THE EFFECTS OF PEER-MEDIATED EMBEDDED INSTRUCTION ON INCLUSIVE INQUIRY SCIENCE FOR STUDENTS WITH SEVERE INTELLECTUAL DISABILITIES

by

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ABSTRACT

BREE ANN JIMENEZ. The effects of peer-mediated embedded instruction on inclusive inquiry science for students with severe intellectual disabilities. (Under the direction of DR. DIANE BROWDER)

There is a growing emphasis on meeting the diverse educational needs of all students which has drawn attention towards inclusive education. The number of students with severe disabilities receiving instruction in inclusive education settings has steadily increased over the past decade (U.S. Department of Education, 2004). Limited research has been conducted on the acquisition of grade-aligned science skills for students with severe disabilities (Browder et al., in press; Courtade et al., in press, Jimenez et al., in press), and even more limited on academic skills in inclusive settings (Carter et al., 2007; Dugan et al., 1995; Jameson et al., 2009). The current study examined the effects of peer-mediated time delay instruction to teach science responses and KWHL chart responses during inclusive inquiry science lessons to students with severe intellectual disabilities. Six general education peers were trained to implement an embedded constant time delay procedure during three science units with five students with severe disabilities. Results indicated that all five students increased the number of correct science responses during all three science units. In addition, all six peers were able to implement the intervention with high fidelity. Finally, high levels of social validity were reported by peers, as well as the general and special education teachers.

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As a final thought, suggestion, and my personal motto; *Don't Postpone Joy!*

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CHAPTER 1: INTRODUCTION

Growing emphasis on meeting the diverse educational needs of all students has drawn attention towards inclusive education. The number of students with developmental disabilities receiving instruction in inclusive education settings has steadily increased over the past decade (U.S. Department of Education, 2004). While the occurrence of inclusion continues to increase, the reality that only 11% of students with intellectual disabilities are fully included (included for 79% or more of the school day) requires attention (Smith, 2007). Inclusion for this population requires more than just physical placement in classrooms with general education peers. Students must receive the supports necessary to participate in the curriculum and content being taught within that classroom. In response to the need for additional supports, a growing body of research has been conducted which demonstrates strategies to benefit the social and educational needs of students with severe disabilities in inclusive education (Giangreco & Putnam, 1991; Hunt & Goetz, 1997; Lipsky & Gartner, 1997). Even with the benefits of inclusion noted, practitioners still face the challenge of providing effective and systematic instruction to students with severe intellectual disabilities in general education classrooms. For example, Schuster, Hemmeter, and Ault (2001), conducted a study with 12 kindergarten through third grade students with moderate and severe intellectual disabilities enrolled in general education classrooms to see how many opportunities were given per day to receive instruction on their Individual Education Programs (IEPs). They found that students either received no instruction on IEP goals or only 45% of goals. The findings of Schuster et al. bring special attention to the need for development of instructional strategies designed to assist general and special education teachers in meeting the needs of students with disabilities enrolled in inclusive classrooms. One strategy in meeting this goal may be to identify methods for teaching general curriculum content to this population in special education settings. While important to review, those methods are limited in the areas of teaching subject matters, such as science.

Teaching science to students with severe disabilities. To date, a limited number of studies have been conducted on acquisition of science content for students with severe disabilities. In a literature review of science content instruction for students with significant cognitive disabilities, Courtade, Spooner, and Browder (2007) found only a few studies. A search of the literature using key terms from the National Science Education Standards (NSES, 1996) revealed 11 studies in which science content (i.e., weather words, first aid skills, relative position) was taught to this population. Limitations were found in that the majority of studies taught students science content only under one of the seven standards defined by NSES, specifically Personal and Social Perspectives. Recently, additional research has been conducted to extend the findings of Courtade et al. (2007) in the area of science content acquisition supporting the instruction of grade-level aligned core content to this population (Browder et al. , in press; Courtade, Browder, Spooner, & DiBiase, in press; Jimenez, Browder, & Courtade, in press; Spooner, Knight, Browder, Courtade, & Jimenez, 2009). Browder et al. (in press) conducted a study in which secondary students were taught to identify grade-content specific vocabulary sight words paired with picture symbols to measure comprehension, using a constant time delay procedure within inquiry science lessons (e.g., chemical reactions, plate tectonics, cell theory). Additionally, Jimenez et al. (in press) investigated the effect of self-directed learning to promote the generalization of science concepts across units of instruction. Using a constant time delay procedure, students were taught to self-direct the use of a KWHL (i.e., K=what do you Know?; W=What do you want to know; H=How will you find out?; L=what did you Learn) chart across lessons and science units. Students showed significant positive outcomes on number of science questions answered correctly across lessons, as well as the self-directional use of the KWHL chart across lessons and units. While this study was conducted in a self-contained special education setting, two generalization probes were conducted in an inclusive secondary science setting. Such findings suggest that students with severe disabilities can learn science concepts; however, limited research has been found teaching science content to this population in inclusive settings.

Teaching science as inquiry. Science education can promote vocabulary and content acquisition while maintaining a self-directed learning environment when inquiry is used (Jimenez et al., in press). In 1996, the National Research Council (NRC) published the National Science Education Standards (NSES) with the intention to define and promote "…science standards for all students" (NRC, 1996, p.2). One component of science education highly promoted by the NSES is the use of inquiry to direct science education. The NRC defines inquiry as "a set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories" (NRC, 1996, p.214). Inquiry emphasizes an "active process" in which students are directed to make observations, pose questions, examine sources to see what they already know, plan investigations, use tools to gather data, propose predictions, and communicate results. According to the NSES, inquiry is a critical component of a science program, requiring more than hands-on activities but a problem-solving process. Because inquiry has been identified as the recommended mode for science content acquisition, it is important to prepare students with severe disabilities to gain science content in inclusive settings via this mode as well.

Teaching science using distributed learning trials. In contrast to inquiry, distributed trial training has been utilized to increase skill acquisition for students with severe disabilities (Wolery, Anthony, Caldwell, Snyder, & Morgante, 2002). Distributed trials training is a strategy that has been used in the field of special education for decades to promote repeated opportunities for learning within the naturally occurring learning environment. Different from massed trial training, distributed trial training can occur throughout a school day or lesson. When used in general education contexts the use of distributed trials is called embedded instruction. Numerous studies have examined the use of embedded instruction to teach specific skills to student with severe disabilities (Jameson, McDonnell, Johnson, Riesen, & Polychronis, 2007; Johnson & McDonnell, 2004; McDonnell, Johnson, Polychronis, & Riesen, 2002; Wolery et al., 2002). For example, Johnson and McDonnell (2004) examined the effects of teacher delivered embedded instruction in a general education elementary classroom on core content with three students with developmental disabilities. A multiple probe across participants design was used to record the percent of correct responses on each student's target skill (i.e., sight words, signing for help, number greater than). They found that embedded instruction was effective in students making academic progress. Results also indicated that both general education teachers were able to implement the embedded instructional procedures with high fidelity.

In embedded instruction, students learn skills within the ongoing routine of a lesson or classroom setting. The systematic presentation of this material is typically presented by a teacher or paraprofessional during natural opportunities. There is a growing research base in the area of using time delay to systematically present material to students through embedded instruction (Jameson et al., 2007; Johnson et al., 2004). For example, Wolery, Anthony, Snyder, Werts, and Katzenmeyer (1997) taught three general education teachers to use embedded instruction to instruct three students with severe disabilities in a general education inclusive classroom. Using a constant time delay procedure, teachers taught students to identify sight words, days of the week, and the food groups within general curriculum content lessons. General education teachers successfully implemented the embedded time delay procedure with high fidelity and minimal training. The use of time delay procedures in the instruction of students with severe disabilities has long been proven effective in the behavioral and academic arena of skills taught to this population (Browder, Ahlgrim-Delzell, Spooner, Mims, & Baker, 2009, Snell & Brown, 2006). Recent science research (Browder et al., in press; Jimenez et al., in press; Spooner et al., 2009) has demonstrated the effectiveness of time delay on student academic outcomes.

One problem with embedded instruction is the amount of trials needed to ensure student learning (Wolery et al., 2002). Most of the research on constant time delay and embedded instruction has involved acquisition of two or more behaviors and requiring at least five trials per behavior per lesson. If the general education teacher is required to embed this number of trials during science instruction, it could possibly hinder the natural context of the lesson for all parties involved. During inquiry science lessons, it would also be difficult for a classroom teacher to embed learning trials for students with severe disabilities, when the majority of the science lesson is conducted via student interaction and hands-on-learning. Additional avenues for embedded instruction in inquiry science may be needed to allow for the natural and appropriate number of trials for student success. One option might be to use peers to embed trials during the science lesson to eliminate unnatural learning trials.

Peer-mediated instruction. A focal point of inclusive education has been the social aspect of students working together in an academic context. In the arena of science education, the NSES has noted the importance of inquiry-based science as an effective mode to fostering student's discovery and content understanding. An essential component of inquiry based learning is the composition of learning groups and peer interaction. A possible strategy to help build the link between social and academic inclusive education may be the use of peer mediation instruction (PMI). There is evidence to suggest that systematic instruction delivered by peers can be effective in teaching students with severe intellectual disabilities academic skills (Dugan et al., 1995; McDonnell, Mathot-Buckner, Thorson, & Fister, 2001; Miracle, Collins, Schuster, & Grisham-Brown, 2001). Spooner et al. (2009) taught high school peers to use a constant time delay procedure to teach students with autism science content vocabulary and picture words. Three peers were taught to use a five second time delay to teach same age students with autism to identify new science vocabulary. Results of this study found that peers were successful in implementing the procedure correctly and the students with autism were also able to learn new science vocabulary through a peer-mediated time delay procedure. According to the Center for Applied Special Technology (CAST), Peer-Mediated Instruction and Intervention (PMII) can be defined as “an alternative classroom arrangement, in which students take an instructional role with classmates or other students” (CAST.org). They also note that “to be most effective, students must be taught roles in the instructional episode; to be systematic, elicit responses, and provide feedback.”

Purpose

The purpose of this study was to examine the effects of peer-mediated embedded instruction using time delay on the number of correct science responses with middle school students with severe disabilities during inclusive inquiry science lessons. An additional purpose of this study was to determine the effects of peer-mediated instruction using time delay on the students’ use of a KWHL chart to self-monitor science responses. Another purpose of this study was to investigate the effects of peer-mediated instruction on student attitudes. Finally, this study determined the effect of peer-mediated instruction on general education students’ science grade averages.

The independent variable was peer-mediated embedded time delay instruction. Secondary level peers without disabilities were selected from a science classroom. The peers were trained to use a constant time delay procedure to embed trials for science responses within an inquiry science lesson. Peers embedded a minimum of three trials per response into each science session. The sessions occurred in the general education classroom with students with severe disabilities. The peers were also trained to embed time delay trials on the use of a KWHL chart within inquiry science lessons.

The primary dependent variable was the number of science responses answered correctly by the student with a severe disability. The number of responses was measured by the researcher during testing probes after each science session with the peer, as well as at least one in vivo probe per unit of instruction. The secondary dependent variable was the number of independent KWHL chart responses. This variable was measured in vivo by the peer. The third dependent variable was the attitudes of the students and peers prior to and post intervention. Attitudes were measured via a student survey using a Likert scale and qualitative data. The fourth dependent variable was peer science grade averages prior to and post intervention.

Significance of the Study

Inclusive education is growing and the call for strategies to assist general and special educators to provide meaningful and effective content instruction to students with severe disabilities is desperately needed. It is important for students with severe disabilities to participate in inclusive science instruction with measurable and appropriate academic outcomes. This investigation adds to the research demonstrating how to use evidence-based teaching methods (i.e., time delay, peer-mediated instruction, embedded instruction) for this population in inclusive science education.

Literature to date on science academic content instruction for students with severe disabilities has been limited. Several of the studies cited in this introduction have not yet been published. While existing literature is promising little has been proven to promote academic science outcomes for this population in inclusive settings. More research is needed in the area of science content acquisition to expand current general curriculum access within naturally occurring settings (i.e., inclusive classrooms). Students with severe disabilities have intensive support needs (Kennedy & Horn, 2004), when combined with the challenges of inclusive education, peer-mediated strategies offers a means to provide additional support. Peer-mediated instruction lends itself well to inclusive education, especially in inquiry science due to classroom dynamics (e.g., learning dyads, cooperative learning groups). Because peer supports require groups of one or two students to work directly with a student with a disability, and inquiry-based science instruction requires groups to work collaboratively it has been hypothesized that the natural occurrence of peer-mediated instruction may easily be promoted within classroom lessons. While much research has been conducted to support the use of peer-mediated instruction, as well as embedded instruction, and some research exists on their application to teach this population academic skills these research bases are limited in the scope of academic skills taught.

Research on peer-mediated instruction in inclusive classrooms has focused on areas such as academic engagement, peer interactions (Dugan et al., 1995), and level of academic responding (McDonnell et al., 2001). These studies do provide a promise of meaningful participation for students with disabilities in academic settings with peer supports; however, they do not allow for measurable academic achievement in core content, such as science. Additionally, the academic skills taught within embedded instruction have typically focused on sight words, required academic social responses (e.g., request for help), and a limited number of math skills (Johnson et al., 2004; McDonnell et al., 2002). This research has provided insight on the effectiveness of embedded instruction on the academic skill acquisition of students with severe disabilities; however, this body of research is limited in the scope of academic skills and content (across subject areas).

Finally, to date very limited research has been identified to support the use of peer-mediated embedded instruction. While both research bases have suggested their effectiveness on academic skills for this population in inclusive settings, additional research was needed to extend and possibly combine inclusive educational strategies to best support students with severe disabilities. As previously noted, inquiry based science provides the appropriate context for such research.

Research Questions

The following primary research questions were addressed:

1. What is the effect of peer-mediated embedded time delay instruction on number of correct science responses?
2. What is the effect of peer-mediated embedded time delay instruction on correct KWHL chart responses?
3. What is the effect of peer-mediated embedded instruction on student social attitudes?
4. What is the effect of peer-mediated embedded instruction on science grade averages of general education peers?

Delimitations

This investigation was conducted in a large urban school district. The school district had a large special education and science curricula department that provides support to classroom teachers. Smaller school districts may not have the same resources. Additionally, an “inclusion charter” had been established in this school system to promote teacher, student, and administrative collaboration for the educational inclusion of all children. While students with severe disabilities had not been largely affected by this charter, attitudes of teachers and students may had been affected by this system-wide commitment.

One general education teacher, one special education teacher, five general education peers, and five special education students participated in this investigation. The small number of participants may hinder the generalization to other teachers and students. All participants are at a middle school level, this may also affect the generalization to other grade level populations.

The use of guided inquiry science has been mandated by the school system. The general education teacher involved in setting up the science lessons has had science training in inquiry. Additionally, peers involved in this study as well as the students with disabilities have had some experience with an inquiry process. While this experience for all participants may be limited, it may provide additional support in the attainment of independent and dependent variables. Those who replicate this intervention will need to have experience in or learn the method of inquiry to successfully duplicate the results.

A method of inquiry was used in this study. The method of inquiry used to teach the science lessons used by the general education teacher will be described, but was not prescribed. While most inquiry models follow the general guidelines outlined by NSES, teachers may ask questions with varying terminology and detail. A variation from the model of inquiry used by the teacher in this study may affect the generalization to other inquiry science classes. Outcomes from this study may be confined to this particular process used.

The student population this intervention focused on are students with some picture and word recognition skills. All students involved in the study were able to read a few sight words and identify a few picture symbols prior to intervention phase. The need to adapt this intervention for students who have not yet met that level of symbol use may be needed to meet the symbolic level of students with more severe disabilities.

Definition of Terms

The terms that will be used in this study with their definitions are presented in this section. The terms chosen for defining in this section are critical for comprehending the implementation procedures and results of this study.

Academic Skill – a skill that can be aligned to a national content standard.

Distributed Trial Training – the interspersal of instructional trials for one task among other training trials for other tasks during an instructional session (Westling & Fox, 2004).

Constant Time Delay – a response prompting procedure using a predetermined number of trials at a 0-second delay, the prompt is systematically faded to a fixed interval of time between the task direction and controlling prompt (Snell & Gast, 1981).

Embedded Instruction – explicit, systematic instruction designed to distribute instructional trials within the on-going routine and activities of the performance environment (McDonnell, Johnson, & McQuivey, 2008).

Inclusion – a practice in which students with disabilities are served primarily in the general education classroom under the responsibility of the general education teacher with the necessary supports for academic and social achievement (Mastopieri & Scruggs, 2007).

Inquiry-based Science – a set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models, and theories (NRC, 1996, p.214.)

National Science Education Standards – are a set of standards set by the National Research Council intended to drive all science education. The seven standards are Science as inquiry, Physical science, Life science, Earth and space science, science and technology, science in personal and social perspectives, and the history and nature of science (NSES, 1996).

Peer Support Interventions (i.e., peer-mediated instruction)– involve one or more peers without disabilities providing academic and social support to student with disabilities (Cushing & Kennedy, 2004). Peers are taught to: (a) adapt class activities to facilitate student participation, (b) provide instruction related to IEP goals, (c) provide frequent feedback to students (Cushing & Kennedy, 1997).

Students with severe disabilities – generally encompasses students with significant disabilities in intellectual, physical, and/or social functioning, including autism (Heward, 2003).

Students with significant cognitive disabilities – one who: (1) requires substantial modifications, adaptations, or supports to meaningfully access the grade-level content; (2) requires intensive individualized instruction in order to acquire and generalize knowledge; and (3) is working toward alternate achievement standards for grade-level content (Browder & Spooner, 2006).

Time delay – a procedure used to teach a discrete response. The instructor introduces the response with an immediate prompt (e.g., saying the word) and the learner repeats each word while looking at the sight word flash card. Over successive trials, small increments of time (e.g., 3 seconds, 5 seconds) are inserted between showing the sights word to the learner and giving the prompt. Typically, after some trials, the learner will anticipate the correct answer and learn the correct responses with near errorless responding (Wolery, Ault, & Doyle, 1992).

CHAPTER 2: REVIEW OF THE LITERATURE

Inclusive Education

The 1954 Supreme Court decision in the case of Brown vs. Board of Education, in which schools were mandated to stop the segregation of students based on race, began a national educational movement towards the inclusion of all students. With the passage of the Education for All Handicapped Children Act of 1975 (PL 94-142), now called the Individuals with Disabilities Education Act (IDEA, 2004), Congress required all national educational systems to include students with disabilities. This landmark piece of federal legislation mandates that students with disabilities should be taught alongside students without disabilities to the greatest extent possible. The 1997 Individuals with Disabilities Education Act (IDEA) brought about a new shift in educational emphasis from previous legislation. By no longer stating that students with disabilities simply be assured accessibility to their “least restrictive environment” (LRE), schools were now accountable for providing all students with a quality education, under the assumption that students with disabilities would participate in both the general classroom and general curriculum. Finally, the passage of the No Child Left Behind Act of 2001 established additional expectations regarding the education of all students, requiring the annual testing of students to monitor academic progress, reported as annual yearly progress (AYP) by schools and school systems.

During the past three decades, growing emphasis on meeting the diverse needs of all students within the national educational system has drawn much attention to the movement towards inclusion. In 1991, Sailor proposed guiding principles to define the components of an inclusive school. These principles have lead much of the work in inclusive education for students with severe disabilities. Sailor's definition of inclusion set forth specific guidelines that all students: (a) attend their home school, (b) are part of natural proportions, (c) attend schools with a zero-rejection philosophy, (d) are placed in age and grade appropriate classes, with no self-contained settings, (e) receive instruction using cooperative learning and peer instructional methods, and (f) are provided their special educational support in context. Since Sailor's definition for inclusion, other definitions have been developed. In 2000, Philipsen defined inclusion "as the attempt to educate children with special needs in general education classrooms." The term inclusion has held multiple meanings in relation to students with disabilities' placement, structure of content delivery, role of participation, or whole school philosophy on student interaction (Ryndak, Jackson, & Billingsley, 2000). Ryndak et al. elaborated on the current evolution of the term inclusion noting the confusion it may cause and miscommunication that may come about due to its various uses. Ryndak and colleagues note that when definitions of inclusion are used, some components such as placement in general education classes can be found frequently, while others appear intermittently (e.g., cooperative learning and peer instructional methods).

In response to the confusion related to the lack of clarity and inconsistencies surrounding the definition of inclusion, Ryndak et al. (2000) conducted a qualitative study to determine how experts in the field of school inclusion for students with moderate and severe disabilities define the term "inclusion." Through their investigation, seven themes arose, with five relating to students with moderate to severe disabilities and the other two related to inclusion as a systemic concept. The five concepts surrounding including students with disabilities were student: (a) placement in natural, typical settings, (b) instruction and learning together with non disabled peers, (c) supports and modifications within general education to meet appropriate learner outcomes, (d) belongingness, equal membership, acceptance, and being valued, and (e) educational teams collaborating to integrate services. The findings from this study suggest that experts agree inclusion is more than physical placement; it also must include general education learner outcomes. Consistent with these findings, Mastropieri and Scruggs's (2007) defined inclusion as a practice in which "students with disabilities are served primarily in the general education classroom under the responsibility of the general education teacher." Mastropieri and Scruggs (2007) also described supports necessary for "successful inclusion" including team collaboration, teaching strategies for student academic outcomes, and student social interaction. For the intentions of this study the definition provided by Mastropieri and Scruggs (2007) will be used. One consistency found among definitions of inclusion was that they often reflect social as well as academic components of student interaction.

Social inclusion for students with moderate and severe disabilities. In 1993, a survey was conducted by Hamre-Nietupski, Hendrickson, Nietupski, and Sasso to determine the best way to facilitate relationships between students with and without disabilities. Results of this survey indicated that special educators found that peer relationships were more likely to emerge when peers were being taught together. To build this research base of social inclusion, Kennedy and Itkonen (1994) investigated the effects of participating in regular education classes on the social contacts and social networks of high school students with severe disabilities. Three high school students with severe disabilities participated in one regular education class period for the course of one school year. The primary findings of this study indicated that with regular class participation, students with severe disabilities were able to increase the frequency of social contacts with non-disabled peers as well as the number of peers participating in those contacts.

Similar findings were acquired by Fryxell and Kennedy (1995) who explored the effects of placement in general education verses self-contained classrooms on the social relationships of 18 students with severe disabilities. Participants included nine students with severe disabilities receiving inclusive education and nine students with severe disabilities receiving services in a self-contained classroom. Students from both groups were matched by age, gender, level of disability, and adaptive social and communicative behavior. A post-test-only control group design with matched comparisons was used to identify differences between the two groups of students in regards to social relationships. Results from direct observations using the Social Contact Assessment Form (SCAF, O'Neil, Horner, Albin, Storey, & Sprague, 1990) and the School-Based Social Network Form (SSNF, Kennedy, 1991) revealed that student placed in general education classrooms had higher levels of social support and larger friendship networks with schoolmates without disabilities.

Findings from Fryxell and Kennedy (1995) were consistent with those of Hendrickson, Shokoohi-Yekta, Hamre-Nietupski, and Gable (1996). Hendrickson and collegues conducted a survey with 1,137 middle and high school students on their perceptions of being friends with peers with severe disabilities. Results for this survey indicated that general education secondary students believed friendship with a student with a severe disability was more likely to occur if the student was included in the general education class.

To gain deeper knowledge of the findings from Fryxell and Kennedy (1995), Kennedy, Shukla, and Flyxell (1997) investigated two groups of middle school students with severe disabilities across one school year. One group of students participated in the general education classroom, while the other was supported in the special education classroom. A post-test only control group design was used to compare each student's social interactions, social support behaviors, and friendship networks were measured. Participant from both groups were matched together based on age, gender, level of disability, adaptive behavior, and adaptive social behavior. Statistical analyses using two-tailed Wilcoxon *T-tests* for matched pairs (n=8) revealed no significant variation between students in the two groups. Using three dependent measures of social engagement, results suggested that students with severe disabilities supported in general education classrooms were more likely to have: (a) more frequent interaction with peers, (b) greater range of social contact with peers without disabilities across a greater range of activities and settings, (c) higher levels of social support behaviors (e.g., greetings, information, companionship), (d) larger friendship networks including peers without disabilities, (e) durable, longer lasting friendships with peers without disabilities.

In an elementary school inclusion setting, Hunt, Alwell, Farron-Davis, and Goetz (1996) examined the effectiveness of a multi-component intervention designed to increase shared interactions between classmates without disabilities and three students with severe disabilities. A multiple-baseline across students design was used. This multi-component intervention consisted of providing peers with ongoing information regarding the student's communication systems, adaptive equipment, and educational activities (e.g., "Todd can tell what he wants with his communication book. This is how it works.") The second component to the intervention was to identify various media that could assist in social exchange between the student with disabilities and their peers (e.g., communication boards, toys or games, cooperative projects). After completion of the entire multi-component intervention students needed less assistance by support staff and there was a significant increase in reciprocal peer interactions.

In more recent years, McDonnell et al. (2003) investigated the social outcomes of 14 elementary school students participating in inclusive classrooms. A quasi-experimental pre/post test design was used to measure student's adaptive behavior measured by the SIB-R. Through this exploratory study, participants were supported in inclusive settings through the use of large and small group instruction, cooperative learning, co-teaching, curriculum and instructional adaptations, parallel instruction, Circles of Friends, peer tutoring, direct instruction, and embedded instruction. Results suggested that students with developmental disabilities who were served primarily in inclusive classes made significant improvements in their adaptive behavior as measured by the SIB-R.

While the initiative for inclusive education of students with severe intellectual disabilities may have began with social inclusion and has much research to support it, as noted by Carter, Hughes, Guth, and Copeland (2005), simply the act of being placed in a general education classroom and having social interaction with peers without disabilities is not enough. It is not surprising that most studies to date with students with severe disabilities and inclusive practices have focused on social inclusion rather than academic inclusion. Recent literature reviews in the area of academic instruction for students with severe disabilities have shown that while some academic instruction has occurred, the breadth across academic strands and content is limited (Browder, Spooner, Wakeman, & Harris, 2008; Browder et al., 2006; Courtade et al., 2007). Until recently, there has been a general lack of focus on academics for this population, especially in inclusive classrooms. The research in social inclusion for this population offers the field of special education a basis to build inclusive practices in the area of academics (Hunt et al., 1996; McDonnell et al., 2003). The legal mandates of IDEA and No Child Left Behind (2001) have heightened the expectations that all students will be taught a standards based curriculum and show student progress.

Academic inclusion for students with moderate to severe disabilities. Early research in the area of academic inclusion for students with moderate to severe disabilities included a study conducted by Hunt, Staub, Alwell, and Goetz (1994). Hunt et al. (1994) used an ABAB time series design to demonstrate that students could acquire targeted IEP objectives (i.e., basic communication skills) within the context of cooperative learning groups in their general education classroom. During cooperative learning math groups, students were taught to independently participate in classroom group activities (e.g., request a turn by hitting a switch, reach for, grasping and passing materials). While Hunt et al. (1994) was an early study on inclusion in an academic class, the limitation of this study was student objective alignment to academic achievement.

The focus of IEP objectives were on communication skills rather than core content in the areas of math, science or language arts.

In more recent years, Hunt, Soto, Maier, and Doering (2003) investigated the effects of a general education and special education collaborative teaming process on the social and academic participation of elementary students with severe disabilities. A multiple baseline across pairs (n=6) of students was used to implement a Unified Plan of Support (UPS) with educational teams to increase social and academic participation within general education inclusive classrooms. Results indicated that the collaborative teaming process was an effective way to increase social engagement and increase academic participation.

Most recently, Dymond et al. (2006) examined the use of a participatory action research (PAR) approach (Greenwood & Levin, 1998) to examine the process of redesigning a science high school course to incorporate the principles of Universal Design for Learning (UDL). To promote access to the general curriculum in science for students with severe cognitive disabilities (SCD), the PAR approach was used to design and evaluate the effectiveness of creating science access for all students. Data was collected for this case study through access interviews, general education teacher's journals, process interviews, meeting minutes, lesson plans, and end of the year focus groups. Findings from qualitative analyses were encouraging towards the positive benefits of UDL principles in course restructuring. Student outcomes were reported based on relationships and interactions, as well as class participation and achievement. The leading outcome discussed was the impact of UDL on the social relationships and participation of students with SCD. In contrast, the authors did not report student learning of science content.

As these studies illustrated, most of the studies on academic inclusion have focused on student engagement with the general curriculum (e.g., time on task, raising hands, communication skills) without specific learning objectives linked to the general curriculum content. For example, Hunt et al. (2003) used an Interaction and Engagement Scale (IES) to observe decreased levels of student non engagement in ongoing classroom activities and increases in interactions (e.g., asking questions, making comments), as well as an increase in positive peer interactions, labeled as academic participation. Even though students with severe disabilities have been physically present within the general curriculum classroom while general curriculum was being presented, students with severe disabilities have not been actively engaged in the same learning that was occurring with their general education classmates (Wehmeyer, Lattin, Lapp-Rincker, & Agran, 2003).

Research to date with this population has strong evidence to support the use of inclusive models to teach social skills and participate in academic settings. In contrast, for students with severe disabilities to learn skills from the general curriculum in inclusive settings they will need instructional support (Spooner, Dymond, Smith, & Kennedy, 2006). Only a small amount of research has been conducted in which students with severe disabilities receive instruction to master grade-level linked core content objectives in inclusive settings (Collins, Evans, Creech-Galloway, Karl, & Miller, 2007; Dugan et al., 1995; McDonnell et al., 2006). In contrast to the studies on academic engagement the emphasis is on student achievement aligned with core content acquisition. There is a strong need for more studies with stronger demonstration for teaching core content such as science. The academic content of science is especially important for students with severe disabilities, like all students, because it provides an understanding of the natural world.

Teaching Science as a Core Content

Inclusive science education. Science education has become a major educational focus in the United States over the past half-century. Prompted by the Russian's Sputnik, the curriculum reform efforts of the 50's have now become a priority in American science education. With the 1985 visit of Halley's Comet, Project 2061 was designed to bring forth scientific literacy to all school aged children. Thus, the 1989 publication *Science for All Americans* was written based on the *Project 2061* panels' recommendations. *Science for All Americans* defined principles for learning and effective science teaching. Finally in 1996, based on those key science education principles, the National Research Council (NRC) published the National Science Education Standards (NSES) with the intention to define and promote "…science standards for all students" (NRC, 1996, p.2). The National Science Education Standards specifically designates accountability for all students' scientific literacy by stating: *"Science in our schools must be for all students. All students, regardless of age, sex, cultural or ethnic background, <u>disabilities,</u> aspirations, or interest and motivation in science, should had the opportunity to attain high levels or scientific literacy"* (p.20).

The student-centered approach of science education fostered by NSES lends itself ingeniously to the inclusion of students with disabilities in science classrooms (Kumar, 2002; Mastropieri & Scruggs, 2000). However, teaching science continues to challenge general educators (Kirch, Bargerhuff, Cowan, & Wheatly, 2007; Kumar, 2000), which may explain why many student with disabilities receive little to no science instruction. The discrepancy of science education students with disabilities receive may be directly related to the lack of preparation special and general education teachers gain to teach this core content area (Gurganus et al., 1995).

A survey by Irving and Nti (2007) illustrated this lack of teacher preparation. The authors surveyed one-hundred and twenty secondary science teachers to assess their knowledge and preparation in working with students with special needs in the science classroom. The authors focused on three questions regarding teacher training, resources needed, and what the teacher needs to do to better meet student needs. A qualitative and quantitative research design was used to analyze the data. Overwhelming results indicated that 100 percent of the teachers surveyed needed support on various instructional methodologies to teach students with disabilities science.

When researchers have demonstrated ways to include students with disabilities, the majority of the research has been conducted with students with learning disabilities. These studies with students with high incidence disabilities have targeted a number of specific strategies, including vocabulary enhancements (e.g., King-Sears, Mercer, & Sindelar, 1992; Scruggs & Mastropieri, 2000); text adaptations (e.g., Bergerud, Lovitt, & Horton, 1988); and hands-on science activities (e.g., McCarthy, 2005; Mastropieri, Scruggs, Mantzicopoulos, Sturgeon, Goodwin, & Chung, 1998). Cawley, Hayden, Cade, and Baker-Krooczynski (2002) suggested that the needs of students with disabilities and the curriculum in which they have traditionally been taught have been mismatched. Students with mild disabilities often display difficulty with inductive and deductive thinking skills, generally associated with scientific reasoning. Instructional methods to strengthen these thinking skills are required to support the comprehension of new and relevant scientific concepts (Mastropieri, Scruggs, Boon, & Carter, 2001; Mastropieri, Scruggs, & Butcher, 1997). A process or method used to teach science to all students using inductive and deductive thinking is *inquiry based science.*

With inquiry based science the focus of student learning is on the “processes of science” rather than “science as a process.” Science should be taught in a way that asks students to combine the processes and their understanding of science using reasoning and critical thinking to develop deeper understanding. Through inquiry learning, students begin to understand the concepts, appreciate “how we know” science, the nature of science, and skills needed to become independent inquirers, and the functionalities associated with science (NSES, 1996). The National Science Education Standards describe the need for students to develop deep understanding of scientific concepts and scientific reasoning through inquiry-based instruction. Palincsar, Magnusson, Collins, and Cutter (2001) conducted a two-year research study investigating the experiences and outcomes of four upper-elementary classrooms of students including, 22 students with mild disabilities, in guided inquiry science instruction. Using both qualitative and quantitative measures, specific advanced instructional strategies were developed in Phase 1 (year 1) of the intervention and implemented in Phase 2 (year 2) of the study. Findings indicated that with advanced strategies (e.g., mini-conferencing, rehearsals for oral presentations, glossary of terms, journal entries being transcribed by paraprofessional or peers) all students’ demonstrated significant gains in Phase 2 over Phase 1 and those students identified as having a disabilities or low-achieving showed considerable growth in conceptual understanding (i.e., thinking and reasoning skills) to those of their non-disabled peers.

Students with disabilities may also benefit from a hands-on approach to science learning. One recent example of research conducted in inclusive science education investigated the outcomes associated with class-wide peer tutoring using differentiated hands-on activities vs. teacher –directed instruction for students with mild disabilities in an inclusive 8th grade science classroom (Mastropieri et al., 2006). Two-hundred and thirteen students (13 classes), including 44 students with disabilities, participated in a 12-week randomized field trial design in which the experimental group received differentiated, peer-mediated, and hands-on learning activities, while the control group received traditional science instruction. Similar to previous research findings, results indicated that all students involved in the collaborative hands-on activities enjoyed the activities, as well as performed better on middle school science content via post tests than the control group.

While the majority of research in the area of inclusive science education for students with disabilities involved students with mild disabilities, some research has been conducted with students with severe disabilities. However limited, it is important to examine those studies in order to develop evidence based strategies and procedures while developing inclusive science models for this population of students.

Science instruction for students with moderate and severe disabilities. Courtade et al., (2007) conducted a comprehensive review of the research on teaching students with significant cognitive disabilities science. Using the strands of science developed by the National Science Education Standards, Courtade and colleagues identified a total of 11 studies. Using the limited number of studies found dating from 1985-2005, the research was organized into categories by science strands. The review found 8 of the 11 studies fell into one category of science instruction: Content Standard F (Science in Personal and Social Perspectives), focusing on safety skills, such as first-aid, disposal of materials, and self-protective behaviors. The focus of two studies found was students relative position in community settings, falling under Content Standard B (Physical Science), while one study fell under the Content Standard D (Earth and Space Science), teaching weather-related sight words. No research was found under Content Standard A (Science as Inquiry), C (Life Science), E (Science and Technology), or G (History and Nature of Science.) Results of this review indicated a need for additional research in the area of teaching students with significant cognitive disabilities science skills across all strands of science.

Since this review, several researchers have investigated science content acquisition for students with severe disabilities (Agran, Cavin, Wehmeyer, & Palmer, 2006; Browder et al., in press; Carter, Cushing, Clark, & Kennedy, 2005; Carter, Sisco, Melekoglu, & Kurkowski, 2007; Collins et al., 2007; Courtade, Browder, Spooner, & DiBiase, in press; Jameson, McDonnell, Johnson, Riesen & Polychrionis, 2007; Jameson, McDonnell, Polychronis, Riesen, 2008; Jimenez et al., in press; McDonnell, Johnson, Polychronis, Riesen, Jameson, & Kercher, 2006; Spooner et al., 2009). In 2006, McDonnell et al. compared the effectiveness of embedded and small-group instruction to teach vocabulary word definitions to four middle school students. Using constant-time delay, differential reinforcement, and systematic error correction procedures, four students were taught to verbally define five words taken from their general education classroom curriculum. Two of the four students focused on the acquisition of science vocabulary (e.g., atom, biosphere, element, molecule). An adapted alternating treatment design was used to investigate the effectiveness of embedded and small-group instruction formats. Both formats of instruction were successful in student vocabulary acquisition.

Courtade et al. (in press) investigated the effects of training teachers in inquiry science on students' participation during an inquiry lesson. The purpose of this investigation was to determine if training teachers of students with moderate and severe intellectual disabilities in the use of a task analysis for inquiry-based instruction could be applied across science content. Four teachers of middle school students with moderate and severe intellectual disabilities were trained to implement an inquiry science lesson. Eight middle school students with moderate and severe disabilities were taught to participate in inquiry science lessons as defined by a 12-step task analysis. The findings of this study demonstrated a functional relationship between the multi-component teacher training package (videotape, manual, application, role play, in vivo feedback) and teacher's ability to instruct students with severe disabilities in the steps of inquiry. The teachers generalized the task analytic instruction across science content areas and all students increased the number of responses to participate in an inquiry lesson.

Browder et al. (in press) conducted a study in which secondary students learned to identify grade-content specific vocabulary sight words paired with picture symbols to measure comprehension, using a constant time delay procedure within inquiry science lessons (e.g., chemical reactions, plate tectonics, cell theory). Using a quasiexperimental group design with special education teachers randomly assigned to either the math or science treatment group, teachers in the science group implemented four inquiry-based science units representing four strands of science identified in the National Science Education Standards (i.e., Earth's history, Earth's waters, chemistry, and microbiology). Results showed that students made gains in their respective content areas. Students who received instruction in science scored higher than students who received instruction in math on the posttest of science vocabulary skills.

Additionally, Jimenez et al. (in press) investigated the effect of self-directed learning to promote the generalization of science concepts across units of instruction. Using a constant time delay procedure middle-school students with moderate and severe intellectual disabilities were taught to self-direct the use of a KWHL (e.g., K=what do you know?) chart across lessons and science units. Students showed significant positive outcomes on number of science questions answered correctly across lessons, as well as the self-directional use of the KWHL chart across lessons and units. While this study was conducted in a self-contained special education setting, two generalization probes were conducted in an inclusive secondary science setting. Such findings suggest that students with moderate and severe intellectual disabilities can learn science concepts; however, limited research has been found teaching science content to this population in inclusive settings. In addition, Courtade et al. (in press), Browder et al. (in press), and Jimenez et al. (in press) were the only three studies found that used the scientific process of inquiry, suggested by NSES, to teach science skills to students with severe disabilities.

Of the limited research on science interventions for students with moderate and severe developmental disabilities, only six were conducted in inclusive settings (Carter et al., 2005; Carter et al., 2007; Collins et al., 2007; Jameson et al., 2007; Jameson et al., 2008; McDonnell et al., 2006), but these did not focus on inquiry. The studies that did focus on inquiry (Courtade et al., in press, Browder et al., in press; Jimenez et al., in press) were not conducted in an inclusive setting, this is why additional research in the area of inquiry science in needed in inclusive settings for students with severe disabilities.

Limitations of current research. Although no studies exist for students with moderate and severe disabilities, there are several based on the experimentation of inquiry-based science with students with mild disabilities in inclusive settings (Dalton, Morocco, Tivnan, & Mead, 1997; Palincsar, Collins, Marono & Maggnusson, 2000; Mastropieri et al., 2006; Mastropieri, Scruggs, Boon, & Carter, 2001; Mastropieri, Scruggs, & Butcher, 1997; Mastropieri, Scruggs, Norland, Berkeley, McDuffie, Tornquist, et al., 2006). In most of these studies, the intervention focused on the effects of hands-on learning vs. traditional science education (i.e., lecture format and text book). While much evidence in support of inquiry learning for students with disabilities exists, more specific instructional strategies and techniques to implement inquiry learning with students with severe disabilities in inclusive settings is needed.

Distributed-Trial Training

Defining an instructional practice. Students with severe disabilities need repeated instructional trials to master new skills. One approach to providing multiple trials is the use of massed trial training, in which a concept or skill is taught in 10 of more consecutive trials (Browder, 2001). While this approach in teaching new skills provides intensive instructional delivery, one possible down fall can be its lack of contextual support. Historically, most of the research in special education has been conducted using a massed trial approach; however, more recent literature has supported the use of distributing instructional trials to provide a greater functional link to the skill and the environment in which the skill would naturally occur. Mulligan, Guess, Holvoet, and Brown (1980) conducted a literature review on the use of massed, distributed, or spaced trial learning finding supporting evidence in favor of distributed trial instruction for students with severe disabilities. Distributed trial training is “the interspersal of instructional trials for one task among other training trials for other tasks during an instructional session” (Westling & Fox, 2004). Previous research on distributed trial training has found this strategy to be effective for students with developmental disabilities (Dunlap & Koegel, 1980, Dunlap & Dunlap, 1987, Mulligan, Lacy, & Guess, 1982, Wolery et al., 2002).

One approach to using distributed trials is to embed trials during the naturally occurring lesson or activity. While there is not currently a consistent definition of embedded instruction the term typically refers to “explicit, systematic instruction designed to distribute instructional trials within the on-going routines and activities of the performance environment” (McDonnell, Johnson, McQuivey, 2008). As the number of students with developmental disabilities being served within general education classes increases (U.S. Department of Education, 2001; Werts, Wolery, Snyder, Caldwell, & Salisbury, 1996) and the need to develop strategies to provide systematic instruction to fit student’s unique learning needs grows, embedded instruction has become one strategy shown effective in the increase of student performance (Hunt & McDonnell, 2007; Snell, 2007). A strong research base exists validating the use of embedded instruction for young children with developmental disabilities (Wolery, 1996).

Embedded social skill instruction. The use of embedded instruction began as a mode to teach students with developmental disabilities social skills and language within the context of the home, school, or community. Various formats have been used to embed response opportunities within ongoing classroom activities, such as activity-based interventions (Losardo & Bricker, 1994), incidental teaching (Hart & Risely, 1975, Cowan & Allen, 2007), milieu teaching (Kaiser, Hendrickson, & Alper, 1991), or pivotal response training (Koegel, Carter, & Koegel, 2003). Embedded instruction has shown to be an effective strategy in social and communication skill training. For example, Yoder (1995) compared the effects of two language intervention methods, milieu teaching and responsive interaction with preschool children with moderate and severe language disabilities. Milieu teaching was found to have the greatest effectiveness in rate of language development for students with the lowest language skills.

Young children's play skills with peers without disabilities have also been investigated using embedded instruction (Fox & Hanline, 1993; Venn, Wolery, Werts, Morris, DeCesare & Cuffs, 1993). Venn et al. (1993) evaluated the effectiveness of teacher-delivered peer-mediated embedded instruction during arts and crafts activities for preschool students with autism. Three males were taught to imitate what their peer was doing using a progressive time delay of 0 seconds, 2 seconds, 4 seconds then 6 seconds. Results indicated that progressive time delay embedded within the arts and crafts activities was effective in increasing student peer imitations.

Embedded academic skill instruction. Although embedded instruction has evidence as an effective instructional strategy; the majority of early research has been conducted in a special education classroom and with preschool age children (Dunlap & Dunlap, 1987; Gaylord-Ross & Holvoet, 1985; Guess & Helmstetter, 1986; Sailor & Guess, 1983). Recent research involving students with moderate and severe disabilities and embedded instruction has focused on the attainment of academic skills, such as science vocabulary or math facts in general education.

One of the first studies conducted investigating the effects of embedded instruction in a general education classroom on academic learning of students with severe disabilities was conducted in 1997, by Wolery et al. Wolery and colleagues taught general education elementary school teachers to embed a constant time delay procedure during lessons provided to students with and without disabilities. Identification of sight words, naming days of the week, and categorizing food into food groups were the skills taught. Findings suggested that students could learn embedded target skills, and general education teachers could successfully implement embedded instruction during general education lessons.

McDonnell, Johnson, Polychronis, and Riesen (2002) taught paraprofessionals to embed instructional trials with four junior high school students with developmental disabilities. The researcher directly drew skills from the general education curriculum and the lessons being taught in three different subject areas (i.e., food and nutrition class, health class, computer class). Paraprofessionals taught students to read or define words included on vocabulary lists from general education class. The special education paraprofessional who was assigned to support each student during that class implemented the embedded instruction technique. Findings indicated that embedded instruction was a successful practice that led to mastery and maintenance of each target skill. Additionally, results found that paraprofessionals were able to implement the embedded instruction procedures with high fidelity.

To compare the effectiveness of constant time delay and simultaneous prompting within an embedded instruction format, Riesen, McDonnell, Johnson, Polychronis and Jameson (2003) conducted a study in which paraprofessionals were trained to embed instructional trials with four junior high school students with moderate disabilities enrolled in inclusive classrooms (i.e., science, US History, German). Students without disabilities in the general education classrooms were expected to read and define select vocabulary. To align to the expectations of the general education classroom, target skills for the four students who participated in this study included reading or verbally defining key vocabulary from their respective general education classroom (e.g., colony, plate tectonics, vier (four in German), condensation). While both procedures were effective in promoting the acquisition of content vocabulary, the constant time delay procedure proved to be more effective for two of the students and the simultaneous prompting for the other students. The paraprofessionals implemented the embedded instruction procedures with a high degree of fidelity, regardless of the prompting and fading procedure used.

To extend the research on embedded instruction as a strategy to support students with developmental disabilities in inclusive classrooms, Johnson and McDonnell (2004) evaluated the effects of embedded instruction in promoting the acquisition of academics or communication skills. Three students were taught to either; match functional sight words, sign for help, or identify “greater than” with two-digit numbers. Two general education teachers implemented the embedded instruction to the students within the general education classroom with a high degree of fidelity. Social validity ratings suggested that teachers viewed embedded instruction as an efficient and practical way to teach students with disabilities within the general education classroom.

An additional area of research in embedded instruction has been the examination of how specific features (i.e., length of time between trials, number of activities in which trials are embedded) of embedded instruction influence student learning. Polychronis, McDonnell, Johnson, Riesen, and Jameson (2004) taught general education teachers to used a two trial distribution schedule to examine how the length of time between trials and number of activities in which trials are embedded would impact the academic learning of four elementary school students with developmental disabilities. Students were taught academic (i.e., number identification, state capitols, time telling) and social skills (i.e., classmate and teacher names). Instructional trials were distributed over 30 min and a 120 minute increment that spanned across two lessons (e.g., math and reading). Results found that both schedules of distribution lead to student acquisition of targeted skills. Two students reached criteria for mastery faster when trials were distributed over a shorter period of time (30 min); however, no significant difference between the rate of target skill acquisition and the two schedules for the other two students was found.

More recently, Jameson, Johnson, Reisen, and Polychronis (2007) compared the effectiveness of one-to-one embedded instruction in a general education classroom with the effectiveness of one-to-one massed trial instruction in a special education classroom. The special education teacher or paraprofessional taught four middle school students to identify or define vocabulary aligned with the general education class in which they participated (i.e., Foods class, Teen living, Earth Science). The special education teacher and paraprofessional embedded all instructional trials in the special education and general education classroom. The results indicated that both instructional strategies were effective in student mastery of target vocabulary. Consistent with previous research, results also suggested that embedded instruction can be held as a promising instructional strategy to support students with developmental disabilities in general education settings.

Who embeds the instruction? Current research in the area of embedded instruction has shown strong evidence for use within inclusive settings. Differing from early research in which embedded instruction was primarily used to instruct students with severe disabilities in vocational and social skills, the current research focus is on academic skill instruction in the natural educational setting. One of the reasons that embedded instruction is used is due to its ability to provide a natural, less-restrictive teaching environment for all students. While most of the research on embedded instruction and academic skill mastery has been implemented with either the teacher (Jameson et al., 2007; Johnson & McDonnell, 2004) or paraprofessional (Jameson et al., 2007; Johnson et al., 2007; McDonnell et al., 2002; Riesen et al., 2003), another option for delivery of distributed trials using embedded instruction is through the use of classroom peers. Limited research has been conducted using peers to embed instructional trials within inclusive classrooms for students with severe disabilities. However, recent research in the area of embedded instruction has begun to investigate the use of peers-mediated instruction when embedding instruction trials in inclusive classrooms.

Jameson, McDonnell, Polychronis, and Riesen (2008) conducted a study in which three general education peers were trained to use embedded constant time delay within a general education classroom (i.e., health; arts and crafts class). Peer tutors taught three middle school students with severe developmental disabilities content specific vocabulary (e.g., lungs; stomach; kiln, glaze) using a 3-second constant time delay procedure. The study demonstrated that peer tutors could be trained to implement embedded instruction using a time delay procedure with fidelity, resulting in skill mastery for all three students. Teacher and peer tutor social validity measures also indicated high levels of satisfaction with the procedures and student outcomes.

Peer-mediated Instruction

Much of the research in the area of teaching students with severe disabilities relies heavily on one-to-one adult-delivered support (Giangreco, Halvorsen, Doyle, & Broer, 2004). Giangreco and Broer (2007) noted the potential repercussions of the widespread use of individually assigned paraprofessionals to support secondary inclusion. This level of support by adults in the classroom may compete with goals of social and academic inclusion set as a target by educational teams (Carter & Kennedy, 2006). An alternative to teacher lead support is the use of classroom peers. Peer support interventions are emerging as an evidence-based strategy to assist students with severe disabilities within the general education classroom with social and academic outcomes (Carter, Sisco, Melekoglu, & Kurkowski, 2007; Cushing, Clark, Carter, & Kennedy, 2005). Peer support arrangements involve inviting one or more peers to provide social and/or academic support to a classmate with a severe disability while receiving supervision and guidance from one or more adults (Carter & Kennedy, 2006; Carter, Cushing, & Kennedy, 2008).

Peers using a time delay procedure to teach social and academic skills. There is a large literature base supporting the use of peers to teach skills to students with severe disabilities (Carter et al., 2007; Cushing & Kennedy, 1997; Kamps et al., 1989; Miracle, Collins, Schuster, & Grisham-Brown, 2001; Romer, Busse, Fewell, & Vadasy, 1985;

Werts, Caldwell, & Wolery, 1996). For example, Kamps et al. (1989) trained two fifth grade students without disabilities to use verbal reinforcement, instructive feedback, and model and verbal prompts to teach two elementary students with autism target academic skills. The academic skills consisted of reading comprehension, coin identification, and the naming of opposites.

Additional research has been conducted on the efficiency in which peers can deliver instruction to students with disabilities (Romer et al., 1985; Miracle et al., 2001). In 1985, Romer and collegues compared the efficiency of peer tutor instruction to teacher delivered instruction on vocational skill acquisition for students with severe disabilities. Results indicated that not only were both peers and teacher instruction effective, less learning trials were required when peers delivered instruction. Consistent with the findings of Romer et al., Miracle et al. (2001) found that both peer delivered and teacher delivered instruction using a constant time delay procedure were effective in reaching target sight word acquisition for high school students with moderate disabilities.

Frequently, the strategy peers learn to implement is time delay prompting (Miracle et al., 2001; Wolery, Werts, Snyder, & Coldwell, 1994). The use of time delay procedures to teach students with severe disabilities has shown to be effective, easy to implement, and more efficient than other errorless strategies (Schuster et al., 1998; Browder et al., 2009). Research has been conducted teaching peers to use time delay to instruct students with disabilities to identify sight word vocabulary (Miracle et al., 2001; Wolery et al., 1994); generalize the reading of cooking labels (Collins, Branson, & Hall, 1995), and prepare food (Godsey, Schuster, Lingo, Collins, & Kleinert, 2008). In 1994, Wolery et al. investigated the effect of a constant time delay procedure delivered by peers in an inclusive elementary school classroom. The constant time delay procedure was found to be effective in promoting positive learning outcomes for students with moderate intellectual disabilities. Additionally, peers were able to implement the procedure with high fidelity.

The effectiveness and reliability of peer tutors using a constant time delay procedure was again evaluated by Godsey et al. in 2008. Peers taught four high school students with moderate and severe disabilities to prepare foods in a classroom kitchen setting. Using a picture recipe, students learned to prepare daily snacks and meals (e.g., milkshake, grilled cheese sandwich). Peer tutors were trained during two 90-minute after school sessions, how to implement the constant time delay procedure (0-s session, 5-s session). Data indicated that all peers were effective in teaching the students the food preparation tasks. Results found that peers implemented the time delay procedure with a high degree of reliability (93% accuracy).

The efficacy of teaching science terms to students with significant cognitive disabilities using a constant time delay procedure delivered by peers was evaluated by Spooner et al. (2009). High school students were trained to use a constant time delay procedure to teach science sight words (e.g., core, layer) and picture match for comprehension to students with autism. A multiple probe across word lists with concurrent replication across students was used to demonstrate a functional relationship between the constant time delay procedure by peers and students acquisition of target vocabulary. Findings indicated that peers were able to successfully implement the time delay procedure with high fidelity, and students were able to master both word lists within 12 sessions.

Using peers to support inclusive practices. The research on using peers to deliver instruction to students with severe disabilities has been around for several decades (Rose, 1981); however much of this research has been conducted in self contained settings (Godsey et al., 2008; Marchand-Martella et al., 1992; Spooner et al., 2009). There is a growing body of evidence to support the use of peer-delivered instruction in an inclusive classroom (Carter, Cushing, Clark, & Kennedy, 2005; Cushing & Kennedy, 1997; McDonnell, Thorson, & Fister, 2001; Wolery et al., 1994).

Dugan et al. (1995) investigated the use of cooperative learning groups in a fourth grade inclusive classroom with students with autism. Cooperative learning groups were established in a social studies classroom, group activities consisted of distribution of materials, peer tutoring on key word and facts from the lesson, and either a worksheet or research activity. Weekly assessments were given on student's acquisition of sight word and comprehension of social study vocabulary (e.g., *Adobe* is used to make bricks). Academic engagement and peer interactions were recorded using time samplings during inclusive lessons. Results from this study found cooperative learning procedures to be an effective practice, benefiting both target students as well as their peers academically and socially. While student with autism did learn some of the academic vocabulary from the lessons via peer delivered instruction, the researchers noted that additional research is needed. Suggested future research included the analysis of specific components of peer-tutoring as well as the appropriateness of the materials being used to teach general curriculum academics to students with autism in the general education classroom.

Research has also been conducted to evaluate the number of peers providing support. Carter, Cushing, Clark, & Kennedy (2005) evaluated the impact of altering the number of participating peers providing support to students with severe disabilities on student social and academic outcomes. Using an ABAB and BABA design, three middle and high school students with moderate disabilities were provided with peer support by either one peer (A) or two peers (B). While both supports had a positive effect on students contact with the general curriculum, and social interaction, a 2:1 ratio of support was found more effective. This level of support was deemed primarily successful for social skill training.

Recently, special attention has been paid to the increases in peer interaction that may be associated with peer support interventions. In 2007, Carter et al. examined the effectiveness of peer support interventions at improving social and academic outcomes for high school student with severe disabilities in core academic classrooms. The researchers acknowledged the need for additional research to promote successful peer interactions while investigating the collateral effects on student's academic engagement. A delayed multiple-baseline across participants design was used with four peer support students and four high school students with moderate to severe disabilities. A one-minute time sampling procedure was used to collect data over a 14-week period of time. Results indicated that the use of a peer support intervention increased student's social interactions and academic engagement.

Finally, only one study has been conducted to date using peers to embed systematic instruction in the inclusive classroom (Jameson, McDonnell, Polychronis, & Riesen, 2008). As previously noted in this paper, findings from this study show that general education peer tutors can be trained quickly and efficiently, resulting in skill acquisition of students with disabilities.

Summary of Research Foundation for the Current Study

Over the past decade the expectation of academic achievement for students with severe disabilities has grown. Mandated by recent legislation students with significant cognitive disabilities must gain access to the general curriculum and demonstrate proficiency in the academic content areas of reading, math, and science (NCLB, 2002). Not only must local education agencies provide evidence of student learning of academic content, students must acquire these skills within the least restrictive environment (IDEA, 2004). Due to mandates such as IDEA and NCLB, the number of students with severe disabilities receiving instruction in inclusive classrooms has steadily increased (U.S. Department of Education, 2001). The positive social and educational benefits of inclusion for students with moderate and severe disabilities have been demonstrated by several research studies conducted over the past several decades (Giangreco & Putnam, 1991; Hunt & Goetz, 1997; Lipsky & Gartner, 1997); however, significant challenges are still present when serving students with severe disabilities in these settings. One challenge that has been encountered with inclusive education for students with severe disabilities has been core content acquisition and the rapid pace in which content is taught.

Embedded instruction is one possible strategy that could be used to increase skill acquisition in academic content areas. With embedded instruction, students are taught target behaviors within the naturally occurring routine of a lesson. Embedded instruction has been successful in teaching school age students with disabilities a variety of academic and social skills. Numerous studies have examined the use of embedded instruction to allow for repeated instruction (Johnson & McDowell, 2004; Wolery et al., 1997; Wolery et al., 2002). Often general education teachers will use this strategy to meet the individual needs of one or two students within a lesson. The natural occurrence of these repeated opportunities to respond are different from mass trial training in that they are distributed throughout a lesson or instructional session. Distributed trial training may be a mode to assist students with severe disabilities in gaining grade linked content mastery. This strategy has proven effective for students with developmental disabilities (Bambara, Warren; & Komisar, 1988; Wolery et al., 2002). Use of systematic instruction strategies; such as time delay, have also been noted as successful while implementing embedded instruction (Polychronis, McDonnell, Johnson, Reisen, & Jamenson, 2004; Wolery et al., 1997). While research suggests the use of embedded instruction to have positive effects on student skill acquisition in inclusive settings (McDonnell, Johnson, Polychronis, & Reisen, 2002; Polychronis et al., 2004; Wolery et al, 1997), very little research to date has been implemented in which someone other than the general education teacher, special education teacher, or teaching assistant has been trained to embed trials for students to respond within an inclusive lesson.

A focal point of inclusive education has been the social aspect of students working together in an academic context. In the arena of science education, the National Science Education Standards (National Research Council, 1996) has noted the importance of inquiry-based science as an effective mode to fostering student's discovery and content understanding. An essential component of inquiry based learning is the composition of learning groups and peer interaction. A possible strategy to help build the link between social and academic inclusive education may be peer mediation. Peer-mediated instruction is a technique that has been used to assist in skill mastery for students with severe cognitive disabilities. Often general education students are paired with same-grade students with a disability in order to teach them a skill. Research has been conducted that has shown that students without disabilities can be effective in teaching students with moderate to severe disabilities a wide range of skills (McDonnell, Mathot-Buckner, Thorson, & Fister, 2001). One benefit peer-mediated instruction offers to the learning environment is the ability to provide additional repetition and learning trials to students within a lesson, opposed to the teacher spending considerable amounts of time on individual instruction at other times during the instructional day.

Potential Contribution of the Current Study

Researchers and practitioners are asking for new support models to provide students with severe disabilities greater access to the general curriculum (Cushing, Clark, Carter, & Kennedy, 2003; Giangreco, Halvorsen, Doyle, & Broer, 2004). Although some research has been conducted with students with severe disabilities on academic gains in inclusive settings, teachers are challenged to include students with severe disabilities in the core content domains, including science (Heller, 2001). Carter, Cushing and Kennedy (2008) suggest that all students have access to a rigorous curriculum in which students with severe disabilities receive the support needed to be successful both academically and socially in inclusive settings.

Based on research using embedded instruction to teach academic skills and research using peer-mediated instruction, additional research is needed to improve student content acquisition in the area of inquiry-based science. Due to the nature of inquiry science it would be difficult for a classroom teacher to embed repeated trails for students when peer groups are expected to guide themselves through the process. Research is needed to examine the use of peer-mediated embedded instruction in inclusive settings on student's ability to participate in group work and acquire new content knowledge.

The dependent variable of this study is unique in that science vocabulary, picture symbols, vocabulary word/match to show comprehension, and concept statements were used. Previous research for students with severe disabilities has measured sight word recognition (Browder & Shear, 1996; Browder et al., in press; Browder, Wakeman, Spooner, Ahlgrim-Delzell, & Algozzine, 2006; Collins, 2007), and picture symbol recognition (Browder et al., in press; Browder et al., 2006). Some research has been conducted in which students are taught to use sight words (e.g., sunny; rain) to fill in sentences, such as "It is sunny" or "It's going to rain today" (Browder et al., 1996); however no research has been conducted in which students have been taught concept statements. Finally, no research has been previously conducted in which sight words, picture symbols, word/picture matching and concept statements have been combined into one metric.

The purpose of this study was to examine the effects of peer-mediated embedded instruction using time delay on the number of science responses correct with middle school students with severe disabilities during inclusive inquiry science lessons. The following primary research questions were addressed: (a) What is the effect of peer-mediated embedded instruction on number of correct science responses?, (b) What is the effect of peer-mediated embedded instruction on independent KWHL chart responses?, (c) What is the effect of peer-mediated embedded instruction on student social attitudes?, (d) What is the effect of peer-mediated embedded instruction on science grade averages of general education peers?

CHAPTER 3: METHOD

Participants

Peer tutors. Six general education students were recruited to participate in this investigation as peer tutors. One peer served as a substitute during the intervention if another peer was absent from class. Students who participated in the study met the following inclusion criteria: (a) middle school student enrolled in a general education science course, (b) nominated by science teacher, (c) passing science course, (d) had consistent attendance, (e) who agreed to be trained and to work as a science peer during science lessons, and (f) met fidelity criteria in training. No prior experience as a peer mentor was expected of general education students; however, experience was noted.

Relevant characteristics of general education students are listed in Table 1. Information is provided on ages of the students, grade level, gender, as well as prior experience with peer mentoring students with severe intellectual disabilities (see Table 1).

Table 1

Characteristics of Peer Tutors

Student	Age	Gender	Grade	Experience as Peer Mentor
Mary’s peer	11	Female	6	Yes (after school program)
Jade’s peer	11	Female	6	No
Devin’s peer	11	Female	6	Yes (gym class in elementary)

Table 1 (continued)

Derek's peer (Unit 1)	11	Female	6	No
Derek's peer (Units 2&3)	11	Male	6	No
Brett's peer	11	Female	6	Yes (summer camp)

Students with disabilities. Additionally, five special education students were recruited to participate in this investigation. Students who participated in the study met the following inclusion criteria: (a) identified as having a moderate/severe intellectual disability (IQ 55 or below), (b) clear response mode, (c) able to identify 20 or more picture symbols, (d) able to identify 10 or more sight words, (e) enrolled in a middle grade (6-8), (f) consistent attendance (absent less than two times per month). The special education teacher nominated the students based on these criteria. The researcher verified the student characteristics by reviewing school cumulative records.

Relevant characteristics of special education students are listed in Table 2. Ages of the students, range of disability, and verbal ability are reported.

Table 2

Characteristics of Students

Student	Age	Gender	Grade	IQ	Disability	Response Mode
Mary	14	Female	7	40 (WISC IV)	ID Mod	Verbal
Jade	11	Female	7	34 (DAS)	ID Mod	Verbal
Devin	13	Male	7	55 (UNIT)	ID Mod	Verbal

Table 2 (continued)

Derek	11	Male	6	53 (Stanford-Binet)	ID Mod	Verbal
Brandon	11	Male	6	49 (DAS)	ID Mod	Verbal

Teachers. One general education science teacher was selected to participate in the study. The teachers was selected based on the following inclusion criteria: (a) middle school science teacher; (b) willing to uses inquiry to teach science lessons and agrees to teach using inquiry 2-3 times per week; (c) uses cooperative base groups; (d) willing to help facilitate inclusive education with five students with severe intellectual disabilities.

One special education teacher was selected to participate in the study based on the following inclusion criteria: (a) middle school teachers of students with severe intellectual disabilities; (b) familiar with systematic instruction (i.e., time delay); (c) willing to help facilitate science booster sessions as needed. After the special education and general education teacher were selected, the researcher contacted the school principal and received permission to recruit the general education and special education students.

The researcher obtained all informed consent (i.e., teacher and parent) and student assents using the format approved by the Institutional Review Board (IRB) at the University of North Carolina at Charlotte (UNC-Charlotte). The informed consents and student assents were signed and returned before participants began to participate in the investigation.

Setting

The teachers and students were members of classes in the Charlotte-Mecklenburg School system. The school system is a large, urban district located in Charlotte, NC. The system serves approximately 126,000 students, 14,000 of whom have disabilities. The participants were recruited from one middle school within the school district.

The special education students were recruited from one classroom serving students with moderate to severe intellectual disabilities. These Specialized Academic Curriculum (SAC) classrooms are located within the integrated public school. The SAC classrooms are designed for students with moderate to severe disabilities who need specialized adaptations to access the general curriculum. The SAC classrooms typically serve eight students with one teacher and one paraprofessional. The SAC classroom in which the students in this study received majority of their instruction consisted of 8 students, 1 teacher, 1 paraprofessional, and 1 interpreter for an individual student.

This investigation took place within the general education science classroom setting outside of the SAC classroom. The student ratio in the general education science classroom was 26:1. The science teacher had six years experience teaching secondary science, with the 2009/2010 year being her first year teaching science in Charlotte-Mecklenburg Schools. This was also the first year the teacher had used the prescribed science curriculum for this school system. The teacher's procedure for teaching inquiry science consisted of: (a) students and teacher read a passage from their text book; (b) teacher introduces the lesson for the day, asking what they know about a given topic with the KWHL chart. Students respond verbally. Teacher prompts students thinking to generate more ideas; (c) teacher asks class what they would like to know about the topic (e.g., plate tectonics) using the KWHL chart. Students respond verbally. Teacher prompts students thinking to generate more ideas; (d) teacher ask class how they might find out more information using the KWHL chart. Students respond verbally, teacher prompts students thinking to generate more ideas; (e) cooperate learning groups of 4-5 students will either participate in an experiment or activity (online cyber – experiment using the SMART board, or actually investigate using materials in their small groups); (f) students report their answers by completing a worksheet, filling in data on a chart, or verbally telling the teacher what they saw. Teacher prompts students thinking to generate more results or deeper understanding of what they experienced; (g) teacher then asks students what they learned from the experience (usually, students then just repeat what they said on their worksheet); (h) teacher directs thinking to next lesson that will be covered in the next class session. The above description of the teacher's instructional procedures and each component of the inquiry lesson were submitted to a science content expert with a rating scale from 1-5 of how well the components of the lesson reflects inquiry, in which the expert indicated the description to be a "4 - above average example of inquiry." The classroom was set up with six large tables, in which groups of four to five students sat around a large rectangle table. Students were allowed to sit wherever they would like; however general education peers placed an extra chair next to them for their special education student to sit during inclusive science lessons. Finally, four to five students without a disability and one student with a disability sat at five of the six tables (cooperative base groups).

An additional setting was used to train the general education students on the peer-mediated instructional method. A one-hour student training workshop was held in the school media center. The training occurred within a small room in the media center. Peers sat at a large table facing the white board where the power point training was presented. Finally, the students were assessed during baseline and probe sessions within the general education classroom for acquisition of the KWHL chart. Assessments were also conducted for baseline and probe sessions at a small table within the special education classroom on science vocabulary and concept statement acquisition; with additional in vivo probes within the general education classroom.

Materials

All materials used during the peer training session were also used during unit 1 of the intervention; however new materials were introduced in unit 2 and 3 (untrained to the peers). A KWHL chart was used to train and assess students self-monitoring of the inquiry process during the science lesson (see Appendix A). The KWHL chart was photocopied for each lesson and each student was given a chart to use within each lesson. The science teacher also used a poster size copy of the KWHL chart on the side whiteboard in the classroom. Science vocabulary words were typed using a word processor then printed and glued onto a 3x5 index card, then laminated for durability. Similarly, science picture symbols (e.g., a rollercoaster moving down a track to symbolize Kinetic Energy) were made using the internet and computer software (i.e., Google images, Microsoft Word clip art) then printed, placed on index cards and laminated. Three science picture symbols were created for each vocabulary word (e.g., Kinetic Energy - rollercoaster, runner, motorcycle). Small pieces of Velcro were placed on the back of each vocabulary card. A piece of construction paper was laminated and three pieces of Velcro placed on the paper to use as a response board. Vocabulary cards were placed on each Velcro piece of the response board during instruction. The response board with Velcro allowed for the peers to change the order of the vocabulary cards during instructional trials.

Concept statements (e.g., Kinetic energy is the energy of motion.) were created using picture symbol computer software (i.e., Writing with Symbols). Picture symbols were placed above key vocabulary in the statement (e.g., motion). Concept statement materials were created with the key vocabulary missing from the statement (e.g., _____is the energy of motion). Exemption of this word was necessary to allow peers to train the independent completion of the concept statement with the students. Concept statements were placed on card stock paper and laminated for durability. A small piece of Velcro was placed on the empty space in the statement to allow for students to place the vocabulary word that completed the statement. See Appendix B for an example of a vocabulary card, picture symbol and concept statement.

All materials used during instruction were used during assessment probes (i.e., vocabulary cards, concept statements). All other materials (e.g., model car, "Brain Pop" virtual experiments) used during lessons were supplied by the general education teacher as part of the inquiry lesson that was taught to the whole class.

Overview of the Method

This study focused on four research questions: (a) What is the effect of peer-mediated embedded time delay instruction on number of correct science responses?; (b) What is the effect of peer-mediated embedded time delay instruction on independent KWHL chart responses?; (c) What is the effect of peer-mediated embedded instruction on student social attitudes?; (d) What is the effect of peer-mediated embedded instruction on general education peer science grade averages? General education peers received training to use a constant time delay procedure to embed trials for science responses within a inquiry science lesson. For clarification purposes, the variables are referred to by name of the measurement tool. The variables, design, and intervention will now be described in more detail.

Dependent Variables

Student science responses data collection form. The first research question was measured using the *Student Science Responses Data Collection Form.* This assessment was given at a small table in the back of the special education classroom to each special education student after each inquiry science lesson (2-3 times per week) implemented in the inclusive science classroom with a general education peer. Each student's performance was measured by the number of independent correct responses (see Appendix C). Student responses included two science words, two science pictures, two science word/picture match, and two concept statements per unit (see Table 3). Science responses were taken directly from the unit of instruction occurring in the general education science classroom, using the state's adopted 6th grade science text (i.e., McDougal Littell).

Table 3

Science Responses for Units 1-3

Unit	Vocabulary	Concept Statement
1. Energy	Technology	<u>Technology</u> helps us use energy.
	Energy	<u>Energy</u> causes change.
2. Temperature & Heat	Kinetic Energy	<u>Kinetic energy</u> is the energy of motion.
	Potential Energy	<u>Potential energy</u> is stored energy.
3. Plate Tectonics	Continents	<u>Continents</u> move slowly over time.
	Tectonic Plates	Continents move because of <u>tectonic plates</u> underneath them.

The validity of the instrument was evaluated by a special education expert and a science content expert. The special education expert evaluated the assessment as a means to measure content acquisition for students with severe disabilities. The science content expert was asked to evaluate the assessment in terms of academic alignments of vocabulary and concept statements chosen. The science content expert validated that each vocabulary word and concept statement were valid content aligned to the unit of instruction being taught.

The researcher and two research graduate students served as the data collectors. The data collector showed each student three flash cards with either the science vocabulary word or picture and asked them to “find _____ (e.g., kinetic energy)”. A generalization measure of the science vocabulary picture symbols were taken by rotating the pictures symbols used for each vocabulary word (e.g., kinetic energy picture 1, kinetic energy picture 2, kinetic energy picture 3). For the assessment of the science vocabulary word/picture match, the data collector showed the student three pictures and asked the student to “match the word to the picture.” The three picture symbols used for the vocabulary term were rotated for this portion of the assessment as well. For the assessment of the concept statement, the data collector showed the student the concept statement with a word missing. When presented with three vocabulary words, the student was asked to place the missing vocabulary word (e.g., “Can you find the word that completes this statement, _____is the energy of motion.”) The data collector waited 5 seconds for the student to respond to each question, then coded each response as either independent correct or incorrect/ no response.

A probe in vivo was taken for each student at least once during each unit of instruction by the researcher. A probe in vivo consisted of the first peer delivered trial for each science response (i.e., word 1, word 2, picture 1, picture 2, picture/word match 1, picture/word math, concept statement 1, concept statement 2). Data was recorded as independent correct or incorrect.

The reliability and validity of this measure was evaluated as part of this research. Traditionally in single subject designs, reliability of the measure is established via interobserver agreement. This term refers to examining the consistency with which the variables can be measured using the instrument.

Interobserver agreement was calculated using the point-by-point method in which number of agreements are divided by the number of agreements plus disagreements and multiplied by 100. Interobserver agreement was taken a minimum of 1 time per unit by a trained special education doctoral student from the university who serves as a second observer.

KWHL chart responses. The second research question examined the use of a KWHL chart to self-monitor science behaviors during an inquiry lesson. During baseline, this dependent variable was measured by the researcher; however, during intervention the KWHL responses were measured in vivo by general education peers on number of KWHL steps initiated independently during an inquiry science lesson (see Appendix D). The *Peer Self-Monitoring Checklist* (see Appendix G) was used to record student responses during science lessons.

Validity of this measure was established by a science content expert. The science content expert verified the students pointing response to the correct section of the chart as an useful skill to measure self-directed learning within an inquiry science lesson. The science content expert also validated the need to recognize each step of the KWHL (what do you Know - K, what do you Want to know - W, How will you find out –H, what did you Learn -L) during an inquiry science lesson.

The peers recorded each step of the KWHL process during daily instruction as an independent correct or incorrect response, and then peers tallied the sum (e.g., 3/4 steps completed). Interobserver reliability of student responses was taken by the researcher who served as a second data collector during a minimum of two sessions per science unit. Interobserver agreement was calculated using a point-by-point method in which number of agreements are divided by the number of agreements plus disagreements and multiplied by 100.

Student attitude Likert scale. The third research question examined the students' attitudes prior to and after being involved in a peer-mediated learning experience. This dependent variable was measured using the *Student/Peer Attitude Survey* (see Appendix E). A one page survey with six questions using a five-point Likert scale was given to students and peers.

The validity of the instrument was evaluated by a special education expert with experience in using peer supports with students with disabilities. The special education expert was asked to evaluate the assessment as a means to measure student attitudes on social inclusion. The special education expert was asked to read each question to validate the subjectivity of the survey questions. No changes were needed.

This assessment was taken at the beginning of the peer training workshops. During this assessment, general education peers given the *Student/Peer Attitude Survey* by the researcher and asked to complete it during the first five minutes of the training session. The same assessment was given to the special education students by the researcher; however, it was modified as needed to fit student communication needs (i.e., read aloud; student pointed to answer, researcher circled). Finally, post intervention all students were asked to complete the same assessment.

In addition to the *Student/Peer Attitude Survey*, after the intervention was complete, peers participated in a 25 minute focus group. Reflection questions adapted from Carter, Cushing, & Kennedy (2009) were asked by the researcher regarding their perception of the intervention, working with a student with a disability, and science inclusion (see Appendix F). Responses were recorded and reported as anecdotal notes to accompany the peer *Student/Peer Attitude Survey.* Responses also served as a student social validity measure. An expert in qualitative research validated reflection questions as a means to gain additional information regarding student perceptions and attitudes. Anecdotal notes were recorded for each question and reviewed by a second observer for consensus.

The fourth research question examined the students' science grade average prior to and after being involved in a peer-mediated learning experience. This dependent variable was measured by collecting a pre/post science grade average. The general education teacher was asked to provide the last five grades in science, based on a 100 point scale, each grade was added together and divided by five to gain an average science grade. Peer grade averages are reported in Table 7.

Experimental Design and Analysis

A single subject design was used to demonstrate a functional relationship between peer-mediated embedded instruction and the primary dependent variable which was student acquisition of science responses. Specifically, the design was a multiple probe across three science units with between participant replications for the five students who receive the peer-mediated embedded instruction. During baseline, the three unit's science responses were probed for each student at minimum of three times or until data was consistent for three sessions (two vocabulary words, two vocabulary picture symbols 'three pictures for each science term, two vocabulary word/picture match, two concept statements per unit of instruction). Then instruction began on Unit 1 for all five students. Students received embedded instruction by peers for a minimum of six inquiry lessons. Prior to a student moving from Unit 1 to Unit 2 responses, the student had to show mastery of two out of eight science responses for two consecutive sessions. Once a student was ready to move to Unit 2, the student was probed on Unit 2 and Unit 3 responses. After a minimum of six lessons had been taught in Unit 2, and a minimum of two unit science responses were mastered, Unit 3 was probed. Unit 3 tasks were then taught for a minimum of six lessons. Unlearned science responses from previous units were taught with booster training sessions by the special education teacher. Booster sessions were conducted in the special education classroom after inquiry lessons, using three massed trial sessions per science response. Booster sessions continued until mastery of that unit's science responses. Mastery of science responses was demonstrated after two consecutive assessment sessions where students correctly identified six out of eight responses. Maintenance probes of previous unit tasks were conducted every three sessions. This allowed students to demonstrate mastery of previously unlearned tasks, as well as show maintenance of learned tasks.

Additionally, observations were made of the generalization of the KWHL chart across lessons and units of science instruction. The KWHL responses were graphed separately from the other responses as these may generalize across all six lessons, and across all three units early in instruction. Experimental control cannot be ascertained for data on acquisition and generalization of the KWHL as these were AB (for acquisition) only.

Finally, a pre/post measure of student and peer social attitudes was collected via survey. Students and peers completed a survey on current student relationships prior to and after intervention as one measure of the study's social validity. In addition, a pre/post measure of peer science grade averages was collected prior to and after participation in peer-mediated embedded instruction during science lessons.

Procedure

General education peer training workshop. Outlined by Carter and Kennedy (2004), four core components of peer support interventions were used in this study: (a) select students; (b) train peers; (c) peer-delivered support; and (d) adult monitoring. Prior to baseline and intervention, six general education middle school peers were selected to participate in the intervention. After baseline and before intervention, during one 1 hour workshop, peers were trained by the researcher to (1) embed a minimum of three learning trials per each science response (two science words, two science pictures, two word/picture matches, two concept statements) using constant time delay, and to (2) embed trials to self-monitor science behaviors using a KWHL chart. The training was delivered using a power point presentation with slides embedded to allow for questions, answers, examples, and guided practice. During the training peers practiced the constant time delay procedure using sample materials used during the intervention. Peers were given a checklist to self-monitor trials given to students (see Appendix G). Peers were taught to check off each trial as they embed it during the lesson.

Procedural fidelity was taken during the training by the researcher on peer's implementation of the time delay procedure, and use of the self-monitoring checklist. Peers were asked to demonstrate the time delay procedure with 85% accuracy. During a simulated lesson, peers were asked to embed trials, and self-monitor how many trials they were able to embed, with 85% accuracy. Peers were given three trials to reach a level of fidelity at or above 85% for both the time-delay procedure, and the use of the self-monitoring checklist. Five of the six peers met 100% fidelity after three trials, with one peer at 88%. Because this peers' fidelity was the lowest, he served as a substitute peer if another peer was absent or dropped out of the study.

Baseline. During baseline, data on all five students was collected using the *Student Science Responses* data collection form. The researcher served as the primary data collector. Inter-observer agreement was taken on one of the three baseline sessions by one graduate assistant. Students were individually assessed on all science responses for each of the three units of instruction during each baseline probe (six vocabulary words, six vocabulary picture symbols, six vocabulary word/picture matches, six concept statements). Baseline data was collected at least once on all three of the vocabulary picture symbols for each science term. All baseline probes followed the same procedures previously described under the *Student Science Responses* Data Collection Form (p. 56).

No feedback was given to students during baseline probes. Data was graphed and visually inspected after each session.

Baseline of student's ability to use a KWHL chart within the inclusive science classroom was taken for three sessions by the researcher prior to intervention (during unit 1) or until consistent data was collected. The KWHL chart was placed in front of each student on the table, and the student was directed to use the KWHL chart during the inquiry lesson. Using the same *KWHL student science responses* data collection form, the research collected baseline data for all three sessions. Interobserver agreement was collected by a research graduate assistant for at least one of the three baseline probes, or 33% of baseline sessions.

General education peers were given the *Student/Peer Attitude Survey* by the researcher during the peer training session. Special education students were given the same assessment with modifications prior to intervention. Post intervention all students were asked to complete the same assessment. Additionally, after the intervention, peers participated in a 25 minute focus group. The researcher asked questions regarding student perception of the intervention, working with a student with a disability, and science inclusion. Finally, a measure of students' science grade averages was collected by the researcher, by asking the general education teacher for the last five grades prior to the intervention and post intervention.

Intervention. When the student response and KWHL baseline was found to be stable for all five students, peer-mediated embedded inquiry teaching sessions began. The intervention included (a) peer-mediated science response training using time delay embedded within an inclusive inquiry science lesson, and (b) peer-mediated embedded instruction on the use of a KWHL chart within an inclusive science lesson.

The intervention began in the general education science classroom. Inquiry science instruction was given by the general education teacher to the entire class of students. The general education teacher and special education teachers met with the researcher during a planning session (i.e., time selected by teacher) prior to baseline for a 20 minute consultation of what she was expected to do. After this brief training, the general education teacher conducted science lessons as usual, assuring that the lesson included an opportunity for the student to identify what they know (K), what they want to know (W), how they will discover it (H), and what they learned (L). The teacher was asked to point to the chart and verbally direct the class to do the same (e.g., Now let's see what we Know about the material, point to the K.") Using this teacher prompt, all students in the class lesson filled in the K of their charts.

Peers used this prompt to embed the constant time delay procedure to teach the use of the KWHL chart. Using a zero second delay, peers pointed to a section of the chart when the teacher gave the prompt, and asked the student to do the same. After two days with no delay in prompting, peers delayed their prompt to 5 seconds, allowing students to self-monitor themselves on the use of the KWHL chart with natural classroom prompts. If the student did not point to the section of the chart after 5 seconds, the peer modeled pointing to the appropriate section and reminded the student to ask for help if they don't know what to do.

Students were placed into a learning group of four to five students, each group consisted of one special education student, and one general education trained peer.

Within the natural context of the inquiry science lesson, peers embedded the designated number of teaching trials using a constant time delay procedure. General education peers also embedded teaching trials using a time delay procedure on the use of the KWHL to self-monitor science behaviors. A checklist was given to general education peers to allow them to self-monitor embedding teaching trials (see Appendix G). This checklist eliminated the chance of students forgetting to embed the teaching trial or waiting until the end of the lesson to embed all teaching trials mass-trial training). The researcher observed all teaching trials and additional support was given to peer-mentors as needed by the researcher (e.g., additional training trials on time delay procedure, behavioral support).

A generalization measure was collected throughout the intervention of this study. Peers were given one of three picture symbols for each vocabulary word to present to the students during each teaching session. The researcher recorded which picture symbol was used during all testing probes to demonstrate generalization of the science vocabulary across picture symbols.

Procedural Fidelity

To assure a reliable training workshop for the general education peers, a procedural fidelity checklist was used (see Appendix H). Data was taken on the researcher’s ability to provide consistent training as planned over the course of the training session. A graduate assistant observed the training sessions and recorded fidelity at 100%.

To provide demonstration of a functional relationship between the independent and dependent variables, treatment integrity was measured using a checklist (see

Appendix J). The primary research questions involved the general education peers ability to successfully implement a time delay procedure embedded in the inquiry science lessons treatment integrity was measured on their ability to consistently provide adequate training to the special education students. The *Peer Procedural Fidelity of Embedded Time Delay Delivery* checklist was used by the researcher a minimum of once per unit of instruction. Correct implementation of the procedure was coded when the peer provided a 5 second delay before modeling the correct answer, and used the correct praise procedure for correct responses, wait responses, or incorrect responses. The observer recorded data in the general education classroom by watching peer/student interactions from the back of the classroom. In the case that a peer did not implement the intervention with a minimum of 80% accuracy, the researcher conducted a booster training session until the peer was able to implement the time delay procedure with a minimum of 80% accuracy. Treatment fidelity was calculated by dividing the number of correct peer behaviors by the number of planned behaviors, and multiplying by 100. Interobserver of peer treatment fidelity was taken a minimum of one time per unit per peer. Due to intrusiveness to the lesson, it did not seem feasible to have two observers per peer for more than one lesson per unit.

Controlling for Threats to Internal and External Validity

Internal validity. Internal validity was established by repeated systematic replication of a functional relationship between the independent and dependent variables. The intervention was demonstrated across three units of science and replicated across five students. History effects were controlled for by the use of staggered baseline probes across science units. Maturation effects were controlled for through documentation of events and changes that affected the classroom, teacher, and students through staggered baselines. Procedural fidelity above 80% was also maintained for all training sessions with general education peers. Instrumentation effects were controlled for by training the data collectors and maintaining at least 80% interobserver agreement.

External validity. In single subject research the control for external validity can be weak. According to Horner et al. (2005), having a sufficient number of participants, behaviors, or settings in the study (at least three) and a sufficient number of studies that show replication of the independent variable (five or more studies) and participants, will address this concern. The demonstration of some external validity occurred through the replication of experimental effects across three science units, and across five students.

Social validity. The practical significance of an educational intervention is another threat to the validity of the study. In order to control for this threat a survey of feasibility was given to the general education and special education teacher to determine the importance of inclusive science education using peer mentors and how feasible this method of inclusive science education was (see Appendix J). Additionally, in response to the final research question regarding student perspectives of the intervention, a survey was given to all peers and students post intervention. This survey was used to determine how the general education and special education peers perceived the intervention to be socially valid. Finally, social validity questions were asked of the peers regarding their perceptions of the intervention procedures, students with disabilities, and inclusion. Using data collected by the classroom teacher (see Table 7) an additional measure of social validity on the impact of peer-mediated instruction on student grades was collected.

CHAPTER 4: RESULTS

Reliability and Treatment Integrity

Reliability

In this section the results on interobserver agreement (IOA) will be provided overall across students and units, as well as for each student. Overall, second observers evaluated 48% of all baseline data collected and 64% of all intervention data collected. Interobserver agreement was 100% for all baseline and intervention sessions observed. For the first student, Mary, second observers evaluated 33% of the baseline data collected and 67% of the intervention data collected for Unit 1: Technology & Energy. Interobserver agreement was 100% for all baseline and intervention sessions observed. The second observers evaluated 33% of the baseline data and 67% of the intervention data collected for Unit 2: Kinetic & Potential Energy. Interobserver agreement was 100% for all baseline and intervention session observed. The second observer evaluated 50% of the baseline data collected and 75% of the intervention data collected for Unit 3: Continents & Plate Tectonics. Interobserver agreement was 100% for all baseline and intervention sessions observed. The second observer evaluated 67% of the baseline data and 71% of the intervention data collected for the KWHL chart responses. Interobserver agreement was 100% for all baseline and intervention sessions observed.

For Jade, second observers evaluated 25% of the baseline data collected and 75% of the intervention data collected for Unit 1 – Technology & Energy. Interobserver agreement was 100% for all baseline and intervention sessions observed. The second observer evaluated 50% of the baseline data and 50% of the intervention data collected for Unit 2: Kinetic & Potential Energy. Interobserver agreement was 100% for all baseline and intervention session observed. The second observer evaluated 60% of the baseline data collected and 50% of the intervention data collected for Unit 3: Continents & Plate Tectonics. Inter-observer reliability was 100% for all baseline and intervention sessions observed. The second observer evaluated 67% of the baseline data and 57% of the intervention data collected for the KWHL chart responses. Interobserver agreement was 100% for all baseline and intervention sessions observed.

For Devin, second observers evaluated 33% of the baseline data collected and 75% of the intervention data collected for Unit 1: Technology & Energy. Interobserver agreement was 100% for all baseline and intervention sessions observed. The second observer evaluated 50% of the baseline data and 60% of the intervention data collected for Unit 2: Kinetic & Potential Energy. Interobserver agreement was 100% for all baseline and intervention session observed. The second observer evaluated 67% of the baseline data collected and 50% of the intervention data collected for Unit 3: Continents & Plate Tectonics. Inter-observer reliability was 100% for all baseline and intervention sessions observed. The second observer evaluated 67% of the baseline data and 43% of the intervention data collected for the KWHL chart responses. Interobserver agreement was 100% for all baseline and intervention sessions observed.

For Derek, second observers evaluated 25% of the baseline data collected and 86% of the intervention data collected for Unit 1: Technology & Energy. Interobserver agreement was 100% for all baseline and intervention sessions observed. The second observer evaluated 40% of the baseline data and 60% of the intervention data collected for Unit 2: Kinetic & Potential Energy. Interobserver agreement was 100% for all baseline and intervention session observed. The second observer evaluated 60% of the baseline data collected and 67% of the intervention data collected for Unit 3: Continents & Plate Tectonics. Inter-observer reliability was 100% for all baseline and intervention sessions observed. The second observer evaluated 67% of the baseline data and 80% of the intervention data collected for the KWHL chart responses. Interobserver agreement was 100% for all baseline and intervention sessions observed.

For Brett, second observers evaluated 33% of the baseline data collected and 60% of the intervention data collected for Unit 1: Technology & Energy. Interobserver agreement was 100% for all baseline and intervention sessions observed. The second observer evaluated 40% of the baseline data and 60% of the intervention data collected for Unit 2: Kinetic & Potential Energy. Interobserver agreement was 100% for all baseline and intervention session observed. The second observer evaluated 60% of the baseline data collected and 50% of the intervention data collected for Unit 3: Continents & Plate Tectonics. Inter-observer reliability was 100% for all baseline and intervention sessions observed. The second observer evaluated 67% of the baseline data and 57% of the intervention data collected for the KWHL chart responses. Interobserver agreement was 100% for all baseline and intervention sessions observed.

Treatment Integrity

Treatment integrity for the researcher's training of the peers was self-monitored by the researcher, as well as monitored by the primary data collector using a checklist

(Appendix H). Interobserver agreement of treatment integrity was collected on 100% and reported with 100% agreement of steps completed.

Using a detailed checklist (Appendix I), a second observer collected procedural fidelity of peer-implementation of the embedded time delay procedure during inquiry science lessons. The KWHL chart responses were part of the 28 step detailed checklist. Table 4 reports the percentage of sessions procedural fidelity was recorded for each peer, as well as the peer procedural fidelity range and mean across science units. Mean Interobserver agreement is reported for sessions observed.

Table 4

Peer Procedural Fidelity

Peer mediator	% of sessions	Fidelity range	Mean	IOA
Peer 1	29%	92% -100%	97%	100%
Peer 2	36%	92% - 100%	98%	100%
Peer 3	21%	100% - 100%	100%	100%
Peer 4 – Unit 1	17%	92%	92%	100%
Peer 4 – Unit 2&3	50%	79% - 100%	95%	100%
Peer 5	21%	92% - 100%	96%	100%

For Mary, the second observers collected procedural fidelity data on one of six lessons taught during Unit 1: Technology & Energy. Procedural fidelity was 92% with 100% IOA. The second observers collected procedural fidelity data on one of four lessons taught during Unit 2: Kinetic & Potential Energy. Procedural fidelity was 100%. The second observers collected procedural fidelity data on two of four lessons taught during Unit 3: Continents & Plate Tectonics. Procedural fidelity ranged from 94% to

100% with a mean of 97%. Interobserver agreement was collected on one session with 100% agreement.

For Jade, the second observers collected procedural fidelity data on two of six lessons taught during Unit 1: Technology & Energy. Procedural fidelity was 100% for both sessions. Interobserver agreement was collected on one session with 100% agreement. The second observers collected procedural fidelity data on two of four lessons taught during Unit 2: Kinetic & Potential Energy. Procedural fidelity was 100% for both sessions. The second observer collected procedural fidelity data on one of four lessons taught during Unit 3: Continents & Plate Tectonics with 92% procedural fidelity.

For Devin, the second observer collected procedural fidelity data on one of six lessons taught during Unit 1: Technology & Energy. Procedural fidelity was 100% with 100% IOA. The second observer collected procedural fidelity data on one of four lessons taught during Unit 2: Kinetic and Potential Energy. Procedural fidelity was 100%. The second observer collected procedural fidelity data on one of four lessons taught during Unit 3: Continents & Plate Tectonics with 100% procedural fidelity.

For Derek, the second observer collected procedural fidelity data on one of six lessons taught during Unit 1: Technology & Energy with 92% procedural fidelity. Prior to Unit 2 instruction, Derek's peer dropped out of the study. The substitute Peer then became Peer 4 for Units 2 and 3. The second observers collected procedural fidelity data on two of four lessons taught during Unit 2: Kinetic & Potential Energy. Procedural fidelity ranged from 79% to 100%. The second observers collected procedural fidelity data on tow of four lessons taught during Unit 3: Continents & Plate Tectonics.

Procedural fidelity was 100% on both sessions. IOA was collected on both sessions with 100% agreement.

For Brett, the second observer collected procedural fidelity data on one of six lessons taught during Unit 1: Technology & Energy. Procedural fidelity was 96% with 100% IOA. The second observers collected procedural fidelity data on one of four lessons taught during Unit 2: Kinetic & Potential Energy. Procedural fidelity was 100% with 100% IOA. The second observers collected procedural fidelity data on one of four lessons taught during Unit 3: Continents & Plate Tectonics with 100% procedural fidelity.

Results for Question 1

What is the effect of peer-mediated embedded time delay instruction on number of correct science responses?

Mary's Scores

Figure 1 provides the total number of correct responses for the eight science vocabulary words, pictures, word/picture match and concept statements asked during each unit of instruction. Within each unit, correct responses across multiple exemplars of picture representations of vocabulary are provided as well. Data from Mary indicated that the intervention had a positive effect on this student's science vocabulary and concept knowledge. Via visual analysis of the graph a functional relationship is demonstrated between peer-mediated embedded time delay instruction and number of correct science responses in all three units.

Unit 1: technology & energy. During baseline, Mary's scores ranged from 1 to 4 with a mean of 2. During intervention, her scores ranged from 3 to 8 with a mean of 5.8. Mary met the mastery criteria after seven instructional sessions, including one booster sessions provided by the special education teacher, then she entered the maintenance phase. In vivo data indicated a correct response score of 3, which was below mastery criteria; however data was taken prior to the student meeting the mastery criteria. The maintenance data ranged from 6 to 8 with a mean of 7, which is above mastery criteria, indicating that she maintained the skills obtained during intervention.

Unit 2: kinetic & potential Energy. During baseline, Mary's scores ranged from 1 to 3 with a mean of 1.8. During intervention, her scores ranged from 2 to 7 with a mean of 5.5. Mary met the mastery criteria after five instructional sessions, including one booster sessions provided by the special education teacher, then she entered the maintenance phase. In vivo data indicated a correct response score of 5, which was below mastery criteria; however data was taken prior to the student meeting the mastery criteria. She entered the maintenance phase after Unit 2 instruction was complete, as per the general education classroom schedule. The maintenance data was 5, which was slightly below mastery criteria, indicating that she maintained most of the skills obtained during intervention.

Unit 3: continents & tectonic plates. During baseline, Mary's scores ranged from 2 to 5 with a mean of 3.2. During intervention, her scores ranged from 4 to 8 with a mean of 5.75. Mary met the mastery criteria after three instruction sessions; however the fourth data session indicated a score of 4 correct. In vivo data indicated a correct response score of 7, which was above mastery criteria. She entered the maintenance phase after Unit 3 instruction was complete, as per the general education classroom schedule. Maintenance data was 8, which was above mastery criteria, indicating that she maintained the skills obtained during intervention.

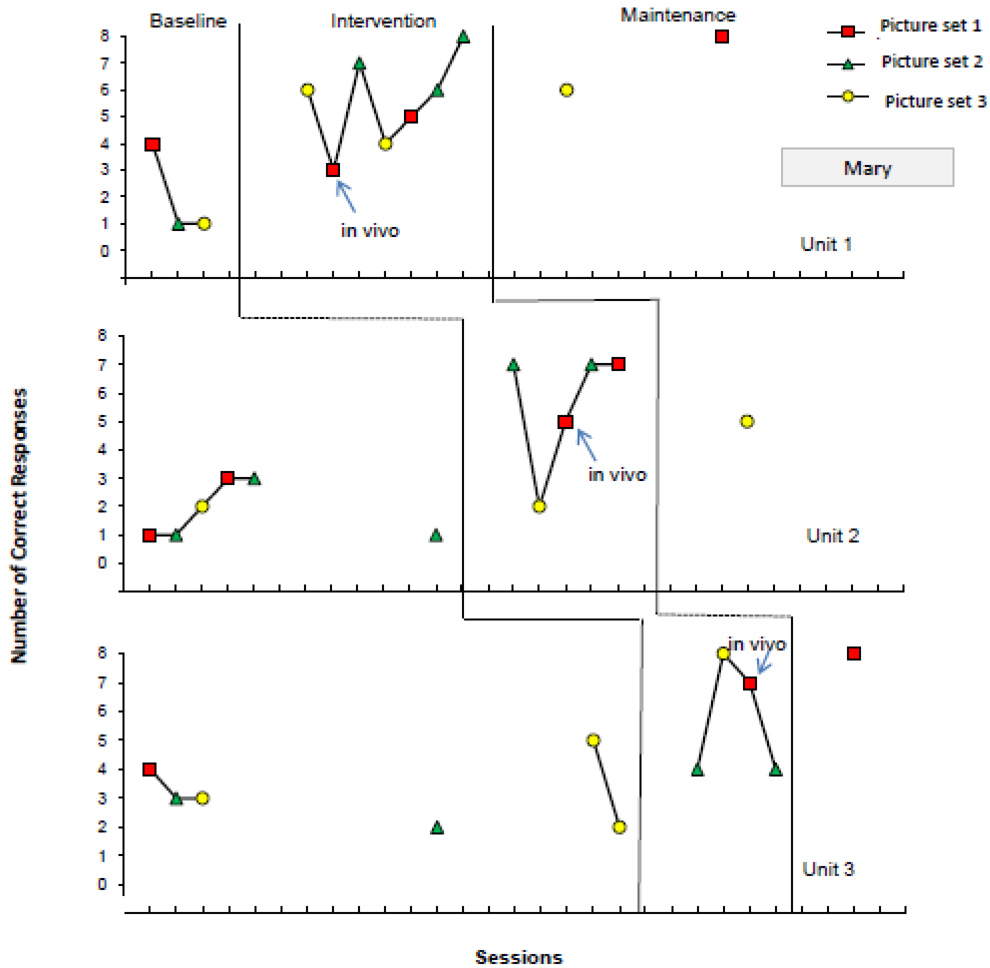

FIGURE 1 – Mary's number of correct science responses across Units 1-3.

Jade's Scores

Figure 2 provides the total number of correct responses for the eight science vocabulary words, pictures, word/picture match and concept statements asked during each unit of instruction. Within each unit, correct responses across multiple exemplars of picture representations of vocabulary are provided as well. Data from this student indicated that the intervention had a positive effect on this student's science vocabulary and concept knowledge. Via visual analysis of the graph a functional relationship was demonstrated between peer-mediated embedded time delay instruction and number of correct science responses in all three units.

Unit 1: technology & energy. During baseline, Jade's scores ranged from 2 to 3 with a mean of 2. During intervention, her scores ranged from 7 to 8 with a mean of 7.8. Jade met the mastery criteria after two instructional sessions. In vivo data indicated a correct response score of 7, which is above mastery criteria. She entered the maintenance phase after unit 1 instruction was complete, as per the general education classroom schedule. The maintenance data ranged from 6 to 8 with a mean of 7, which was above mastery criteria, indicating that she maintained the skills obtained during intervention.

Unit 2: kinetic & potential energy. During baseline, Jade's score ranged from 1 to 2 with a mean of 88%. During intervention, her scores ranged from 3 to 8 with a mean of 6. Jade met the mastery criteria after six instructional sessions, including two booster sessions provided by the special education teacher, then entered the maintenance phase. In vivo data indicated a correct response score of 3, which was below mastery criteria; however data was taken prior to the student meeting the mastery criteria. She entered the maintenance phase after Unit 2 instruction was complete, as per the general education classroom schedule. The maintenance data was 2 for two consecutive sessions, which was below mastery criteria, indicating that she did not maintain the skills learned during intervention. After one booster session, maintenance data was taken. Data indicated a correct response score of 5, which was slightly below mastery criteria; however above previous maintenance scores.

Unit 3: continents & tectonic plates. During baseline, Jade's score was 2 out of 8 consistently over 5 probes. During intervention, her scores ranged from 5 to 8 with a mean of 6.5. Jade met the mastery criteria after four instruction sessions. The first in vivo data session indicated a correct response score of 5, which is below mastery criteria. The second in vivo data session indicated a correct response score of 8, which was above mastery criteria. She entered the maintenance phase after Unit 3 instruction was complete, as per the general education classroom schedule. Maintenance data was 8, which was above mastery criteria, indicating that she maintained the skills obtained during intervention.

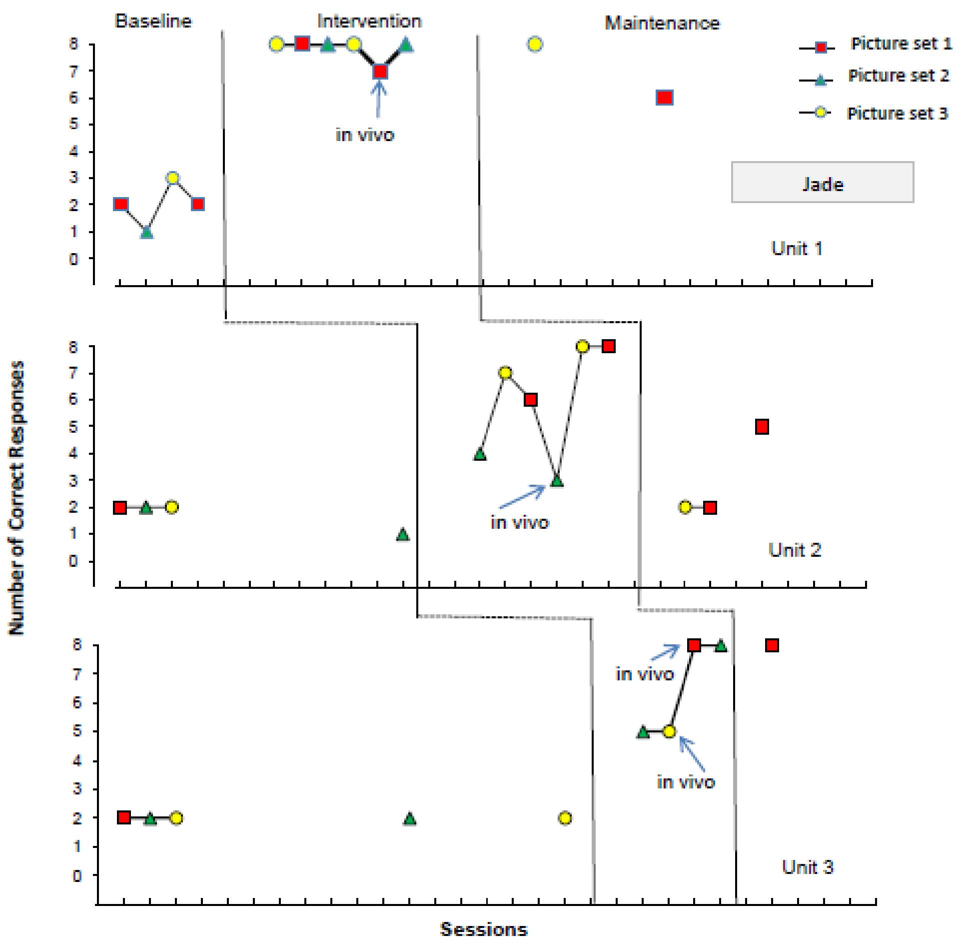

FIGURE 2 – Jade's number of correct science responses across Units 1-3.

Devin's Scores

Figure 3 provides the total number of correct responses for the eight science vocabulary words, pictures, word/picture match and concept statements asked during each unit of instruction. Within each unit, correct responses across multiple exemplars of picture representations of vocabulary are provided as well. Data from this student indicated that the intervention had a positive effect on this student's science vocabulary and concept knowledge for Units 1 and 2; however the student's baseline probe data prior to Unit 3 intervention shows mastery. Via visual analysis of the graph a functional relationship cannot be determined between peer-mediated embedded time delay instruction and number of correct science responses in all three units.

Unit 1: technology & energy. During baseline, Devin's scores ranged from 2 to 4 with a mean of 2.7. During intervention, his scores ranged from 6 to 8 with a mean of 7.7. Devin met the mastery criteria after two instructional sessions. In vivo data indicated a correct response score of 8, which is above mastery criteria. He entered the maintenance phase after Unit 1 instruction was complete, as per the general education classroom schedule. The maintenance data ranged from 7 to 8 with a mean of 7.5, which was above mastery criteria, indicating that he maintained the skills obtained during intervention.

Unit 2: kinetic & potential energy. During baseline, Devin's score ranged from 3 to 4 with a mean of 3.5. During intervention, his scores ranged from 7 to 8 with a mean of 7.5. Devin met the mastery criteria after two instruction sessions. In vivo data indicated a correct response score of 7, which was above mastery criteria. He entered the maintenance phase after Unit 2 instruction was complete, as per the general education classroom schedule. The maintenance data was 8, which is above mastery criteria, indicating that he maintained the skills obtained during intervention.

Unit 3: continents & tectonic plates. During baseline, Devin's scores ranged from 3 to 7 with a mean of 5.1. Devin met mastery criteria prior to intervention. During intervention, his scores ranged from 6 to 8 with a mean of 7.3. In vivo data indicated a correct response score of 8, which was above mastery criteria. The maintenance data was 8, which is above mastery criteria, indicating that he maintained the skills obtained during intervention.

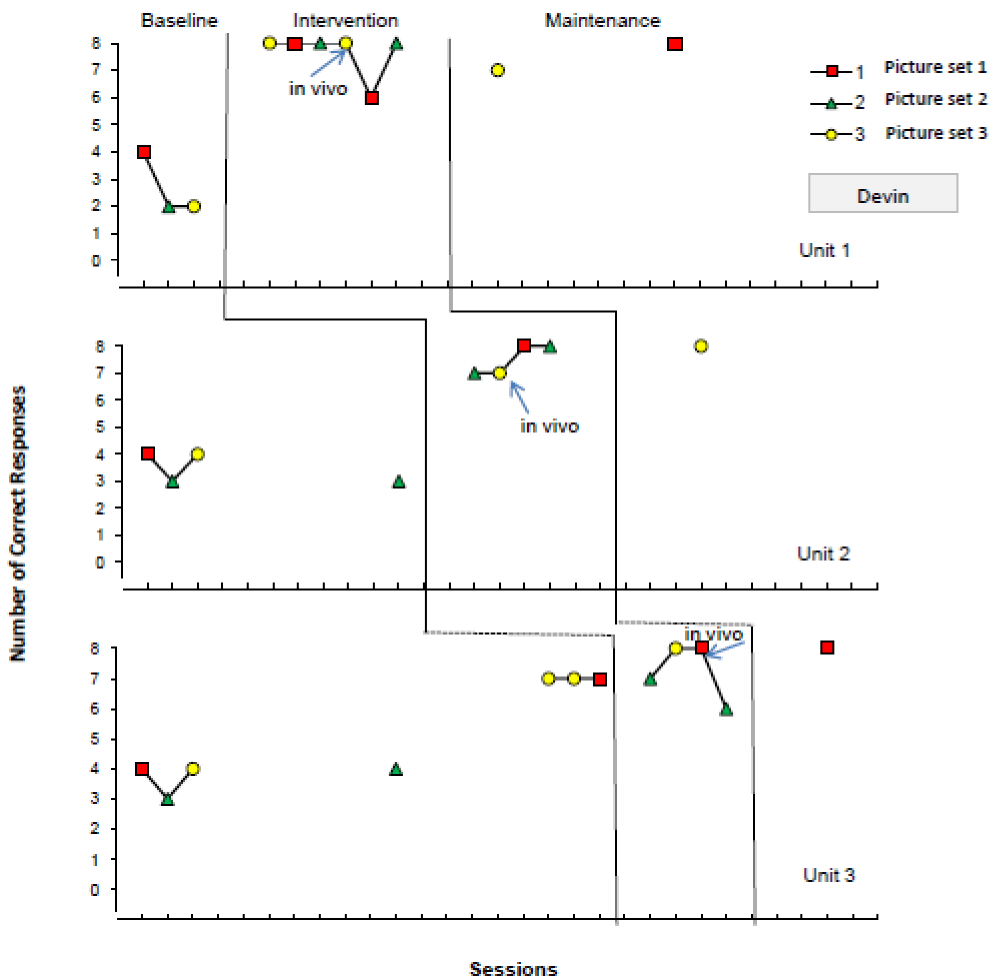

FIGURE 3 – Devin's number of correct science responses across Units 1-3.

Derek's Scores

Figure 4 provides the total number of correct responses for the eight science vocabulary words, pictures, word/picture match and concept statements asked during each unit of instruction. Within each unit, correct responses across multiple exemplars of picture representations of vocabulary are provided as well. Data from this student indicated that the intervention had a positive effect on this student's science vocabulary and concept knowledge. Via visual analysis of the graph a functional relationship was demonstrated between peer-mediated embedded time delay instruction and number of correct science responses in all three units.

Unit 1: technology & energy. During baseline, Derek's scores ranged from 2 to 6 with a mean of 4.8. During intervention, his scores were 8 out of 8 responses correct for all 5 sessions. Derek met the mastery criteria after two instructional sessions. In vivo data indicated a correct response score of 8, which is above mastery criteria. He entered the maintenance phase after Unit 1 instruction was complete, as per the general education classroom schedule. The maintenance data was 8 for two sessions, which is above mastery criteria, indicating that he maintained the skills obtained during intervention.

Unit 2: kinetic & potential energy. During baseline, Derek's score ranged from 3 to 6 with a mean of 3.6. During intervention, his score was 8 out of 8 consistently for all 3 sessions. Derek met the mastery criteria after two instruction sessions. In vivo data indicated a correct response score of 8, which is above mastery criteria. He entered the maintenance phase after Unit 2 instruction was complete, as per the general education classroom schedule. The maintenance data was 8, which is above mastery criteria, indicating that he maintained the skills obtained during intervention.

Unit 3: continents & tectonic plates. During baseline, Derek's scores ranged from 3 to 5 with a mean of 3.5. During intervention, his score was 8 out of 8 consistently for 3 sessions. Derek met the mastery criteria after two instruction sessions. In vivo data indicated a correct response score of 8, which was above mastery criteria. He entered the maintenance phase after Unit 3 instruction was complete, as per the general education classroom schedule. The maintenance data was 8, which is above mastery criteria, indicating that he maintained the skills obtained during intervention.

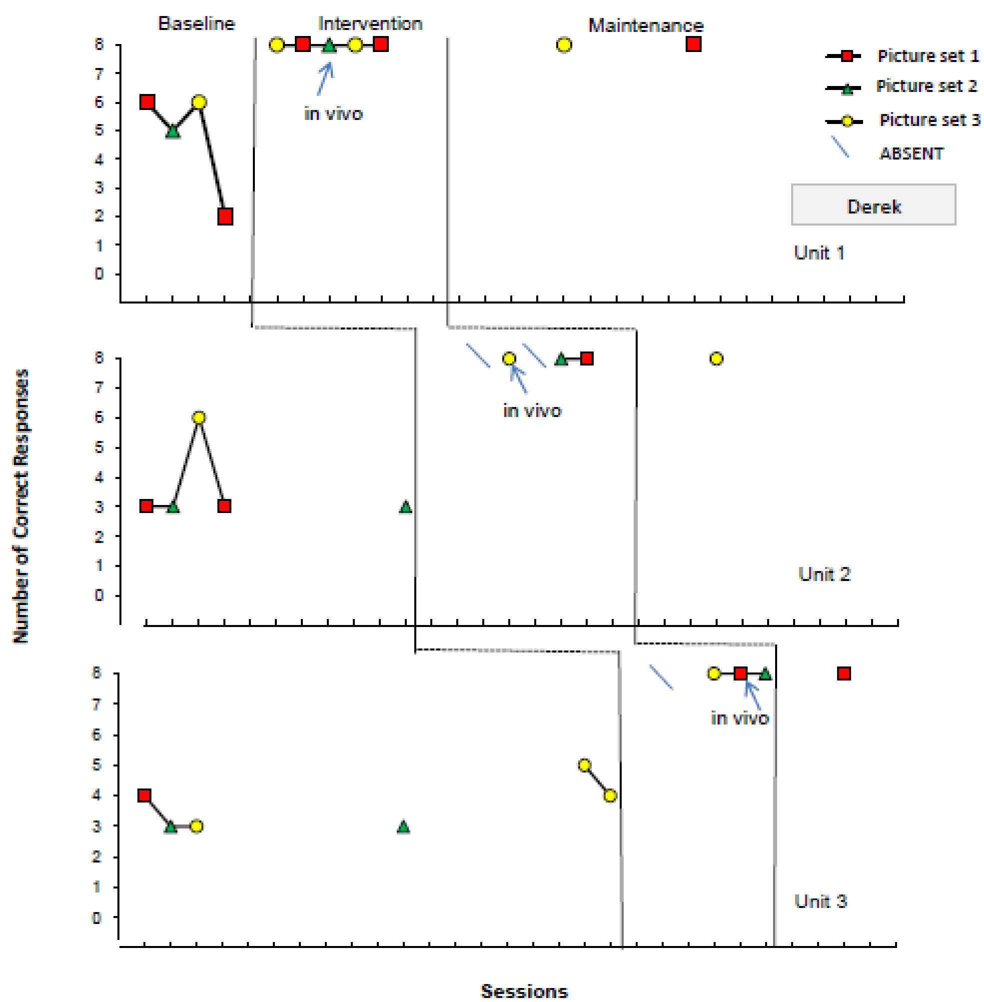

FIGURE 4 – Derek's number of correct science responses across Units 1-3.

Brett's Scores

Figure 5 provides the total number of correct responses for the eight science vocabulary words, pictures, word/picture match and concept statements asked during each unit of instruction. Within each unit, correct responses across multiple exemplars of picture representations of vocabulary are provided as well. Data from this student indicated that the intervention had a positive effect on this student's science vocabulary and concept knowledge. Via visual analysis of the graph a functional relationship was demonstrated peer-mediated embedded time delay instruction and number of correct science responses in all three units.

Unit 1: technology & energy. During baseline, Brett's scores ranged from 1 to 2 with a mean of 1.7. During intervention, his scores ranged from 5 to 8 with a mean of 6.9. Brett met the mastery criteria after eight instructional sessions, including two booster sessions delivered by the special education teacher, then entered the maintenance phase. In vivo data indicated a correct response score of 6, which is at mastery criteria. The maintenance data ranged from 6 to 8 with a mean of 7, which is above mastery criteria, indicating that he maintained the skills obtained during intervention.

Unit 2: kinetic & potential energy. During baseline, Brett's score ranged from 0 to 3 with a mean of 1. During intervention, his scores ranged from 2 to 8 with a mean of 4.8. Two in vivo data sessions occurred, the first session indicated a correct response score of 3, which is below mastery criteria. The second in vivo session indicated a correct response score of 7, which is above mastery criteria. Brett met the mastery criteria after 12 instructional sessions, including eight booster sessions delivered by the special education teacher.

Unit 3: continents & tectonic plates. During baseline, Brett's scores ranged from 3 to 4 with a mean of 3.2. During intervention, his scores ranged from 4 to 6 with a mean of 5.3. Brett met the mastery criteria after three instruction sessions; however the fourth data session indicated a score of 5 correct. Two in vivo data sessions were taken, both sessions indicated a correct response score of 6, which is at the mastery criteria. Maintenance data was 7, which is above mastery criteria, indicating that he maintained the skills obtained during intervention.

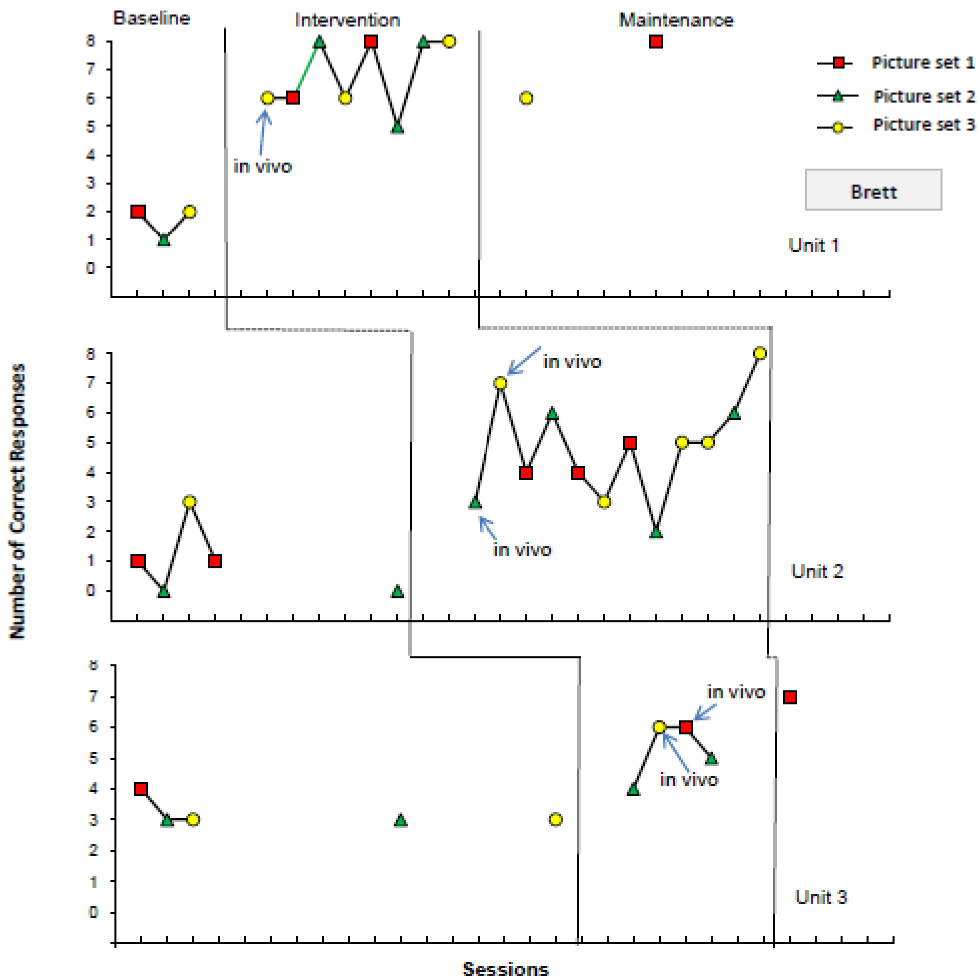

FIGURE 5 – Brett's number of correct science responses across Units 1-3.

Question 2

What is the effect of peer-mediated embedded time delay instruction on correct KWHL chart responses?

Mary's Scores

Figure 6 provides the total number of correct KWHL responses across all three units of instruction. Data from this student indicated that the intervention increased the student's ability to self-monitor science behaviors during an inquiry lesson. Baseline data occurred during Unit 1and intervention at a zero-second time delay occurred during instruction on Unit 1 and Unit 2.

Units 1-3. During baseline, Mary scored 0 responses correct out of 4 consistently for three probe sessions. During intervention, her scores ranged from 1 to 4 with a mean of 3.3. Mary demonstrated maintenance and generalization of all 4 steps across Unit 2 and Unit 3.

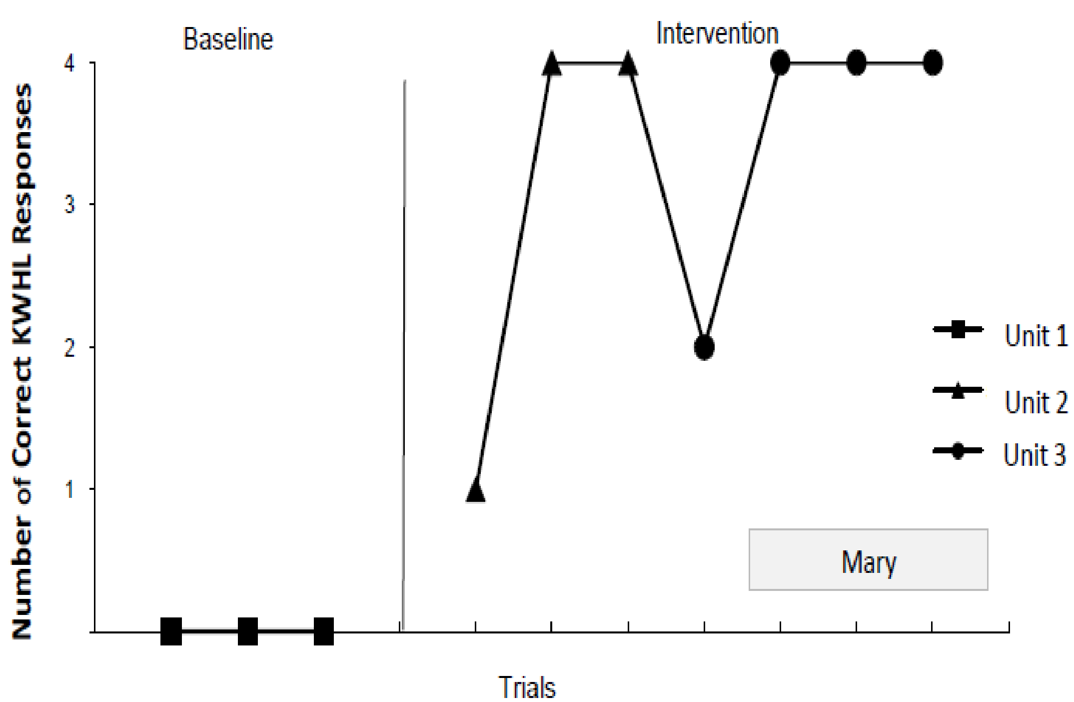

FIGURE 6 – Mary's number of correct KWHL chart responses.

Jade's Scores

Figure 7 provides the total number of correct KWHL responses across all three units of instruction. Data from this student indicated that the intervention increased the student's ability to self-monitor science behaviors during an inquiry lesson. Baseline data occurred during Unit 1and intervention at a zero-second time delay occurred during instruction on Unit 1 and Unit 2.

Units 1-3. During baseline, Jade scored 0 responses correct out of 4 consistently for three probe sessions. During intervention, her scores ranged from 1 to 4 with a mean of 2.8. Jade demonstrated maintenance and generalization of 3 steps across Unit 2 and Unit 3.

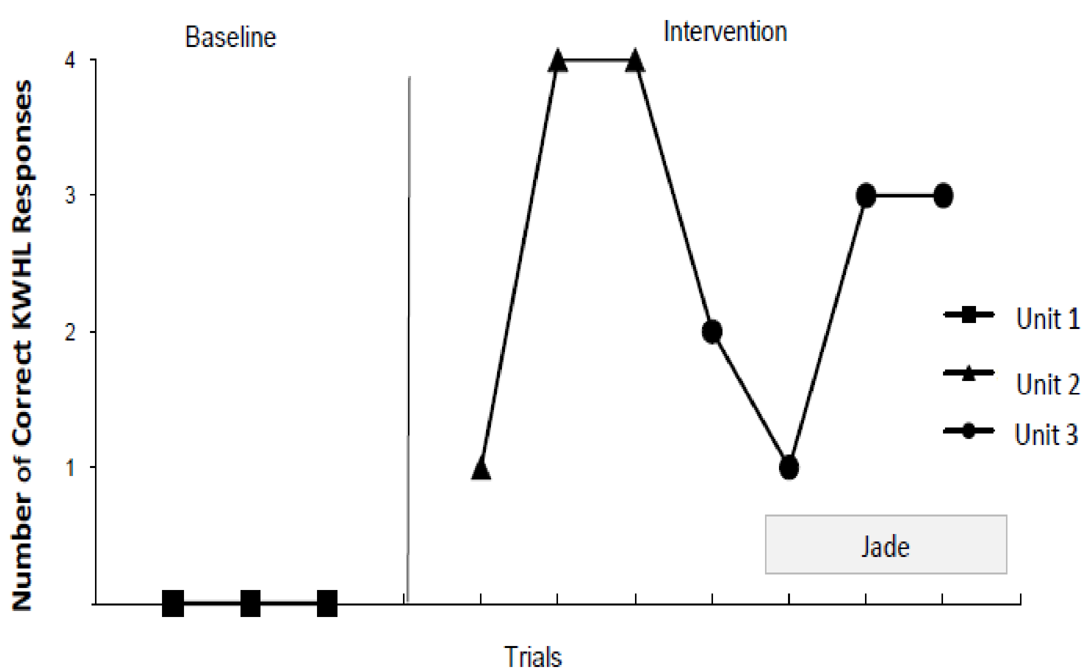

FIGURE 7 – Jade's number of correct KWHL chart responses.

Devin's Scores

Figure 8 provides the total number of correct KWHL responses across all three units of instruction. Data from this student indicated that the intervention increased this student's ability to self-monitor science behaviors during an inquiry lesson. Baseline data occurred during Unit 1and intervention at a zero-second time delay occurred during instruction on Unit 1 and Unit 2.

Units 1-3. During baseline, Devin's scored 0 responses correct out of 4 consistently for three probe sessions. During intervention, his scores ranged from 1 to 4 with a mean of 3.3. Devin demonstrated maintenance and generalization of all 4 steps across Unit 2 and Unit 3.

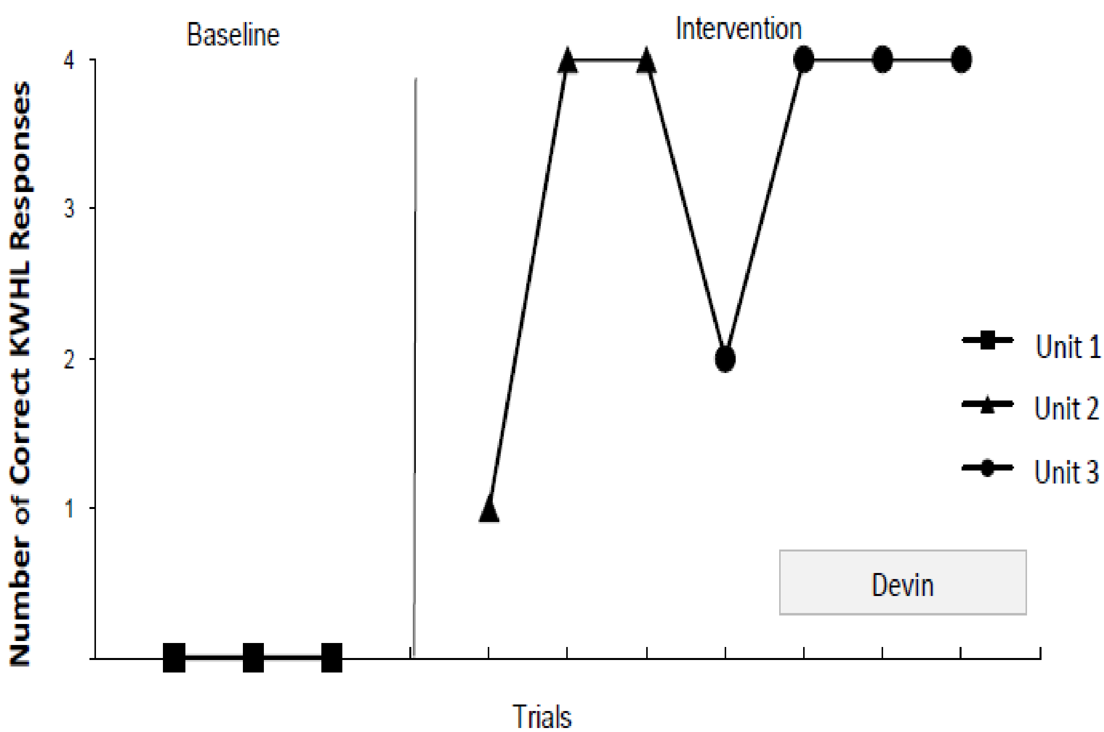

FIGURE 8 – Devin's number of correct KWHL chart responses.

Derek's Scores

Figure 9 provides the total number of correct KWHL responses across all three units of instruction. Data from this student indicated that the intervention increased this student's ability to self-monitor science behaviors during an inquiry lesson. Baseline data occurred during Unit 1 and intervention at a zero-second time delay occurred during instruction on Unit 1 and Unit 2.

Units 1-3. During baseline, Derek's scored 0 responses correct out of 4 consistently for three probe sessions. During intervention, his scores ranged from 2 to 4 with a mean of 3.4. Derek demonstrated maintenance and generalization of 4 steps across Unit 2 and maintenance and generalization of 2 steps across Unit 3.

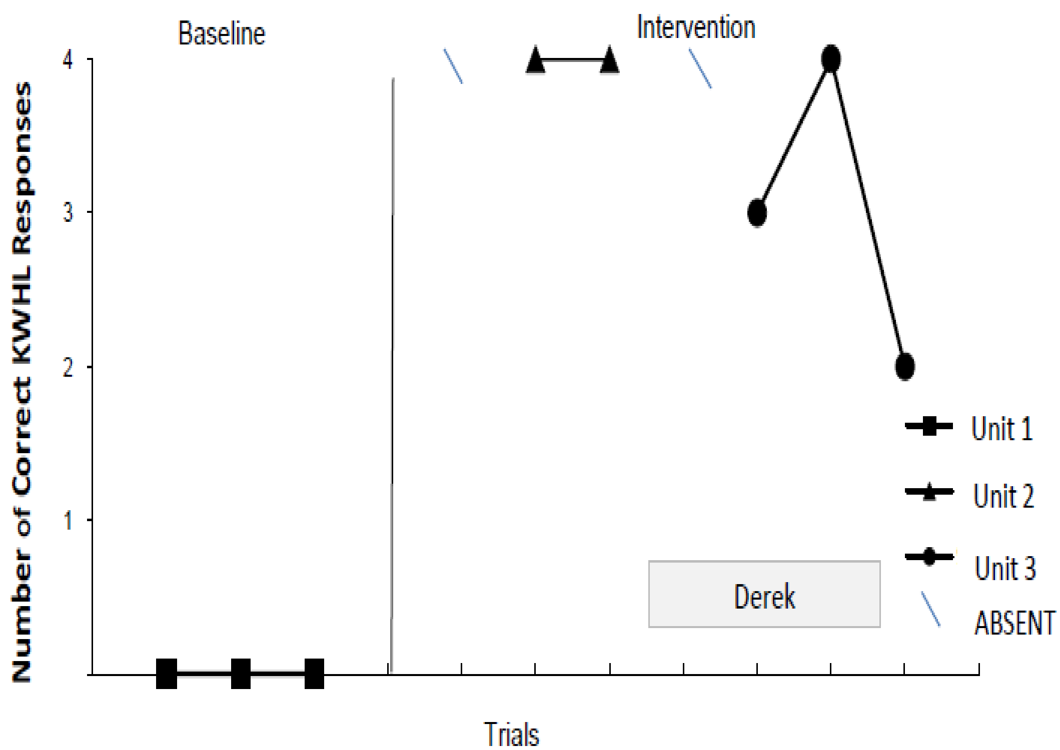

FIGURE 9 – Derek's number of correct KWHL chart responses.

Brett's Scores

Figure 10 provides the total number of correct KWHL responses across all three units of instruction. Data from this student indicated that the intervention increased this student's ability to self-monitor science behaviors during an inquiry lesson. Baseline data occurred during Unit 1 and intervention at a zero-second time delay occurred during instruction on Unit 1 and Unit 2.

Units 1-3. During baseline, Brett's scored 0 responses correct out of 4 consistently for three probe sessions. During intervention, his scores ranged from 0 to 4 with a mean of 2.6. Brett demonstrated maintenance and generalization of all 4 steps across Unit 2 and Unit 3.

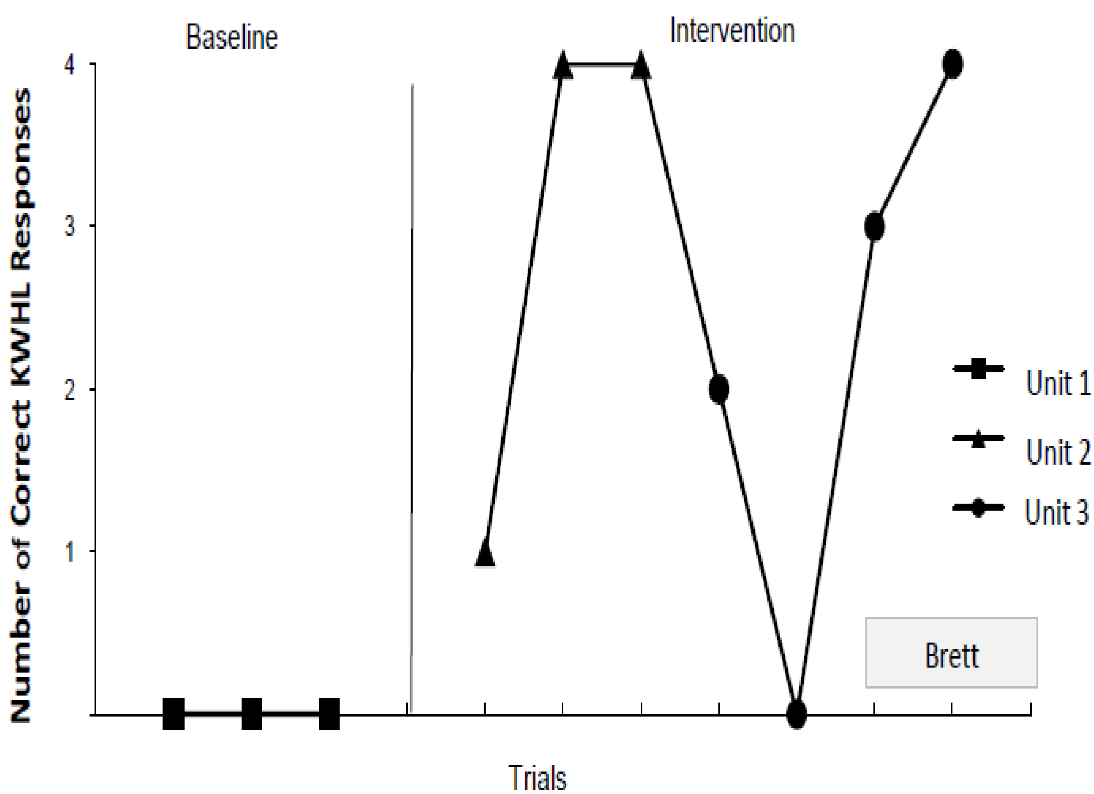

FIGURE 10 – Brett's number of correct KWHL chart responses.

Results for Question 3

What is the effect of peer-mediated embedded instruction on student social attitudes?

Students and peers responded to a survey related to their social attitudes of peer-mediated instruction pre and post intervention. The survey contained six questions which could be answered using a 5-point Likert scale (i.e., SA=strongly agree, A=agree, N=not sure, D=disagree, SD=strongly disagree); however the response options were written specific to the question given (see Appendix C). In order to determine a numerical range, values were assigned to each of the 5 points (i.e., 5=strongly agree, 1=strongly disagree). Table 5 presents data from the pre and post *Student/Peer Attitude Survey*, showing an increase in student social attitudes across all peers and student participants. Table 6 presents mean scores for each participant pre and post *Student/Peer Attitude Survey,* showing an increase in each student's overall social attitude.

Table 5

Student/Peer Attitude Survey pre and post scores across questions and student

Item	Participant	Pre	Post
How do you feel about spending time with your peer buddy	Mary	5	4
	Mary's peer	1	5
*1st response option was not on a Likert Scale	Jade	1	4
	Jade's peer	1	4
	Devin	3	4
	Devin's peer	1	5
	Derek	3	5
	Derek's peer	1	4

Table 5 (continued)

	Brett	1	5
	Brett's peer	1	5
How important do you think it is to learn science together?	Mary	5	5
	Mary's peer	4	5
	Jade	4	5
	Jade's peer	4	3
	Devin	3	5
	Devin's peer	5	5
	Derek	5	3
	Derek's peer	4	5
	Brett	3	5
	Brett's peer	5	5
How comfortable are you with your role as a peer buddy?	Mary	4	5
	Mary's peer	3	5
	Jade	3	5
	Jade's peer	3	4
	Devin	3	5
	Devin's peer	3	5
	Derek	3	5
	Derek's peer	4	5
	Brett	2	5
	Brett's peer	4	5

Table 5 (continued)

Do you think you will learn anything from your peer buddy?	Mary	5	5
	Mary’s peer	3	4
	Jade	5	5
	Jade’s peer	4	3
	Devin	4	5
	Devin’s peer	4	5
	Derek	4	4
	Derek’s peer	4	4
	Brett	4	5
	Brett’s peer	5	5
Would you like to continue to work with your peer buddy?	Mary	n/a	5
	Mary’s peer	n/a	5
	Jade	n/a	4
	Jade’s peer	n/a	5
	Devin	n/a	4
	Devin’s peer	n/a	5
	Derek	n/a	5
	Derek’s peer	n/a	5
	Brett	n/a	5
	Brett’s peer	n/a	5

Table 5 (continued)

How important do you think it is to learn science together?	Mary	5	5
	Mary’s peer	4	5
	Jade	4	5
	Jade’s peer	4	3
	Devin	3	5
	Devin’s peer	5	5
	Derek	5	3
	Derek’s peer	4	5
	Brett	3	5
	Brett’s peer	5	5
How comfortable are you with your role as a peer buddy?	Mary	4	5
	Mary’s peer	3	5
	Jade	3	5
	Jade’s peer	3	4
	Devin	3	5
	Devin’s peer	3	5
	Derek	3	5
	Derek’s peer	4	5
	Brett	2	5
	Brett’s peer	4	5

Table 5 (continued)

Do you think you will learn anything from your peer buddy?	Mary	5	5
	Mary’s peer	3	4
	Jade	5	5
	Jade’s peer	4	3
	Devin	4	5
	Devin’s peer	4	5
	Derek	4	4
	Derek’s peer	4	4
	Brett	4	5
	Brett’s peer	5	5
Would you like to continue to work with your peer buddy?	Mary	n/a	5
	Mary’s peer	n/a	5
	Jade	n/a	4
	Jade’s peer	n/a	5
	Devin	n/a	4
	Devin’s peer	n/a	5
	Derek	n/a	5
	Derek’s peer	n/a	5
	Brett	n/a	5
	Brett’s peer	n/a	5

Table 6

Student/Peer Attitude Survey pre/post mean scores across students

Student	Pre Survey Mean Score	Post Survey Mean Score
Mary	4.75	4.8
Mary’s peer	2.75	4.8
Jade	3.25	4.6
Jade’s peer	3.0	3.8
Devin	3.25	4.6
Devin’s peer	3.25	5
Derek	3.75	4.4
Derek’s peer	3.25	4.6
Brett	2.5	5
Brett’s peer	3.75	5

Results for Question 4

What is the effect of peer-mediated embedded instruction on science grade averages of general education peers?

Table 7 presents the data collected by the classroom teacher on the impact of peer-mediated instruction on the general education peers science grade average. All six peers science grade average remained steady based on their science grade average prior to the beginning of the study, and their grade average post intervention. General education Peer 3 and 4 demonstrated higher science grade averages after intervention.

Table 7

General Education Peer Science Grade Averages Pre/Post Intervention

Peer	Pre science grade average	Post science grade average
1	*87% B*	*88% B*
2	*86% B*	*85% B*
3	*72% C*	*82% B*
4 (Unit 1 only)	*82% prior to unit 1 B*	*83% after unit 1 B*
4 (Unit 2 and 3 only)	*79% prior to unit 1 C*	*86% B*
5	*80% B*	*84% B*

Social Validity Results

What Were General Education Peers Perceptions of the Peer-Mediated Intervention?

Following the intervention, the five general education peers participated in a 25 minute focus group. The focus group was held in the school media center in a small conference room. The researcher asked the students 12 questions regarding their perceptions of the intervention procedures, students with disabilities, and inclusion. Students were given unlimited time to discuss their perceptions and comments were recorded. Student responses were transcribed and IOA was taken by a second observer on the number of comments made, recorded, and accuracy of transcription. Interobserver agreement was reported at 100%. Table 8 presents the results of the General Education Peer Focus Group.

Table 8

Peer Reflection (Focus Group) Social Validity Results

Item	Responses
1. How would you describe your experience working with your partner?	- I would say fun -Really memorable, because you don't do it all the time - Fun
2. Did you enjoy serving in this role? In what ways? What did you like the most?	-When she gets the answer right -I like when they get the answers wrong and then realize it and correct their answers.
3. Where there aspects of this role you particularly enjoyed? Found difficult?	-It was difficult when I had to do other work, but I could manage it. -It would be difficult for my student, when they would switch the pictures
4. In what ways have you benefited from participating in this way? What have you learned?	-Not all people immediately know this stuff, but they could learn the information. -I benefitted from helping someone learn more than they knew.
5. What changes have you noticed in your partner, if any?	-She learned more about the new words -She communicates more -He seems excited (to work on science), and can't wait.
6. Do you think this was a beneficial experience for your partner? If no, how?	-When I did the 0 delay, he didn't know it, but by the third time, he did know the words.
7. What have you learned about the most effective ways to support your partner?	-Keep smiling, and when they get it wrong, just point to the right one.
8. What strategies have been working really well? Not as well?	*Worked well:* -Repetition is a big part, they search their brains -Doing it more than once a week *Not so well:* -Doing other pictures and skipping around from words to concepts to pictures, slips my students brain

Table 8 (continued)

9. Is there any additional support or help that you feel would help you to be more effective in this role?	-No, not really
10. Are there other things you would like to do with your partner?	- Doing other experiments with them could help (peer referenced coke bottle experiment that occurred during the study.) Experiments will help him remember -Field trips -Work together in other subjects, because I really enjoy this.
11. What makes someone a member of this class?	-People accept them -Hitting the smart board and participating -Participating with things in class
12. How do other students in the classroom understand your role as a peer support?	-Maybe, I am not sure if they have has students work with them, but other students like to help me when I am teaching -Other students note when I am doing it wrong, they always want to help

Focus group questions adapted from Carter, Cushing & Kennedy, 2009

How Do Teachers Perceive Peer-Mediated Embedded Science Instruction?

Following the intervention, a feasibility survey was given to the general education and special education teachers involved in the study (see Appendix J). The survey contained six questions which could be answered using a 5-point Likert scale (i.e., SA=strongly agree, A=agree, N=not sure, D=disagree, SD=strongly disagree). In order to determine a numerical range and mean, values were assigned to each of the 5 points (i.e., 5=strongly agree, 1=strongly disagree). A space to write in additional comments was also included at the bottom of the survey. Both of the teachers (100%) returned the survey.

Both respondents added additional comments. Table 9 presents the results of the *Teacher Survey of Feasibility*. Scores for the six questions ranged from 3 to 5.

Table 9

Teacher Survey of Feasibility Results

Item	General Ed. Teacher	Special Ed. Teacher
1. I think this student population should be taught science.	5	5
2. I will continue to use peer-mediated embedded instruction to teach science to students with disabilities.	3	4
3. I think that peer-mediated embedded instruction is an appropriate way to teach science to this population in inclusive settings.	4	5
4. I feel peer embedded instruction offers a natural context for this population to learn science terms and behaviors.	4	5
5. Using peers to embed science trials during an inquiry lesson is a manageable instructional tool in the inclusive classroom.	4	5
6. I would recommend teaching inquiry science using peer-mediated embedded instruction to other teachers serving students with disabilities in an inclusive classroom.	4	5

Additional comments:

- General Education teacher: My “helper” students enjoyed the additional responsibilities and did not show any loss of cognitive ability according to pre and post data that I analyzed. Personally, I would be comfortable using this strategy weekly but not daily.

- Special Education teacher: The students who are served academically in a Specialized Academic Curriculum really loved participating in the Science class. They enjoyed working with their peers. It was amazing to see them identify and tell what “Kinetic Energy” means! We are very grateful for this opportunity and hope that we can continue this at our school.

CHAPTER 5: DISCUSSION

The purpose of this investigation was to determine if peer-mediated embedded time delay instruction during middle-school inquiry science lessons was an effective strategy to teach science behaviors to students with severe intellectual disabilities. A multiple probe design across science units was used to determine the impact of the independent variable on the primary dependent variable.

The following outcomes were found for the research questions that guided this investigation:

(a) What is the effect of peer-mediated embedded time delay instruction on number of correct science responses? Based on the finding of this study a functional relationship was found between peer-mediated embedded time delay instruction and number of correct science responses for four of the five students across all three science units. All students were able to show generalization of science vocabulary across picture symbols (i.e., three picture representations of potential energy). All students also were able to demonstrate maintenance of science responses for Unit 1 and Unit 3. Four students were able to demonstrate maintenance of science responses for Unit 2.

(b) What is the effect of peer-mediated embedded time delay instruction on correct KWHL chart responses? While no functional relationship could be determined with this AB research design, the students did master steps of the KWHL behavior and demonstrated generalization across two units of instruction.

(c) What is the effect of peer-mediated embedded instruction on student social attitudes? Findings of this study indicated that both students and peers social attitudes increased after participating in peer-mediated instruction.

(d) What is the effect of peer-mediated embedded instruction on science grade averages of general education peers? Student science grade averages remained constant after participating in peer-mediated instruction. Finally, social validity measures indicated a high degree of satisfaction with the intervention and its intended outcomes.

In general, these finding are consistent with previous studies on science instruction for students with severe intellectual disabilities showing that students with severe disabilities can learn science vocabulary (e.g., Browder et al., 2009; Jimenez et al., 2010; McDonnell et al., 2006). Findings are also consistent with previous studies on the use of embedded instruction demonstrating that this strategy to be an effective approach to teach academics to students with severe intellectual disabilities in inclusive settings (e.g., Jameson et al., 2007; Johnson et al., 2004; McDonnell et al, 2002; Wolery et al., 1997). This research is also consistent with previous studies demonstrating that the use of peer-mediated instruction is an effective strategy for the delivery of academic content to students with severe intellectual disabilities (e.g., Carter et al., 2005; Carter et al., 2007; Jameson et al., 2008). Each of these findings will now be discussed.

Effects of the Intervention on the Dependent Variables

Question 1: What is the Effect of Peer-Mediated Embedded Time Delay Instruction on Number of Correct Science Responses?

In this study there was an overall functional relationship between the peer-mediated embedded time delay instruction and the number of correct student science responses. Four of the five students showed an increase on the number of correct science responses from baseline to post-intervention across all three units of instruction. One student showed an increase on the number of correct science responses from baseline to post-intervention across two of the three units of instruction.

One important component of the intervention was the embedded time delay procedure. Previously, McDonnell et al. (2002) taught paraeducators to embed time-delay trials for four students with moderate disabilities to read and define academic sight words within the context of an inclusive setting. In the current study general education peers, rather than paraeductors, learned to embed trials for students with severe disabilities to identify science sight words, picture symbols, match words to picture symbols and concept statements. McDonnell et al. (2002) found that paraeducators were able to embed trials using systematic instruction at a high fidelity level which led to the acquisition of sight words and definitions by all four students. Similarly, in this study peers were able to effectively embed trials using systematic instruction (i.e., time-delay) within an inclusive classroom which led to the acquisition of science vocabulary and concept statements for all five students.

Although not using an embedded format, other researchers have trained peers to use time delay or had peers provide instructional support, that was more general than time delay, within inclusive classrooms. Miracle, Collins, Schuster, and Grisham-Brown (2001) found that both peer delivered and teacher delivered instruction using a constant time-delay procedure were effective in teaching sight words to high school students with moderate disabilities. Not all peer support interventions have been as specific as time delay. Carter, Sisco, Melekoglu, and Kurkowski (2007) examined the effectiveness of peer support interventions (e.g., verbal prompts, inviting students to participate in small group activities, positive feedback) to improve social and academic outcomes for high school student with severe disabilities in core academic classrooms. Results indicated that the use of a peer support intervention increased student's social interactions and academic engagement. In Carter et al. (2007) students were considered *academically engaged* when they were actively involved in or attending to the materials being used during the lesson (e.g., asking questions, attending to teacher, looking at class-related materials). In contrast, this study extends the literature by showing peers can teach specific academic content in inclusive settings.

One other study has also shown that peers can embed constant time-day trials in inclusive classrooms. Jameson et al. (2008) trained general education peers to use embedded constant time-delay within a general education classroom (i.e., health; arts and crafts class). Students with severe disabilities learned content specific vocabulary (e.g., lungs; stomach; kiln, glaze). The study demonstrated that peer tutors could be trained to implement embedded instruction using a time-delay procedure with high levels of procedural fidelity, resulting in skill mastery for all three students with disabilities. This study extends the work of Jameson et al., by showing peers can teach additional grade-level aligned content in core subject areas (i.e., science) resulting in student skill mastery across science units using embedded time-delay instruction.

Question 2: What is the Effect of Peer-Mediated Embedded Time Delay Instruction on Correct KWHL Chart Responses?

Although no causal inference can be made from the AB design, student outcome data indicates a positive relationship between the peer-mediated embedded time delay instruction and the number of correct student KWHL chart responses. The current study adds to the growing research showing that students with severe intellectual disabilities can acquire science skills (Agran et al., 2006; Jameson et al., 2008; McDonnell et al., 2006). However, a limitation of prior research on science instruction for this population is that it has focused on isolated skills such as word identification or definitions. While these skills are important in science instruction, this study extended the science skills to be taught to .include self-direction of the inquiry process.

One prior study targeted student acquisition of inquiry in science (Jimenez et al., in press). Jimenez et al. (in press) found the use of a constant time delay procedure to be an effective method to teach three students to self-direct the use of a KWHL chart in inquiry science lessons. Three middle school students with moderate intellectual disabilities learned to use a KWHL chart to self-direct science responses across three lessons within two science units. Generalization probes were measured within the context of an inclusive science setting. Courtade et al., (in press) also focused on inquiry-based lessons, but targeted teacher acquisition of a 10 step task-analysis to teach inquiry science lessons to students with moderate intellectual disabilities. The current study contributes to this body of emerging research on using an inquiry process in science instruction for students with severe disabilities by showing that peers, rather than a special education teacher, can promote the inquiry process in science. Additionally, this study builds on this body of research by demonstrating that students with severe disabilities can be taught to self-monitor their own inquiry learning within the natural context of a science lesson.

This emerging research on using an inquiry approach with students with severe developmental disabilities is important because research in the area of general education science emphasizes the need for inquiry based science learning (Shymansky, Kyle, & Alport, 1983). The National Research Council developed *How People Learn* (Bransford, Brown, & Cocking, 1999), based on research across content areas, with important contributions from the research on science learning. This report was synthesized to determine what is important in the science learning of all students. Using these findings, The National Research Council developed a definition of inquiry. In the current study, the intervention was developed to be consistent with this NRC definition (see definition in Chapter 1.). However, a limitation of the typical general education inquiry approach is that the level of guidance students with disabilities may need to learn may not be enough support (Kirschner, Sweller, & Clark, 2006; Scruggs & Mastropieri, 1995). Because students with severe disabilities need systematic repeated trials to learn new skills, the need exists for research that defines how to develop interventions that systematically teach students to use an inquiry process. The intervention used in the current study demonstrates an adaptation that included the use of systematic instruction known to be successful with students with severe intellectual disabilities (i.e., time-delay, Browder et al., 2009), and the learning process recommended for instruction in the general education classroom (i.e., inquiry, NRC, 1996). Specifically, through peer's use of systematic time-delay instruction, the students learned to use a KWHL chart to follow an inquiry lesson. This adaptation may be applicable across other content areas. For example, the Institute for Inquiry promotes the use of a KWHL strategy to teach English language arts as well as science (http://www.exploratorium.edu/ifi/index.html). The North Carolina State University Teacher Resource Room provides teachers with a chart and directions to use this strategy while teaching a variety of state standards (http://www.ncsu.edu/midlink/tch.wk.rm.htm).

Question 3: What is the Effect of Peer-Mediated Embedded Instruction on Student Social Attitudes?

The literature on using peer-mediated instruction to assist in academic and social gains for students with severe intellectual disabilities is extensive; however most interventions are supported through the use of social validation by teachers (e.g., Copeland et al., 2002), researchers (e.g., Jackson, Ryndak, & Billingsley, 2000), or parents (e.g., Palmer, Fuller, Arora, & Nelson, 2001). Limited research has been conducted on the viewpoints of general education students regarding inclusion of students with severe disabilities (e.g., Carter, Hughes, Copeland, & Breen, 2001). Copeland et al. (2004) evaluated general education high school students' perspectives on general curriculum access and peer supports. High school students found peer supports beneficial to both the general education and special education students, as well as providing positive social relationships among students. Copeland et al. also found that students felt that teachers benefited from increased supports for students with disabilities.

Like Copeland et al., peers in this study reported positive effects for peer instruction. Unlike Copeland et al., this study evaluated the effect of inclusive practices on student perceptions of both special education and general education students. This study contributes to the body of literature on student perceptions of inclusive practices by providing the perceptions of general education and special education students using the same measure. Rather than asking only general education peers about their perceptions of students with disabilities, both sets of student's perceptions were gained on inclusion, science education, and peer-mediated learning.

Social validity measures are important to take, especially when including student perspectives. One way to support the validity of teaching science to students with severe disabilities is to measure the social perspectives of those students with severe disabilities.

Question 4: What is the Effect of Peer-Mediated Embedded Instruction on Science Grade Averages of General Education Peers?

Results indicated that peer-mediated embedded instruction did not have a negative effect on peers' science grade averages. All five student's science grade either remained the same or increased. Similarly, Cushing and Kennedy (1997) found that students who are struggling themselves academically showed improvement after being a peer instructor. Carter et al. (2005) evaluated the impact of altering the number of students in peer support arrangements on the social and academic outcomes of students with severe disabilities. Carter et al. measured the impact of the alternating peer support intervention on the peers and found no detrimental effect to peer's engagement or grades.

Discussion of Social Validity

Assessing the social validity of an intervention is necessary to determine if the outcomes of research are of practical significance to key stakeholders (Wolf, 1978). The social validation of an intervention also is an essential criteria for a research study to become an evidence based practice (Horner et al., 2005). It is important to determine the acceptability of an intervention for it to be replicated in the future. In this study support for social validity was found with the general education teacher, special education teacher, and peers. Each of these findings will now be discussed.

What Were General Education Peers Perceptions of the Peer-Mediated Intervention?

All five general education peers participated in a 25 minute focus group in which questions were asked regarding their participation as a peer-mediator. The focus group responses indicated that all five peers felt positive about the use of peer-mediated instruction. They felt the use of embedded instruction in science was “fun” and “memorable”. When peers were asked how they personally benefitted from participating in the study, one peer mentioned that they benefitted by helping someone learn more than they already knew. Additional changed in the special education students were noticed by their peers, such as learning more science words, increased communication, and student excitement to “work on science.” Overall all five students seemed to enjoy working with students with severe disabilities in science. They indicated they would like to continue to work as a peer mentor not only in science but other subjects as well.

How Do Teachers Perceive Peer-Mediated Embedded Science Instruction?

Both the general education and special education teacher responded to the *Teacher Survey of Feasibility.* The survey indicated that both teachers felt positive about use the method of peer-mediated embedded instruction to teach students with severe intellectual disabilities in the inclusive science classroom. A “not sure” response was indicated once for the following question: “I will continue to use peer-mediated embedded instruction to teach science to students with disabilities.” The special education teacher responded “strongly agree” and the general education teacher responded “agree” for the following question: “I feel peer-mediated embedded instruction offers a natural context for this population to learn science terms and behaviors.” These responses are consistent with responses from general educators and special educators involved in prior research using peer-mediated embedded instruction in their classrooms (Jameson et al., 2008). Additional comments in the current study also support the social benefits of peer-mediated embedded instruction in the inclusive science classroom. The special education teachers indicated that her students "really loved participating in the science class." Overall both teachers seemed to like this instructional method and would recommend teaching inquiry science using peer-mediated embedded instruction to other teachers serving students with disabilities in an inclusive classroom.

Limitations

Several limitations must be considered when analyzing results related to the current study. First, the small size of participants limited the generalizability of the findings of the study. In contrast, when considered with the overall literature on peer mediated instruction or embedded instruction, the current study adds to the overall evidence on using both peer-mediated instruction and embedded instruction to teach science to students with moderate and severe intellectual disabilities. Currently, there is only one other study on the use of peer-mediated embedded instruction conducted in inclusive education with students with severe disabilities (Jameson et al., 2008). More research needs to be conducted on the use of peer-mediated embedded instruction for this to be considered an evidence-based practice. Horner et al. (2005) provide guidelines for a practice to be evidence-based is that the intervention has been replicated across a minimum of five single-subject studies (meeting the criteria of minimally acceptable methodological criteria and document experimental control); are conducted by different researchers, with at least 22 participants (including this study 8 participants would be represented), across at least 3 geographic regions (including this study two regions would be represented; UT; NC). Using these criteria, peer-mediated embedded instruction would be considered an emerging practice, suggesting future research to gain more knowledge about this method of inclusive instruction.

Another limitation of the study was the ceiling effect on the student acquisition of KWHL chart responses that was created by their opportunities being contingent on the general education teacher performance. That is, the peers could only instruct the student with disabilities to use the KWHL chart responses when the teacher performed the preselected cue (i.e., point to the letter of the chart while asking the inquiry question). On one occasion the teacher asked the questions during the inquiry science lesson without pointing to the chart. During intervention, the teacher did not always perform all four cues consistently. Without the appropriate teacher cue (low teacher fidelity of KWHL steps), students were less likely to respond appropriately. In contrast, student data of KWHL responses show immediate change once the intervention began and when the teacher used the correct prompting system for the self-direction of the inquiry chart. The KWHL intervention was also introduced without an experimental design (AB) due to logistics of the classroom practice. Future research is needed in which the use of the KWHL chart intervention is used across students to demonstrate experimental control of self-directed learning.

A third limitation of the study was the format used for measuring comprehension of science terms and concept statements. During assessment sessions, students were asked to identify the answer (e.g., What picture shows kinetic energy?) from an array of three responses. For each question asked, the field of responses included one correct response and two incorrect responses (distractor options). Students had a 33% chance of selecting a correct response at random. One possible solution to this limitation would be to increase the number of response options to four, reducing the likihood of students selecting the correct response by chance to 25%. Some students may be able to generate a verbal response to the questions, but the picture/ word match would still require a receptive response option. One possible alternative for the concept statement would be to ask students to define the term or state the concept statement.

A fourth limitation of the study was the number of students who needed additional instruction from the special education teacher to reach the mastery criteria across science units. While all student's science responses increased with the use of peer-mediated embedded time-delay instruction, additional massed trials using time-delay provided by the special education teacher was needed for three of the students consistently across one or two units to reach mastery. When interpreting results, it is important to note that some students may benefit from peer-mediated embedded systematic instruction, but will require intensive 1:1 support from a special education teacher to meet mastery criteria. Another possible explanation for the student's need of this intensive support is the fact that peers were only given six lessons to embed trials, more trials may have been needed rather than more intensive support from the teacher. Unfortunately, more trials were not an option due to the rapid progression of the units taught within inclusive science classrooms.

A final limitation of the study was Devin's growth during baseline probes for Unit 3. It is undetermined how he acquired the new Unit 3 vocabulary prior to the intervention. Devin was not taught the materials within his special education class or general education classroom prior to the intervention. As mentioned in the third limitation of this study, it is possible that he was able to select the correct answer due to a

33% chance, but unlikely since the baseline probe session was repeated over days and picture symbols (generalization).

Suggestions for Future Research

The results of this study indicate that peers are able to implement, with high fidelity, embedded time delay instruction with students with severe intellectual disabilities. In addition, the results suggest that students with severe disabilities were able to acquire new science content across units of instruction at the same pace as the general education curriculum occurs. In order for this method of instruction to become an evidence-based practice further research using the same intervention must be conducted (Horner et al., 2005). The intervention should be replicated at least 3 more times, with at least 1 more different researcher in 1 or more location. It is also important that the intervention be studied with different aged students in order to determine if the intervention can be used with different school aged populations. Furthermore, this study was conducted in an inclusive science classroom. In order to make the results of the intervention stronger, future research should investigate the effects of peer-mediated embedded instruction in other core content areas (e.g., math, social studies).

Another recommendation is to expand the overall research in academics for this population in inclusive settings. Limited research exists in the area of reading, math, and science for students with significant intellectual disabilities; however, that research base is growing (Browder, Wakeman, et al., 2006; Browder et al., in press; Courtade et al., in press; Courtade, Spooner, Browder, 2007; Jimenez, et al., in press). The research that exists demonstrates meaningful extensions to the general curriculum with useable methods (e.g., systematic instruction). Unfortunately, previous research has primarily been conducted on instruction in special education settings. Replication in inclusive settings is needed in all academic areas to promote the inclusion of students with disabilities in general education classrooms. While this study did expand the options for student responding of academic content by concept statement completion, future research should continue to redefine measures of academic learning for students with significant intellectual disabilities (e.g., match concept statement to experiment in which concept is demonstrated).

A third recommendation is to continue research in the area of inquiry science for students with severe disabilities. The National Research Council (1996) recommends inquiry-based instruction as a method to teach science, as more students with severe disabilities participate in inclusive science classrooms, techniques for students to participate and self-direct their own learning need to be explored. The use of a KWHL chart may provide students with a graphic organizer that allows them to be part of cooperative learning groups, show attention of the lesson that is occurring, and record information gained. Only one other study currently exists in which student with severe disabilities (Jimenez et al., in press) use a KWHL chart in an inclusive science classroom. More research is needed to extend the use of this chart to record student knowledge.

A final suggestion is to determine the long-term impact of peer-mediated embedded instruction on peers involved in the implementation of the strategy. While no effect was found on student's science grade averages and only positive attitudes were reported during this study, future research is needed to determine the length at which peers should be expected to participate in such supports. General education students participated in this intervention for approximately nine weeks. It is unknown if attitudes or grades would have been negatively impacted had the study lasted longer. It is possible, that peers take turns providing supports to students with severe disabilities in the inclusive classroom, allowing more peers to participate with less pressure on one peer for long periods of time.

Implications for Practice

General education and special education teachers who are teaching students with disabilities in inclusive classrooms can gain a method of instruction from this study. Although this is only the second study to use both peer-mediation and embedded instruction in the inclusive classroom, positive results from both studies indicates a promising research-based practice. Most importantly, results of this investigation show that general education peers are able to successfully embed systematic instruction during the naturally occurring inquiry science lesson, resulting in the academic learning of students with severe disabilities. Furthermore, when students with severe disabilities are included in general education science, academic gains can be made in grade-aligned, core content.

As inclusive education grows, strategies to assist general and special educators are needed. The combination of peer-mediated instruction and embedded instruction were used in this intervention. Via the use of systematic instruction (i.e., time-delay) peers were able to embed learning trials of science content aligned with the same content they were currently learning. Additionally, peers used systematic instruction to teach students with severe disabilities how to self-monitor their own inquiry learning with the use of a KWHL chart.

Students with severe disabilities are expected to participate and demonstrate growth on end-of grade assessments in science (NCLB, 2002). It is important to develop methods for students to participate in inclusive science instruction with measurable and appropriate academic outcomes. Students with severe disabilities have intensive support needs (Kennedy & Horn, 2004), when combined with the challenges of inclusive education, peer-mediated strategies offer a means to provide additional support. The use of peer-mediated embedded instruction provides students with severe disabilities the opportunity to receive intensive support within the naturally occurring lesson from the least intrusive support provider.

Summary

Currently, research regarding teaching science to student with severe disabilities is limited, especially in inclusive contexts. However, the number of students with disabilities receiving services in inclusive classrooms are growing (U.S. Department of Education, 2004). In order for inclusive educators to provide the intense support students with severe disabilities need to gain academic success, additional instructional strategies are needed. Although there is limited research on how to teach academics to students with severe disabilities in the general education classroom, there is a growing research base on how to use peers to implement instruction. Additionally, there is a growing research base on embedding learning trials in the naturally occurring lesson.

The purpose of this study was to determine the effects of peer-mediated embedded time delay instruction on student science responses. Findings indicate that the use of general education peers to embed science instruction using time delay was successful for middle school students with severe disabilities in this study. Replications of this intervention may lead to an evidence-based practice for the use of peer-mediated embedded instruction to teach academic responses to students with severe disabilities in inclusive settings.

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APPENDIX A: KWHL CHART

KWHL Chart			
What do we Know?	What do we Want to know?	How can we find out?	What did we Learn?

APPENDIX B: VOCABULARY/PICTURE SYMBOL
AND CONCEPT STATEMENT EXAMPLE

Kinetic energy

__________________is the energy of motion.

APPENDIX C

Student Science Responses
Data Collection Form

SAMPLE

Student: 1 2 (3) 4 5 Unit: 1 (2) 3

Picture set		Set 2						
Science Response	Date:	2/10						
1. Word 1		(+) -	+ -	+ -	+ -	+ -	+ -	+ -
2. Word 2		+ (-)	+ -	+ -	+ -	+ -	+ -	+ -
3. Picture 1		(+) -	+ -	+ -	+ -	+ -	+ -	+ -
4. Picture 2		+ (-)	+ -	+ -	+ -	+ -	+ -	+ -
5.Picture/Word Match 1		+ (-)	+ -	+ -	+ -	+ -	+ -	+ -
6.Picture/Word Match 2		+ (-)	+ -	+ -	+ -	+ -	+ -	+ -
7.Concept Statement 1		(+) -	+ -	+ -	+ -	+ -	+ -	+ -
8.. Concept Statement 2		+ (-)	+ -	+ -	+ -	+ -	+ -	+ -
	Score	3						
Data taken by		BJ						

<u>Score Guide:</u>

+ Independent Correct

- Independent Incorrect/no response

<u>Notes:</u>

APPENDIX D

KWHL Student Science Responses

Data Collection Form

SAMPLE

Student: 1 2 (3) 4 5 Unit: 1 2 (3)

Peer: 1 2 (3) 4 5

Science Response	Date:	2.10					
1.Identified K		(+) -	+ -	+ -	+ -	+ -	+ -
2. Identified W		+ (-)	+ -	+ -	+ -	+ -	+ -
3. Identified H		(+) -	+ -	+ -	+ -	+ -	+ -
4. Identified L		+ (-)	+ -	+ -	+ -	+ -	+ -
	Score:	2					

<u>Score Guide:</u>

+ Independent Correct

- Independent Incorrect/no response

Notes:

APPENDIX E

Student/Peer Attitude Survey

Peer: 1 2 3 4 5 Student: 1 2 3 4 5 Pre Post

Mark the box that best describes how you feel about each statement.

1. **How do you feel about spending time with your peer buddy?**

I don't know I have never worked with them before. ** option not on a Likert Scale*	**I don't really like it very much.**	**It is o.k., sometimes it is hard to work with them.**	**I like it, my peer buddy is nice.**	**I love it, we get along very well.**

2. **How important do you think it is to learn science together?**

I don't think it is very important, science is not very important for my buddy to know.	**Learning science together is o.k., but it doesn't really make a difference if we learn together or separate.**	**It is fun, we both can learn different things in science.**	**It is important because we can learn about the same science concepts and help each other.**	**It is very important, because we can help each other and learn about the same science concepts.**

3. **How comfortable are you with your role with your peer buddy?**

Not at all, I don't really think I will be able to do it.	**Not very comfortable, but I will try it.**	**A little bit, I will learn as I do it.**	**I am comfortable.**	**Very, I know exactly what to do.**

4. **Do you think you will learn anything from your peer buddy?**

No, they don't really know anything.	**Probably not, I will already know what they try to teach me.**	**Sometimes they may know things that I can learn.**	**Yes, they may teach me a couple of things**	**Yes, they can offer me lots of new things to learn.**

5. **Would you like to continue to work with your peer buddy?**

No, it was too hard to work with them.	**Probably not, they were o.k. but I didn't really enjoy it.**	**Maybe, I will think about it. I liked it sometimes.**	**Yes, I liked working with them.**	**Definitely, this was fun and I made a new friend.**

APPENDIX F

Peer Reflection Questions

Post Intervention

1. How would you describe your experience working with your partner?

2. Did you enjoy serving in this role? In what ways? What did you like most?

3. Were there aspects of this role you particularly enjoyed? Found difficult?

4. In what ways have you benefited from participating in this way? What have you learned?

5.What changes have you noticed in your partner, if any?

6. Do you think this was a beneficial experience for your partner? If so, how?

7. What have you learned about the most effective ways to support your partner?

8.What strategies have been working really well? Not so well?

9.Is there any additional support or help that you feel would help you to be more effective in this role?

10. Are there other things you would like to do with your partner?

11.What makes someone a member of this class?

12. How do other students in the classroom understand your role as a peer support?

Adapted from Carter, E. W., Cushing, L. S., & Kennedy, C. H. (2009)

APPENDIX G

Peer Self-Monitoring Checklist

SAMPLE

Peer: 1 2 3 (4) 5 Unit: 2 Student: 1 2 3 (4) 5

Embedded with time delay procedure	Date	2.10					
Word 1 Kinetic Energy		+					
Word 1		+					
Word 1		+					
Word 2 Potential Energy		+					
Word 2		+					
Word 2		+					
Pic 1 Kinetic Energy		+					
Pic 1		+					
Pic 1		+					
Pic 2 Potential Energy		+					
Pic 2		+					
Pic 2		+					
Pic/Word1 Kinetic Energy		+					
Pic/Word 1		+					
Pic/Word 1		+					
Pic/Word 2Potential Energy		+					
Pic/Word 2		+					
Pic/Word 2		+					
Concept 1 Kinetic Energy		+					
Concept 1		+					
Concept 1		+					
Concept 2 Potential Energy		+					
Concept 2		+					
Concept 2		+					
K		+					
W		+					
H		+					
L		+					

+ Peer checks off each set completed as embedded during lesson.

APPENDIX H

Peer Training Workshop Fidelity

Training Component	+ present/ - no present	Notes (time log)
Who are the students – Disability awareness		
Expectations of Peers		
Time Delay Procedure		
KWHL chart		
Questions/Answers		

Training Date: _________________

Who trained peers: ________________

Fidelity Taken by: ________________

Starting time of training: ________________

End time of training: _________________

Number of peers in training: _______________

APPENDIX I

Peer Procedural Fidelity **Embedded Time Delay Delivery**

Peer: 1 2 3 4 5 Unit: 1 2 3 With Student 1 2 3 4

Embedded with time delay procedure	Date:							
Word 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Word 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Word 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Word 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Word 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Word 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic/Word 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic/Word 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic/Word 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic/Word 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic/Word 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Pic/Word 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Concept 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Concept 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Concept 1		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Concept 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Concept 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
Concept 2		+ -	+ -	+ -	+ -	+ -	+ -	+ -
K on chart		+ -	+ -	+ -	+ -	+ -	+ -	+ -
W on chart		+ -	+ -	+ -	+ -	+ -	+ -	+ -
H on chart		+ -	+ -	+ -	+ -	+ -	+ -	+ -
L on chart		+ -	+ -	+ -	+ -	+ -	+ -	+ -
	Score:	/28	/28	/28	/28	/28	/28	/28
	%							
	Taken By:							

\+ accuracy procedure embedded

\- incorrect procedure embedded / no trial given

APPENDIX J

Teacher Survey of Feasibility

1. I think this student population should be taught science.

Strongly Agree Agree Not Sure Disagree Strongly Disagree

2. I will continue to use peer-mediated embedded instruction to teach science to students with disabilities.

Strongly Agree Agree Not Sure Disagree Strongly Disagree

3. I think that peer-mediated embedded instruction is an appropriate way to teach science to this population in inclusive settings.

Strongly Agree Agree Not Sure Disagree Strongly Disagree

4. I feel peer-mediated embedded instruction offers a natural context for this population to learn science terms and behaviors.

Strongly Agree Agree Not Sure Disagree Strongly Disagree

5. Using peers to embed science trials during an inquiry lesson is a manageable instructional tool in the inclusive science classroom.

Strongly Agree Agree Not Sure Disagree Strongly Disagree

6. I would recommend teaching inquiry science using peer-mediated embedded instruction to other teachers serving students with disabilities in an inclusive classroom.

Strongly Agree Agree Not Sure Disagree Strongly Disagree

Additional Comment: