during 25% of Ben’s training sessions. She collected PF reliability during 43% of Jacob’s discrete task training sessions and 60% of his chained task training sessions.

Another FMD teacher collected PF data during the SP procedure training session conducted by the special education teacher for the paraprofessional and the peer tutor. Teacher behaviors included (a) showing instructional PowerPoint, (b) modeling SP procedure, (c) allowing instructors to practice SP procedure with each other, (d) collecting data on ability to implement SP procedure with 100% accuracy, and (e) reviewing student folders with each instructor.

The investigators calculated PF agreement by dividing the number of completed steps by the number of possible steps and multiplying by 100 (Billingsley, White, & Munson, 1980). They calculated IOA by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100 (Gast, 2010). PF reliability agreement was 100% for all probe sessions across students. IOA reliability agreement was also 100% during baseline probe and daily probe sessions across students. PF reliability agreement was 100% during Kate’s discrete task training sessions and ranged from 83% to 100% (mean = 92%) during her chained task training sessions. During one training session, the peer tutor forgot to praise Kate for completing a step correctly. PF reliability agreement was 83% during Ben’s discrete task training sessions (collected once because he reached criterion after two sessions). The paraprofessional did not deliver the controlling prompt before Ben said one of his vocabulary words during one session. During Ben’s chained task training sessions, PF agreement ranged from 83% to 100% (mean = 92%). During one session, the paraprofessional did not deliver the controlling prompt before Ben pushed the “search” button on the computer. PF agreement during Jacob’s discrete task train-
ing sessions was 100%. During chained task training sessions, PF agreement ranged from 83% to 100% (mean = 92%). Jacob filled in one of the boxes of the Punnett square before the paraprofessional delivered the controlling prompt during one session. PF agreement for the SP training for instructors conducted by the teacher was 100%.

**Results**

The SP procedure was effective in teaching STEM content skills to three secondary students with moderate intellectual disabilities within general education classroom settings. The effectiveness of the SP procedure for the three students can be viewed in Figure 1. In addition, the paraprofessionals and the peer tutor implemented the intervention with a high degree of procedural fidelity.

**Effectiveness and Efficiency Data**

During baseline sessions, all three students’ data were stable at 0% for both the discrete task and chained task. Kate met criterion for her discrete task in six instructional sessions and for her chained task in 10 instructional sessions. The total time for discrete task instructional sessions was 12 min (mean = 2 min per session). The total time for chained task instructional sessions was 56 min (mean = 5 min 36 s per session). Ben met criterion for his discrete task in four sessions and for his chained task in eight sessions. His total time for instruction on the discrete task was 9 min (mean = 2 min 15 s per session) and 43 min for his chained task (mean = 5 min 24 s per session). Jacob met criterion for his discrete task in seven sessions, totaling 20 min (mean = 3 min per session). He met criterion for his chained task in five instructional sessions, totaling 14 min (mean = 2 min 48 s per session).

**Maintenance and Generalization**

All three students maintained their target skills at 100% criterion for 1 month after intervention ended. The students also generalized at least some of their target skills during probe sessions resembling the state’s AA-AAS: (a) Kate - mean of 100% correct responses for discrete and 80% for chained task, (b) Ben - mean 100% correct responses for discrete task and 60% for chained task; and (c) Jacob - mean of 60% correct responses for discrete task and 100% for chained task.

**Social Validity**

Results of the social validity survey were, for the most part, positive. Prior to the beginning of the investigation and Kate’s inclusion in the Algebra class, 12 of the typically developing students said that they thought students with moderate intellectual disabilities should attend regular classes and five thought they should not; after the study, 15 students said students with MSD should attend. All 17 students thought students with moderate intellectual disabilities could learn core content following the investigation. Prior to the investigation, 16 of the peers thought that students with moderate intellectual disabilities should be taught core content, and only one did not. Following the investigation, all 17 students thought students with moderate intellectual disabilities should be taught core content. Prior to the investigation, the general education students identified several benefits of students with moderate intellectual disabilities being included in the regular classroom that increased following the investigation: (a) social interaction (increase from 8 to 10), (b) academic gains (increase from 5 to 7), (c) communication skills (remained the same at 8), and (d) self-esteem (increase from 6 to 9).

The Algebra teacher had mostly positive responses prior to the investigation. He stated that he thought students from the FMD classroom should attend regular classes, could learn core content, and would benefit from inclusion in the areas of social integration and academic advantages. He stated that he did not think students with moderate intellectual disabilities should be taught core content, as pacing would be a serious issue. After the investigation, the same teacher said that he thought students from the FMD classroom should be taught grade level core content, just at a modified pace.

**Discussion**

The purpose of the current investigation was to evaluate the effectiveness of an embedded
SP procedure in teaching STEM content and skills to students with moderate intellectual disabilities in an inclusive setting. All students mastered their target skills after a peer tutor or a paraprofessional provided an embedded SP procedure within the normal routines in a general education classroom. Students also maintained their target skills for at least 1 month following instruction and generalized the skills with 60% to 100% correct responding.

Figure 1. Percent correct responses.
One challenge to including students with moderate intellectual disabilities in general education classes is that the pace of instruction is usually much quicker than in special education classes. This concern is especially valid when students are learning more challenging content or chained skills in higher grades. The use of embedded SP in the current study, however, may negate these concerns since the student participants reached 100% on their discrete tasks in an average of 3.7 sessions and 100% on their chained tasks in an average of five sessions. Similarly, Reisen et al. (2003) compared SP to CTD to teach discrete tasks and found that three of the four participants reached 100% in just three sessions.

Other studies also have demonstrated that the SP procedure can be effective in teaching core content skills to students with disabilities. For example, Head et al. (2011) and Pennington, Stenhoff, Gibson, and Ballou (2012) both used SP to teach core content to students with high incidence disabilities. The current investigation extended this research and the research conducted by Collins et al. (2007) with students with moderate intellectual disabilities by using an embedded SP procedure to teach STEM content to students with moderate intellectual disabilities in inclusive classrooms. Embedded SP by a peer, paraprofessional, or the classroom teacher may benefit a diverse group of students (e.g., students with learning disabilities, English language learners, students at risk) in learning STEM content in inclusive contexts.

In addition to the current study, generalization and maintenance of learned skills also has been a concern in previous studies teaching core content to students with moderate intellectual disabilities. For example, in a study by Knight, Smith, Spooner, and Browder (2011), students learned science descriptors using objects during the intervention condition and were able to generalize to novel objects but had more difficulty generalizing when using pictures or within an inquiry-based lesson. In the current study, the special education teacher planned with the general education teacher to carefully select STEM skills that a student would likely use in the future in various settings or that would be considered foundational knowledge for more complex material.

The use of a peer tutor to implement instruction was an important component of the intervention. Peers and paraprofessionals found the SP procedure easy to use and made few errors, leading to a high degree of procedural fidelity. Previous studies have supported these findings when using systematic instructional procedures. For example, Jimenez et al. (2012) showed that peer tutors could implement the CTD procedure within an inclusive science class to teach science vocabulary words, pictures, and concept statements to students with moderate intellectual disabilities, while Collins, Branson, Hall, and Rankin (2001) showed that a peer tutor could implement the SLP procedure within an inclusive English class to teach writing. One of the contributions of this study is that a peer tutor implemented the SP procedure with high fidelity in teaching both a discrete task and a chained task in an inclusive math classroom.

Working with peers may have led to students experiencing social benefits. The pre- and post-intervention social validity surveys completed by the students in the general education Algebra class indicated increased acceptance of the students with moderate intellectual disabilities by the general education students. One of the students originally stated that the students from the FMD classroom should not be allowed to attend regular classes because “...people will make fun of them and cause them emotional pain. As much as I want to see them have a chance to see others, it is my experience that people are cruel.” Following the investigation, this same student said that students from the self-contained classroom should not be allowed to attend regular classes because “…from what I’ve seen in here, no one made her feel uncomfortable or sad.” This student had indicated that he had a cousin and several friends with disabilities. After the investigation, he wrote that he had a disability as well. It is possible that his past personal experiences had influenced his initial apprehension, but, after having Kate included in his class, he was able to see that peers could be accepting of differences.
Implications for Practitioners

With the increased focus in public schools on STEM education, it is important for teachers to consider ways in which all students can participate and gain generalizable skills in this content. In the current study, special and general education teachers collaborated to determine targeted skills that linked to the standards and that were reasonable to teach in a short period of time. More importantly, generalizable, maintainable skills were selected with the intent to benefit students with disabilities now and in the future, as these skills were based on students’ current interests and post secondary goals. Although the area STEM may be intimidating for some special education teachers, the current study demonstrates how students with moderate disabilities can learn individualized grade-appropriate STEM content linked to post secondary goals in an inclusive classroom. While the pace of instruction in general education settings (especially in high school) is certainly a barrier for many students with disabilities, use of the SP may be one way to combat this barrier since it is a brief, yet effective, instructional strategy. In addition, this study illustrates how social benefits can be a collateral gain when students with disabilities are included with their same-aged peers in STEM.

Limitations and Future Research

Several limitations should be noted when considering the results of this investigation. First, a small number of students participated in the investigation, limiting the validity of the findings. Only two investigations to date (Collins, 2007; Reisen et al., 2003) have examined the effectiveness of the SP procedure in teaching core content to students with MSD in inclusive settings, and there were only four participants in each of those investigations. Additional research is needed before this can be considered an evidence-based practice.

A second limitation is the skills that were taught. Each student received instruction on five vocabulary words or geometric shapes and one chained task. The researchers determined that these skills were equal in complexity, but the results of the study may indicate otherwise. Ben and Jacob made immediate progress with their chained tasks and reached 100% after only four and three sessions, respectively. Kate, on the other hand, did not make any progress during the first four sessions and took eight sessions to reach 100% criterion. This could be due to the fact that, even though all chained tasks had six steps in the task analysis, solving linear equations may be a more complex (or less motivating) task than filling out Punnett squares or looking up information on the Internet.

A third limitation was the use of single opportunity probes for assessing chained tasks during probe sessions. Baseline levels may not have been so low if the students had been given the opportunity to complete each step of the task analysis rather than being stopped after their first error, which occurred on the first step for all of the participants. The researchers used single opportunity probes to reduce the likelihood that learning would occur if the instructor completed some of the steps during probe conditions, but this may not have accurately reflected the ability of the students to perform some of the steps.

A fourth limitation was in the timing that the skills were taught. Instruction took place when other students were doing independent seatwork or other similar situations in the general education classroom in order to prevent distractions to the other students; however, it may not be considered a truly “inclusive” time to teach the skill. Future researchers should require more involvement from general education teachers in the delivery of systematic instruction. General educators or peers could implement the SP procedure during typical instructional times. If general educators were actively involved in systematic interventions, it could enlighten them on the benefits of inclusion and the practical inclusion strategies for instruction, as indicated by the survey response of the Algebra teacher in this investigation.

The fifth limitation was in the manner in which probe sessions were conducted. Probes were conducted in the special education classroom by the special education teacher. This limited distractions and ensured greater reliability of the data, as the special education teacher was highly trained in the SP procedure and data collection procedures. However, future research should look at data col-
lection in a natural setting (i.e. the inclusive classroom).

Finally, the use of peer tutors is more socially acceptable than the use of a paraprofessional in inclusive classrooms. Carter, Sisco, Melekoglu, and Kurkowski (2007) showed that students with disabilities engaged in more social interactions when working with a peer than when working with a paraprofessional. Due to scheduling conflicts, both a peer and a paraprofessional delivered instruction in the current study, demonstrating that participants could acquire the academic skills from both types of instructors in similar time frames. Future research, however, should focus on the use of peers in inclusive settings and determine if peer-directed instruction in inclusive classrooms will result in both the acquisition of academic skills and increased social interactions. Additional research could examine methods aimed at increasing both academic and social benefits in the context of real-world, problem-based learning (e.g., engage in inquiry process using cooperative small groups of typically-developing peers to learn processes of science as well as communication, such as asking questions).

One of the goals of this investigation was to teach STEM related content and skills to students eligible for the AA-AAS. Another suggestion for future research would be to compare the AA-AAS scores of students taught in segregated classroom to the scores of students taught with systematic instruction in inclusive settings since this could provide further support for the inclusion of students with MSD.

Conclusion

As STEM continues to receive national attention and additional states continue to adopt CCSS and NGSS, educators need effective and efficient instructional strategies for supporting students with a wide range of needs in inclusive classrooms. Results from this study support the use of SP by instructors other than the special or general education teacher for teaching STEM content to students with complex needs. Further, this study shows that educators can work together to benefit all of the students in their classroom, both socially and academically. Negative perceptions can be changed as a result of increased access to natural contexts and general education curricula, as evidenced by the change in attitudes of the peers and classroom teacher. Since embedded SP (a) is easy to implement, (b) is less time consuming than many other systematic instructional procedures, (c) can result in fewer errors than other prompting strategies, and (d) can be used by a variety of instructors, including teachers, paraprofessionals, and peers with a high degree of fidelity, educators may want to consider using practice in inclusive contexts to promote progress in, maintenance, and generalization of STEM content areas.

References


Received: 19 November 2014
Initial Acceptance: 17 January 2015
Final Acceptance: 4 May 2015