USING COMPUTER ASSISTED INSTRUCTION TO TEACH SCIENCE FACTS TO STUDENTS WITH MODERATE TO SEVERE DISABILITIES

DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Education in the
College of Education
at the University of Kentucky

By

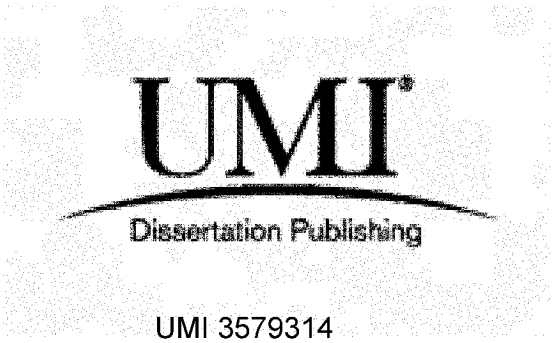
Amy Ketterer Berrong

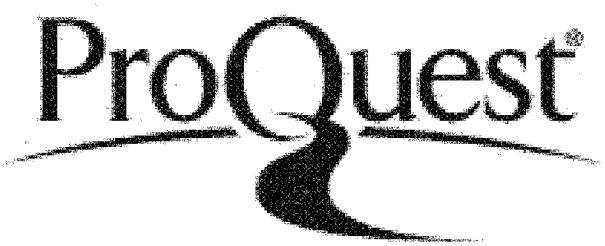
Lexington, Kentucky

Director: Dr. Belva Collins, Professor of Special Education

Lexington, Kentucky

2011





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Previous research has found the use of computer-assisted instruction (CAI) to be effective in teaching skills to a variety of populations. Students with and without disabilities have been taught a variety of skills including social skills and core academic content using CAI. Students with moderate to severe disabilities (MSD) have been taught a variety of functional skills, including communication skills, using CAI. Teaching students with MSD core academic content using CAI has not been investigated in the literature. This study investigated the ability of 7 elementary students with MSD to learn general education science content using CAI. Three students at one elementary school mastered all three tiers of stimuli, and one student mastered two tiers before the study was concluded due to the end of the school year. Due to the end of the school year, maintenance could not be assessed. One student from another elementary made it to criteria on Tier 1. All of the participants' scores at the first mentioned elementary improved from the initial probe data to the final probe data regarding the acquisition of nontargeted information and generalization to real life examples.

KEYWORDS: Computer, science, moderate disabilities, constant time delay, elementary students.

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6 · 28 · 2011

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Director of Dissertation

Director of Graduate Studies

6-23-11

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Introduction

Literature Review

The education of students with moderate to severe disabilities (MSD) has continuously changed over the years. In the beginning, most of these individuals were not provided an education at all but were placed in institutions or simply stayed at home. Then, programs began to teach individuals with MSD functional skills in segregated school settings and later in inclusive settings. The Individuals with Disability Education Act Amendments (IDEA, 1997) and No Child Left Behind (NCLB, 2002) require that all students be given access to the general education curriculum and included in assessments. States have now moved toward standards-based educational reform for all students and large-scale assessments are used to measure student achievement (Karvonen, Flowers, Browder, Wakeman, & Algozzine, 2006). All states have created alternate assessments to fulfill this requirement for students labeled as having MSD. The Kentucky alternate portfolio evaluates the achievement of students with MSD on grade level standards in reading, mathematics, writing, social studies and science (Kentucky Department of Education, 2010).

Students with MSD have been shown to require more opportunities than students without disabilities to learn information. As a result, students with MSD who are included in regular education classes need more opportunities to learn the standards than students without disabilities. Teachers must find ways to embed extra instruction on standards for students with MSD to acquire the information. This could happen in a variety of ways including small group instruction (Collins, 2007), 1:1 instruction with an instructional assistant or special education teacher (Collins, 2007), or instruction using an

individualized computer program. Some students with MSD may receive their instruction in the special education classroom based on recommendations from the Individualized Education Program (IEP) team. These students will still need extra practice following instruction to acquire the information. This can be difficult when the special education teacher may need to teach other goals on the IEP in addition to the academic standards. Teachers also must provide instruction for the rest of the class, which is typically made up of students with diverse ages and goals. The use of individualized computer programs could address this problem as it could be used both in inclusive and resource settings.

Computer Assisted Instruction

Computer-assisted instruction (CAI) is the practice of providing students with instruction, practice, or assessments using a computer (Kulik & Kulik, 1991). CAI can provide a variety of educational benefits to students and teachers, including the ability to individualize instruction, provide immediate feedback, and collect student performance data with the possibility to conduct frequent assessment (Mayfield, Glenn, & Vollmer, 2008). Many students find working on the computer enjoyable and reinforcing, and studies often cite the preference of CAI over typical instructional methods (Fitzgerald, & Koury, 1996). The use of CAI allows for students to receive new content or extra practice while reducing teacher load so that more student needs can effectively be met at one time while still individualizing instruction as needed, and individualized data still can be collected on student progress as well.

CAI has been shown to be effective in teaching an array of skills to diverse populations. It has been used successfully to teach reading skills to elementary aged students (Macaruso, Hook, & McCabe, 2006), at-risk preschool students (Huffstetter, King, Onwuegbuzie, Schneider, & Powell-Smith, 2010), kindergartners (Macaruso &

Walker, 2008), and students with learning disabilities (LD; Marston, 1995). Hine, Goldman, and Cosden (1990) used CAI to teach writing skills to elementary and middle school age students with multiple disabilities. CAI has been used to teach social studies content to elementary age students (Jerome & Barbetta, 2005) and high school students (Higgens & Boone, 1990) who are labeled as LD. Ferretti, MacArthur, and Okolo (2001) taught history content to elementary students with multiple disabilities using CAI. CAI also has been found to be effective in teaching math skills. Calhoon, Fuchs, and Hamlet (2000) used CAI successfully to teach math skills to students in high school diagnosed as having math learning disabilities. CAI also has been used to effectively teach math skills to elementary (Irish, 2002) and middle school (Okolo, 1992) aged students with LD. Some of the studies used computer instruction alone while others used it in conjunction with teacher led instruction, but all found that the students improved or acquired new skills in the content areas noted.

The studies noted above are just a few from the literature which have shown that typical students and students with high incidence disabilities can learn skills using well-designed software in computer-mediated applications (Fitzgerald, Koury, & Mitchem, 2008). Research also has shown that students with MSD have improved or acquired new skills using CAI. In the literature, the skills targeted using CAI with MSD students can be categorized into three broad groups: (a) self-help, (b) communication, and (c) vocational skills, with some skills falling into more than one category. See Table 1.1 for more information relating to these studies that will be discussed below.

Table 1.1 Studies using CAI with Students who have Moderate to Severe Disabilities

Reference	Participants	Dependent Variable	Procedure	Design	Results
Ayers, K. M., & Langone, J. (2002).	n = 3 6 to 10 yrs moderate intellectual disability ID	Acquisition and generalization of purchasing skills	video enhanced computer-based instruction (Dollar Plus)	Multiple probe design across tasks and replicated across students	Effective in teaching the skills.
Ayers, K. M., Langone, J., Boon, R. T., & Norman, A. (2006)	n = 4 14 yrs moderate disabilities	to teach purchasing skills & further generalization.	Computer-based instruction using prompting, pictures (Project Shop)	Multiple probe across participants design	3 of the students improved their ability to count dollar amounts
Davies, D. K., Stock, S. E. , & Wehmeyer, M. L. (2002)	n = 12 19-46 yrs mild to moderate disabilities	Reduce prompts needed to keep participants on schedule	Use palmtop pc w/schedule software to increase task completion and reduce prompting	Two group within subjects design	Improved participants ability to independently follow a schedule and reduced the use of staff prompts
Hagiwara, T., Myles, B. M. (1999)	n= 3 7-11 yrs Autism with low cognitive functioning	Improve on-task or hand washing	Multimedia social story intervention	Multiple baseline design across settings	Improved and generalized on task or hand washing behaviors
Hutcherson, K. Langone, J., Ayers, K. & Clees, T. (2004)	n = 4 14 to 16 yrs moder- ate to severe disability ID	Select grocery store items and generalize to natural setting	Computer-based instruction using prompting, pictures , & narrator (Project Shop)	Multiple probe design across behaviors and replicated across students	Improved locating items and generalization to the grocery.
Lancioni, G. E., Singh, N. N., O'Reilly, M. F., Sigafoos, J. , Oliva, D., Cingolani, E.R. (2009)	n = 3 9 to 18 years severe to profound disability ID	To choose and access environmental stimuli	A computer program and switches which allowed participant to choose and access stimuli	Multiple probe across responses design	Students were successful in using the switches to choose stimulus.
Langone, J. Shade, J., & Clees, T. J. (1999)	n = 4 13 to 15 yrs moderate to severe disabilities	Selection of grocery items (cereal boxes)	Photos used with Hyperstudio	Multiple probe across subjects design	The duration it took students to find the items decreased.

Table 1.1 (continued)

Mechling, L. C. (2004)	n = 3 13-18 yrs mild to moderate ID	to teach isle sign reading & locating items	A 5 s CTD used with a multimedia (pics & clips) computer-based instruction program	Multiple probe design	Increased fluency by reducing the need for picture prompts
Mechling, L. C. (2006)	n = 4 3 to 18 yrs Profound disabilities ID	frequency of stimulus activations, via a single switch	Comparison of the A adapted toys and devices, B commercial cause and effect software, C instructor-created video programs.	A multi element design with no baseline and a best treatments phase	Activations were greater using when using the instructor created video programs.
Mechling, L. C., Cronin, B., (2006).	n = 3 17-20 yrs Moderate to severe disability ID	order food at fast food restaurants	Used video & hyperstudio	Multiple probe design across word sets replicated across students	Students mastered targeted stimuli, learned through observational learning, and generalized the information.
Mechling, L., & Gast, D. L, (2003).	n = 3 12-18 yrs mild to moderate intellectual disability ID	teach grocery word associations and store locations	A 3 s CTD with Multi-media (video, pictures, text) instruction using *Hyperstudio*	Multiple probe design across word pairs and replicated across students	Effective in teaching generalized reading of associated word pairs and locations of grocery items
Mechling, L., Gast, D. L., & Barthold, S. (2003)	n= CA= 16-18 yrs moderate disabilities ID	use automated payment machines	3 s CTD with multimedia program (interactive, video captions, photographs)	A multiple probe design across participants	Effective in teaching generalized operation of APMs with a debit card
Mechling, L.C., Gast D. L., & Cronin, B. A. (2006)	n = 2 13 - 14 yrs autism + MMD or MD ID	task completion time	Tangible reinforcers vs. video of tangible reinforcer and reinforcers not in classroom	ABAB design	Errors were low in both conditions but, task completion time was shorter during the video reinforcement condition

Table 1.1 (continued)

Mechling, L. C., Gast, D. L., & Krupa, K. (2007).	n = 3 19 to 20 yrs moderate intellectual disability ID	Reading grocery words, matching grocery items to photos, and observational learning .	smart board with a 3 s CTD	Multiple probe design across word sets replicated across students	Students mastered words and observational learning of non-target information
Mechling, L. C., Gast, D. L., & Langone, J. (2002)	n = 4 9 to 17 yrs moderate intellectual disability ID	Read grocery aisle sign words and location of the items	SLP with multimedia program (interactive, video captions, photographs)	A multiple probe design across word sets, replicated across participants.	Students successfully learned target stimuli and generalized the skill
Meching, L. S., Gast, D., Seid, N. H., (2009)	n = 3 17 yr ASD ID (mod cognitive disability) *	Complete recipes (pizza, hamburger helper, & ham & cheese sandwich)	self-prompting PDA system using video, picture, and auditory prompt levels	Multiple probe design across three sets and replicated across students	Effective teaching multi-step tasks
Mechling, L. C., Gast, D. L., & Thompson, K. L. (2008)	n = 3 19-21 yrs moderate cognitive disability ID	Reading grocery aisle words	3 CTD Compared using SMART Board vs. traditional flash cards in small groups	Adapted alternating treatments design across two conditions and replicated across students	Both methods were effective but more observational learning occurred using the SMART board.
Mechling, L, & Langone, J. (2000)	n= 2 CA = 11, 24 yrs moderate, severe ID	Identify communicatio n pictures	SLP with a computer program (pictures, video)	A multiple probe design across behaviors, replicated across participants.	Students improved picture selection and generalized the behavior to their communicatio n devices
Mechling, L. C., & Ortega-Hurndon, (2007).	n = 3 20 to 23 yrs moderate intellectual disability ID	to teach watering plants, delivering mail, & changing paper towels	A 3 s CTD with PowerPoint, movie maker, & magic touch screen	Multiple probe design across tasks replicated across students	Found to be effective. Students learned tasks, generalized skills and maintained them.
Mechling, L. C., Pridgen, L. S., & Cronin, B. A. (2005).	n = 3 17 to 20 yrs Moderate to Severe Disability ID	verbally respond to questions and make purchases in fast food restaurants.	3 s CTD with Computer-based video instruction Using Hyperstudio and a touch screen on a laptop	Multiple probe design across participants	Students successfully learned to verbal responses and generalized and maintained the behavior

Table 1.1 (continued)

Riffel, L. A., Wehmeyer, M. L., Turnbull, A. P., Lattimore, J. , Davies, D., Stock, S., et al. (2005)	n = 4 19 to 20 yrs mild to moderate disabilities	Promoting independent performance of transition-related tasks	palmtop PC-based self directed visual and auditory prompting system (Visual Assistant)	A multiple probe across multiple-student design	The number of prompts that the participants needed to complete tasks was reduced.

*other participants were described as having a cognitive functioning level above the moderate to severe range

Many of the self-help skills that have been taught were related to community-based instruction. Research has shown the need for students with MSD to be taught self-help skills in the environment where they will be used. This can be difficult to do with limited staff, student schedules, and reduced budgets. Most of the studies relating to self-help were addressing this issue in that they used videos and or pictures from the natural environment to teach skills or improve fluency. Nine of these studies targeted shopping skills. The primary skills targeted were reading grocery words and/or locating grocery items (Hutcherson, Langone, Ayers, & Clees, 2004; Langone, Shade, & Clees, 1999; Mechling, 2004; Mechling, Gast, & Langone, 2002; Mechling, & Gast, 2003; Mechling, Gast, & Krupa, 2007; Mechling, Gast, & Thompson, 2008). Some of these studies were targeting grocery word identification to improve grocery shopping fluency with students who had been matching pictures (Langone, Shade, Clees, & Day, 1999; Mechling, 2004). One study (Mechling, Gast, & Seid, 2009) targeted cooking skills and used a palm top computer to present an activity created by the researcher that used videos, pictures, and auditory prompts. All of the studies showed positive results related to the targeted behavior.

Money skills were targeted as another self-help area, which included purchasing items (Ayers & Langone, 2002; Ayers, Langone, Boon, & Norman, 2006,) and making

debit card purchases using an APM (i.e., automatic payment machine) at grocery, pet, and clothing stores (Mechling, Gast, & Barthold, 2003). The studies used either pictures or video with prompting on the computer to successfully teach the targeted skills, which generalized to the natural environments in which they are typically performed.

Two of the studies (Mechling et al., 2007; Mechling et al., 2008) that targeted self-help skills used SMART Boards for instruction while the others used table top computers or laptops. The studies that used the SMART Boards for instruction found that it improved observational learning when compared to traditional teaching with flash cards in small groups. Other skills that fall under self-help included activating a switch (Mechling, 2006) and using switches with the computer to make choices (Lancioni et al., 2009). In the study targeting switch activation, the computer was used to show teacher-created videos and commercial cause and effect software to see their effect on students' rate of switch activation. Mechling (2006) found that students activated switches more often when reinforced with teacher-created videos followed by commercially purchased cause and effect software than when switch-activated toys and devices were used. Lancioni et al. (2009) and Mechling (2006) were 2 of the 14 self-help related studies that included students with severe to profound disabilities versus students with moderate disabilities.

Hagiwara and Myles (1999) used the computer to improve social skills through computerized social stories. The intervention involved the participants watching social stories in their special education classroom to improve hand washing and on-task behavior. As with many of the other self-help related studies, data were collected not only to see if students improved their performance on targeted behaviors, but generalized these skills to other settings.

The studies targeting self-help skills over all resulted in the students learning the targeted skill(s) and generalizing them to the natural setting. Twelve of the 14 studies included the use of photographs in the computer activity used for intervention. Two of the studies included commercially created software in the intervention, 2 used software created under a federal grant, and 10 of the studies used activities created by the researcher. In some of the studies, the same level of mastery was not found for all participants. For example, Hagiwara and Myles (1999) found that only 1 out of 3 of the participants generalized the learned skill to other environments. The researchers noted that this might have been due to the characteristics of the students' disability (i.e., autism). This was the only self-help skill related study that included students with autism. The majority of the participants were students labeled with moderate intellectual disabilities.

Although communication is sometimes considered to be a self-help skill, it was categorized separately here due to the critical speech and language needs of many students with MSD. The skills taught that fall under the communication category were identifying pictures to use with augmentative communication (Mechling & Langone, 2000) and ordering fast food (Mechling, & Cronin, 2006; Mechling, Pridgen, & Cronin, 2005). While the studies related to self-help targeted mostly students with mild and moderate disabilities, these three studies targeting communication all involved students with not just moderate but with severe disabilities. All used computer activities that were created by the researchers and used a combination of video and still pictures. The subjects learned the targeted communication skills and generalized using the pictures on their communication devices in the natural environment where they would be used.

The remaining studies in the literature that used computers for instruction with students with MSD relate to vocational skills. These skills include improving task completion through the use of computer-based video clips for reinforcement (Mechling, Gast, & Cronin, 2006); teaching multiple step job tasks, such as delivering mail and watering plants (Mechling, & Ortega-Hurndon, 2007); and teaching transition or vocational related tasks using a palmtop PC (Cihak, Kessler, & Alberto, 2008; Riffel et al., 2005). Some of the skills taught using the palmtop PC included setting tables, doing laundry, cleaning windows, making cookies, vacuuming, indicating to an adult a task was finished, and packaging. Two of these studies (Davies, Stock, & Wehmeyer, 2002; Riffel et al., 2005) used commercially purchased software, two used researcher created videos (Mechling et al., 2006; Mechling & Ortega-Hurndon, 2007), and all used still pictures. All studies also resulted in positive outcomes regarding the targeted behaviors.

Some of the studies that used computers to teach students with MSD involved skills that relate to functional academics, such as grocery word identification, and readiness, such as task completion. Only one of the studies targeted skills directly relating to general education academic content (i.e., counting money). None of the studies targeted academic areas of social studies or science content.

Response Prompting Procedure

One strategy that is used to teach a variety of skills to students with MSD is time delay. Time delay, which includes constant time delay (CTD) and progressive time delay (PTD), is a prompting procedure that has been found to be effective in teaching a variety of skills to students with disabilities, including those with MSD (Wolery, Ault, & Doyle, 1992). When using the CTD procedure, the student is given a stimulus followed by an interval to make a response. Initially, the response interval is 0 s, which allows the

student to practice producing the correct response to the task direction, after which the response interval is increased to a larger set time (e.g., 5 s). Examples of skills that have been taught to students with MSD using time delay include word definitions (e.g., Schuster & Stevens, 1990), chained tasks involving food preparation (e.g., Godsey, Schuster, Lingo, Collins, & Kleinert, 2008), and safe handling of potentially dangerous materials (e.g., Collins, & Griffen, 1996). Seven out of 21 of the studies that taught skills using CAI to students with MSD identified the use of some form of time delay in the intervention. As previously noted, none of these studies targeted regular education academic content, but all had successfully taught students to acquire skills or improve fluency using both CAI and a time delay teaching procedure.

Instructive Feedback

The use of instructive feedback has been found to be effective when used with CTD to teach students with MSD. Instructive feedback is a teaching strategy used to improve the efficiency of teaching where information is strategically included into one or more of the following places: (a) the antecedent, (b) the prompt, or (c) the consequent event of an instructional trial sequence (Collins, 2007). This procedure has been found to be effective in promoting the acquisition of extra information both related and unrelated to the target stimuli (e.g., Fiscus, Schuster, Morse, & Collins, 2002).

Research Question

The research studies described support the effectiveness of teaching skills to students with MSD using CAI. The research literature also shows the effectiveness of time delay in teaching a variety of skills to students with MSD and that the use of instructive feedback can make teaching more efficient. The research literature involving the use of CAI with students with MSD presently has not focused on teaching general

education academic content with the exception of some functional skills related to academic skills or content. No published studies have addressed teaching general education science content to students with MSD beyond those linked to science standards, such as self-help and safety skills (Courtade, Spooner, & Browder, 2007). None of the science-related studies involved CAI. This investigation was designed to answer the following questions: (a) Will students with MSD acquire general education science content when taught using CAI and a CTD procedure? (b) Will the students acquire related instructive feedback placed in the consequence event? and (c) Will the students maintain and generalize the information?

Chapter Two

Method

Participants

Students. The participants included in this study were 7 students from two special education classrooms for students with MSD. The schools, Blue Elementary and Cohen Elementary, were located in rural settings located in close proximity to the researcher's university. The participants from Blue Elementary included 2 males and 2 females, their ages ranging from 8 to 11 years. The participants from Cohen Elementary included 2 males and 1 female, their ages ranging from 7 to 9 years. Participants were chosen based on their age, ability to use a computer, ability to attend to a task for at least 5 min, ability to follow one-step directions, and current or future participation in the state's alternate assessment on alternate achievement standards that assesses science content knowledge. The computer skills needed to participate in this study included the student's ability to view materials on the computer monitor, use a mouse, hear information presented on the computer with headphones (used to reduce distractions in the classroom), and listen and click the correct location on the screen to respond to the computer prompt. Alternate keyboards were not used in an attempt to reduce the interference of other variables on the results and because none of the students participating typically used an alternative keyboard in place of a mouse. One student from Blue Elementary pointed to the answer on the computer screen and the teacher clicked his response, as this was how the student had been responding on the computer since the classroom touch screen broke several months before the study began. Permission for the students to participate in this study was gained from their legal guardians using the permission form that can be found in Appendix A.

Blue Elementary. Abbie was a 10 year 6 month old female diagnosed as having moderate mental disability. She had an IQ of 51 that was obtained from the WISC-III (Wechsler, 1991). Abbie could follow simple directions and walk to inclusive classes independently. She was included in a general education class for recess, lunch, science, physical education, art, and music. She worked on an Edmark computer-reading program with minimal support when she was in the special education classroom. Abbie could attend for minimum of 5 min and use a mouse on the computer.

Elijah was an 11 year 2 month old boy diagnosed as having moderate mental disability. He had an IQ of 54 that was obtained from the WISC-III (Wechsler, 1991). Elijah could follow two-step directions and walk to inclusive activities independently. He was included in a general education class for recess, lunch, science, physical education, art, and music. He typically followed directions, but could easily be distracted from tasks. He worked on an Edmark computer reading program independently when he was in the special education classroom. Elijah could attend for a minimum of 5 min and use a mouse on the computer.

Blair was an 8 year 3 month old girl diagnosed as having a moderate mental disability. She had an IQ of 48 that was obtained from the WISC-III (Wechsler, 1991). Blair could follow familiar one-step directions and often need support to walk to inclusive activities due to behavior concerns. She was included in a general education class for recess, lunch, science, physical education, art, and music. She followed directions, but at times exhibited inappropriate behaviors to gain attention. She worked on an Edmark computer reading program with minimal support when she was in the special education classroom. Blair could attend for a minimum of 5 min, occasionally needing verbal reminders to stay on task, and she could use a computer mouse.

Christian was a 9 year 7 month old boy diagnosed as having autism. He had obtained an IQ score of 46 from the WISC-III (Wechsler, 1991). Christian could independently follow familiar one-step directions but needed prompting with unfamiliar directions. He could walk to inclusive activities independently but needed support once he was in these settings. He was included in a regular education class for recess, lunch, science, physical education, art, and music. He could easily be distracted from tasks and could quickly become agitated. At the time of the study, Christian began exhibiting more inappropriate behaviors than in the past, including yelling, refusing to comply with requests, and hitting. He worked on an Edmark computer reading program with support when he was in the special education classroom. Christian could attend for a minimum of 3 min and typically longer, but he often required verbal prompts to stay on-task. He could listen to the computer and indicate his answer by pointing to the computer screen.

Cohen Elementary. Jack was an 8 year 5 month old boy labeled as having a functional mental disability. He had an obtained IQ score of 50 from the WISC-III (Wechsler, 1991). Jack could independently follow familiar one step directions, but needed help with novel directions. He transitioned to the following inclusion classes independently; recess, lunch, physical education, art, music, science, and social studies. He needed help following directions, completing tasks, and staying on task when in the general education setting. Jack could attend for 5 min or more, but needed verbal prompts to stay on task for new or difficult activities. He could use a computer mouse to make choices.

Kenzi was a 7 year 7 month old girl labeled as having a developmental delay. She did not have an obtained IQ score yet, but tested in the 1st percentile on the *Developmental Inventory*. She could independently follow familiar one-step directions

but needed prompting with unfamiliar directions. She attended the following general education activities with support; recess, lunch, music, physical education, art, social studies, and science. She was easily distracted from tasks and could become fixated with certain objects, including shoes. Kenzi could attend for a minimum of 3 min, but she often required verbal prompts to stay on-task. She could listen to the computer and use a mouse to make choices on the computer.

Derek was a 9 year 6 month old boy labeled as having a moderate mental disability. He had an obtained IQ of 48 from the WISC-III (Wechsler, 1991). Derek used a wheelchair with little support. He had a degenerative condition that affected his central nervous system. He was included in the general education setting with support for lunch, recess, art, music, physical education, science, and social studies. He could follow familiar one step directions, but needed help with more complicated directions or physical support. Derek could attend for a minimum of 3 min and use a mouse to respond on the computer.

At the time of the study, all students were to be taught and assessed on regular education core content as a requirement of NCLB. As such, the students included in the study were receiving lessons targeted at teaching the state science standards in an inclusive general education classroom and/or in a special education resource classroom. None of the participants received direct instruction, including errorless learning procedures (i.e., CTD or other response prompting procedures), on the targeted skills outside of the intervention in this study until after they reached criterion on the skill as part of the intervention in this study. By the intervention taking place before the student received other instruction on the targeted stimuli, the interference threat to internal validity was reduced.

Once the teachers chose students they believed had the prerequisite to participate, the researcher interviewed the participants' teacher and observed the students at a computer activity in an attempt to ensure they had the behaviors needed to participate in the study. The computer activity was an Intellitools activity created by the researcher that focused on animal identification (i.e., cat, dog, and fish) where the students were required to exhibit the behaviors needed to participate in the study.

Staff. The classroom teachers collected data on the flash card and real object probes. The classroom teachers also collected data during each session to ensure the computer was working correctly and the student was attending to the computer. The teacher at Blue Elementary was a female who had completed her degree in teaching students with MSD and had completed 20 hrs towards her masters' degree in MSD. She had been an elementary classroom teacher for students with MSD for 5 years at the time of the study. The teacher at Cohen Elementary was a female who had completed her master's degree in MSD. She had taught elementary students with MSD for 16 years. The researcher was a female who had a master's degree in teaching students with moderate to severe disabilities and had finished the coursework needed to obtain a doctorate in Special Education. She had taught students with MSD at the elementary level for approximately 12 years and had collected reliability data for three research projects, not including this study. The researcher, who was familiar with reliability collection, collected both the inter-observer and procedural reliability for probe and instructional sessions.

Skill Selection

Three science standards were chosen from the list of standards that were used for both the general education curriculum and the alternate assessment for students with

MSD in the state where the research took place. The three standards were chosen based on whether key points from the standard could be represented visually on the computer, therefore avoiding abstract concepts that would be difficult to depict with pictures on the computer. The researcher also chose standards which, based on her teaching experience, were easier in general for students with MSD to acquire with some degree of proficiency. This was done to try to avoid standards which might be difficult for students with MSD to master, no matter how they were instructed on the material. The standards chosen also had at least three main pieces of information that could be used for instruction. The three standards were (a) "States of Matter" (i.e., solid, liquid, and gas), (b) the "Food Chain" (i.e., consumer, producer, and decomposer), and (c) the "Life Cycle" (i.e., beginning, growth development, and reproduction). See Table 2.2 for more information about the standards. For example, with the concept of "States of Matter," the targeted stimuli were identifying pictures as to whether they were a solid, liquid, or gas, and there was one piece of non-targeted information for each stimulus. A list of the stimuli can be found in the third column in Table 2.3. The fourth column on Table 2.3 lists the non-targeted stimuli that were presented as instructive feedback at the end of each trial.

Table 2.2 Kentucky Science Standards Chosen for Instruction

Standard	Targeted Concepts from Standard
SC-04-1.1.1 Students will explain how matter, including water can be changed from one state to another. Materials can exist in different states- solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling. Resulting cause and effect relationships should be explored, described and predicted.	Solid, liquid, gas

Table 2.2 (continued)

SC-04-3.4.3 Students will compare a variety of "Life Cycles" of plants and animals in order to classify and make inferences about an organism. Plants and animals have "Life Cycles" that include the beginning of life, growth and development, reproduction and death. The details of a "Life Cycle" are different for different organisms. Models of organisms' "Life Cycles" should be used to classify and make inferences about an organism.	Beginning, growth and development, and the reproductive stage
SC-04-4.6.1 Students will analyze patterns and make generalizations about the basic relationships of plants and animals in an ecosystem ("Food Chain"). Plants make their own food. All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants. Basic relationships and connections between organisms in "Food Chains", including the flow of energy, can be used to discover patterns within ecosystems.	Producers, consumers, and decomposers

Table 2.3 Targeted, non-targeted, and generalization stimuli

Standard	Targeted Concept	Stimuli Used to Teach Concept	Non-targeted Stimuli	Generalization Stimuli
States of Matter	Solid	apple, books	ball	Cup
	Liquid	water, orange juice	paint	milk
	Gas	steam from pot and tea kettle	air	air from a balloon
Life Cycles	Beginning Stage	butterfly eggs, frog eggs	plant seeds	*praying mantis soft egg case
	Growth & Development Stage	caterpillar, pollywog	seedling	*praying mantis nymphs
	Reproductive Stage	butterfly, frog	producing plant	*adult praying mantis

Table 2.3 (continued)

The Food Chain	Producers	grass, plant	tree	plant
	Consumers	dog, cow	people	beta fish
	Decomposers	mold, fungi	worms	molded bread

*As noted in text, life size plastic replicas were used. A picture can be found in Appendix J.

Instructional Setting and Arrangement

The sessions took place in the students' special education classrooms. There were two types of probe sessions (a) teacher probe sessions, and (b) computer probe sessions. For the teacher probes using flash cards and the real object probe session trials, the students were seated with their teacher at a table in the special education classroom with the students' backs to the classroom to reduce distractions. For computer probes and the intervention sessions, the students were seated at the classroom computer with their backs to the classroom. The classroom teachers stayed in close proximity (within a foot on the students' left or right side) to see the computer and to provide support, if needed (e.g., fix issues with the computer or redirect the student to attend to the task). A divider was used for one student (i.e., Kenzi) to block visual distractions in the classroom. The investigator sat behind the students and to their right when reliability data were collected.

Materials and Equipment

The materials needed for the teacher probes included flashcards, real objects, and probe data collection sheets. The researcher created the flashcards using 3 in. x 5 in. white unlined index cards and professionally printed copies of the pictures used in the computer probes and instructional activities. The pictures were approximately 3 in. x 3 in.

and were printed in color to resemble as close as possible those used in the program. The cards were laminated to increase durability during the study.

The researcher created three activities for the intervention using the *Classroom Suite* software by Intellitools. Each activity targeted a chosen concept. A list of the concepts and targeted stimuli are found in Table 2.3. The first screen for each activity was the title page where the students heard what the targeted concepts were for that activity. On the second page, which looked like the first trial screen, the students heard the instructions for the activity. On this page, the students were told the concept on which they were working, what was going to happen, and what they were expected to do. The screen automatically changed, and the students were presented with the first screen of a trial. The first screen for all trials had a black background and three pictures in a row in the middle of the screen with ¼ in. between the pictures. The pictures included the targeted stimuli and two distracters. They were told to "Click on the picture of a _____." For 0-s delay trials, they were automatically taken to a screen with a black background where only the correct picture was visible, and they were told to "Click on the picture of ___." Once they clicked on the picture, they were taken to a screen with a white background which showed the three pictures of the concept that were used in the activity and audio instructive feedback was presented. During the 5-s delay trials, the students were given 5-s to find the correct picture from the initial trial screen with three pictures. If they clicked on the correct picture, they received verbal praise. Then, the screen changed to the screen with the white background that showed the three pictures of the concept that were used in the activity, and they heard instructive feedback. After 3-s, the students were shown the next trial screen. If they did not respond or they responded incorrectly, they were taken to the screen with only the correct picture visible, were told

to "Click on ___," and had to click on the correct answer before they were taken to the instructive feedback screen. This pattern continued until the students had been presented with four trials on each of the three-targeted stimuli for a total of 12 trials. See Appendix H for examples of screen shots and Appendix I for an example script of a trial.

The computer activity used to probe the targeted stimuli and instructive feedback was visually comparable to the instructional activity except the students were only shown the first screen of a trial (i.e., a black background with three pictures in the center of the screen). They were told to "Click on the _____," and they had 5-s to click on a picture before the program automatically advanced to the next trial.

Identical sets of real objects were used in both classrooms to test for generalization of the mastered concepts. For the "States of Matter" concept, a baby food jar containing milk was used for liquid, a small yellow cup was used as a solid, and a balloon filled with air was used for gas. When using the balloon, the teacher would hold the opening of the balloon near the student's hand and let out some of the air so they could feel the air. Since having a set of identical examples of the "Life Cycle" would be difficult to obtain each time a student needed to be probed, it was decided to use life size plastic replicas of the praying mantis "Life Cycle." The examples chosen were the soft egg case, nymphs, and the adult replica. See Appendix J for a picture of the replicas. For the "Food Chain" examples, a small plant was used as a producer, an orange goldfish was used for a consumer, and a moldy piece of sliced white bread in a plastic sandwich bag was used as a decomposer. In addition, the classroom teachers used the data sheet found in Appendix B to collect probe data.

For the computer probes and instructional sessions, seven computer activities and the on-task and probe reliability data sheets were needed. The researcher created the

seven programs (i.e., a probe, a 0-s delay activity for each tier, and a 5-s delay activity for each tier) using the *Intellitools Classroom Suite* software. This program was used to create the computer activities because of its ability to input pictures, include instructive feedback, and collect data on student responses; its availability in many MSD classrooms; and the availability of a website where teachers can share programs online that they have created. The online sharing site could improve the dissemination of the programs that could be modified for individual students who might be suited for this type of instruction based on the results of this study. The CAI programs that were created for this study included features that have been used in studies that resulted in the acquisition of skills or improved fluency. The features included were the use of sound and pictures (Hitchcock & Noonan, 2000; Mechling, Gast, & Krupa, 2007). The activities created included an activity which probed both the targeted and non-targeted stimuli, a 0-s delay activity for each concept for a total of three 0-s activities, and a 5-s delay activity for each of the concepts for a total of three 5-s activities. The teacher also used the on-task data sheet found in Appendix F to record if the student was on-task and/or the computer activity was running correctly.

A usability test was performed with an elementary student with MSD and a typical preschooler after the initial programs were completed. Both students were evaluated for their ability to navigate the program and were asked questions relating to how they liked the activity, whether they understood what they were supposed to do, if they could identify the pictures, and whether the voice used was easy to understand. A professor from the researcher's affiliated university and the professor's class of doctoral students who were studying technology and program evaluation performed a heuristic evaluation on the computer activities. The suggestions reported by participants in both

activities were applied to the computer program before implementation. These suggestions included clarifying some of the pictures and simplifying some of the language used in the computer activities. The programs were designed with the same black or white background on all pages and the same computer voice; a CTD procedure was used in each program. The programs also used real pictures from the Internet instead of line drawings in an attempt to present the concepts as clearly as possible and due to the fact that some of the participants may not have been ready to learn using line drawings.

The other materials needed for the study included reliability data sheets, a notebook to store student graphs, student graphs, a folder to store the on-task data sheets, and a flash drive used to store computer data from each session. Reliability data sheets were created for the teacher probes, the computer probes, and the instructional sessions. A copy of the teacher probe session reliability data sheet can be found in Appendix C. Copies of the probe and instructional session reliability data sheet can be found in Appendix D and E respectively.

General Procedures

The students were probed on the target stimuli and nontargeted information both on the computer and by their classroom teacher using flash cards. They were probed off the computer in an attempt to ensure that the students truly did or did not know the information and rule out interference due to the presentation of the information on the computer. This also provided data as to whether stimuli mastered on the computer generalized to other presentation formats. The students were probed on all stimuli approximately a day before the intervention began and again within a day after the students reached criteria on a concept.

Sessions were conducted during the school day in the students' classrooms. Most sessions were conducted twice each day unless the students' schedules did not permit. The probe sessions lasted less than 10 min, and the intervention sessions lasted no more than 5 min. All sessions were conducted in a 1:1 format with one student at a time working with either the teacher for probe sessions, or on the computer with the teacher monitoring. For all sessions on the computer, the classroom teacher called or brought the students to the computer, waited until they were seated, and reminded them that they were to listen to the program and use the mouse, when needed. The students were then prompted to click on their names and the correct activity they were to complete that session. The classroom teachers were stationed behind the students in a position where they could observe and monitor the computer and the students. At the end of the sessions, the teacher verbally praised the students for working hard and had the students log off the computer. The researcher saved the students' data on a flash drive at the end of each week and transferred the data from the sessions to each participant's graph.

Baseline/Probe Procedures

Computer probes. Students were probed on the computer for both targeted stimuli and non-target stimuli used as instructive feedback. The first screen of the probe activity told the students what concepts the activity targeted and explained to them that they needed to listen to the questions and click on the picture that best answered the question correctly. The activity then automatically went to the first screen of a probe trial on which three pictures were presented and the students were asked to find the targeted stimuli. A star was used to record a correct response, an "X" for incorrect responses, and "NR" for no responses. Students were probed on the two examples used in the intervention activities for each of the nine concepts for a total of 18 trials. See Table 3 for

a complete list of stimuli. The computer presented the six trials for the "States of Matter" concepts, then automatically started to probe the stimuli for the concepts of the "Life Cycle" and, finally, the stimuli for the "Food Chain," for a total of 18 trials. The computer reinforced the students verbally for on-task behavior on a fixed ratio of every 3 trials (FR3).

Once the students completed the probes for the target stimuli, the instructive feedback probe began. The students were probed for three non-targeted stimuli for each of the three targeted standards for a total of nine non-targeted stimuli. For example, there were three non-targeted stimuli for the "States of Matter," one each for solid, liquid, and gas. See Table 2.3 for a complete list of the non-targeted stimuli. As in the targeted stimuli probe, the students were reinforced verbally by the computer for on-task behavior on a FR3 schedule. The students received no feedback regarding their responses.

Teacher probes. At the beginning of the probe sessions, the students were told that they were going to look at some pictures relating to science, were asked some questions, and were told that they were to find the picture that best answered the question correctly. The students were probed using flashcards of pictures that were identical to those used in the computer activities. They were shown three pictures, including that of the correct answer and two distracters, and asked to "Find the ____." The students were given 5 s to choose a picture either by pointing, touching, or verbally labeling the picture before the next trial was presented. The students received no instructive feedback on their responses just like in the computer probes. The same 18 targeted stimuli and 9 instructive feedback pictures that were probed on the computer were probed using flashcards.

Following the stimulus, if the student pointed to, touched, or verbally labeled the correct picture, a "+" was recorded on the teachers probe data sheet. If the student

responded incorrectly after the stimulus was given by pointing, touching, or labeling a picture other than the correct picture, a "-" was recorded on the data sheet. For example, if the student was shown pictures of water, a ball, and steam and asked to find the picture of a gas, the answer was recorded as correct if the student pointed to or touched the picture of steam or said, "steam." If a student did not touch and or label any of the three pictures within 5 s, "NR" for no response was recorded for that trial. The student was reinforced for on-task behavior on a variable reinforcement schedule of 3 (VR3). The student was considered on-task if he or she was looking at the pictures or the researcher, sitting in his or her seat, and appeared to be listening to the teacher, which was defined as responding appropriately to directions (i.e., touching a picture, eyes on the cards, or eyes on teacher). A sample of the teacher probe data sheet can be found in Appendix B. The researcher graphed all data and kept both the probe sheets and the graphs in a notebook that the researcher kept.

Instructional Procedures

The students were seated at the computer and told that they were going to work on science. If the computer program was not already started, the teacher started the program and told the students to click on their names. The teacher then pointed to the computer activity the students needed to complete that session and the students clicked on the activity. If a problem occurred with the program (e.g., no sound, activity shuts down, etc.) during the instructional session, the teacher closed the program, then reopened the program and restarted the activity.

A CTD procedure was used to teach the targeted stimuli. The students participated in three sessions at a 0-s delay interval. All trials were presented with a black background and three responses in the middle of the screen (i.e., the correct response and

two distracters). During the 0-s sessions, the students were presented with this screen and asked to "Find the ___," after which the screen automatically changed to a screen with only the correct answer pictured on a black background for the students to click. After clicking on the correct answer, they were shown a page with a white background and pictures of the two targeted examples of the concept. This page also included a picture of a third example that was presented as instructive feedback. The students also heard each picture verbally labeled according to the concept it represented. A list of all examples used for each concept can be found in Table 2.3.

All subsequent sessions employed a 5 s delay interval until the students reached criteria on the targeted stimuli. If students did not select the correct picture within 5 s or they selected an incorrect answer, the students were shown a page that showed only the correct answer for them to choose so that the students always practiced choosing the correct response. If the students chose the incorrect response, they heard, "No, ____ is _____," and were shown a screen with only the correct picture and heard, "____ is ____; click on the ____." When they clicked on the correct picture, the screen changed to the screen with a white background where they saw and heard the instructive feedback.

If the students clicked on the correct response, the students were verbally reinforced and taken to the screen with the white background that showed pictures of the two targeted stimuli, and the instructive feedback (i.e., the third example). The students were shown this screen at the end of each trial. The students were not only shown all three examples, but heard the concept and the pictures labeled. For example, at the end of a trial for "solid," the students were taken to a page that showed a picture of an apple, books, and a ball. They also heard, "Apples and books are solid matter. A ball is also a solid." An example of an instructional trial can be found in Appendix I.

The students were given two trials for each of the six stimuli (i.e., two for each concept) for the standard receiving instruction, for a total of 12 trials each session. The location of the correct answer varied randomly for each trial from the first, middle, or last spot. Once students reached criteria on a concept, they were probed on all three concepts before beginning intervention on the next concept. Due to school ending, a probe to check for maintenance and generalization after the students reached criteria could not be completed.

The computer sessions lasted less than 10 min for probes and less than 5 min for instructional sessions, depending on how fast students progressed through the program. The computer program collected data on the student responses, and these data were stored on a flash drive at the end of each school week. Sessions typically were conducted twice each day (i.e., once in the morning and once in the afternoon). The investigator collected procedural and inter-observer reliability data a minimum of once for every condition.

Maintenance Procedures

Due to the end of the school year, time did not allow for the students to be probed after reaching criteria on all standards to check for maintenance.

On-task and Computer Functioning Data Collection

The classroom teacher collected data every 2 min to record whether the computer program was working correctly and if the student was on-task. A check mark was placed next to the word "computer" on the data sheet if the computer program was working correctly (i.e., the program was advancing appropriately and the sound was working correctly). A " - " was recorded in the correct column if the computer was not working correctly, and a note was made on the data sheet identifying what was not working

correctly. After recording on the data sheet whether the computer was working correctly or not, the teacher then looked at the student and record a"+" if the student was on-task and a "–" if the student was off-task. These data were noted on the data sheet next to the word "student." On-task was defined as students having their hand on the mouse, sitting in a chair, and looking at the computer at least once within 3 s. The last criterion was included so that students were not penalized if they looked away for a second but were still listening to the computer program. A copy of this data sheet can be found in Appendix F.

Generalization Procedures

The students were shown pictures of three examples of the targeted concept to increase the chances of generalization. The students received instruction on two of the examples and the third example was presented as instructive feedback. The instructive feedback screen for a concept (e.g., solid) that was presented at the end of each trial showed the students pictures of all three examples, and each was verbally labeled. The examples chosen were ones commonly used in elementary settings so that there was a high probability that the students would have seen them or would likely be exposed to them in other settings in the future.

Experimental Design

Experimental control was evaluated through the use of a multiple probe design across behaviors replicated across subjects (Holcombe, Wolery, & Gast, 1994; Murphy & Bryan, 1980). A multiple probe design across three science standards replicated across students was used in this study. Students were probed on the science standards 1 day prior to the beginning of intervention. A 0-s delay interval was used for a minimum of 3 days after which a 5-s delay interval was used until students reached the criteria of 100%

independent correct responses on all trials. The students were probed within 4 days (due to weekends, holidays, and absences) of reaching criteria on a standard. The students were probed individually on the science standards. They were probed as described above on both the computer and with the teacher using flash cards and real objects. Experimental control was demonstrated through the multiple probe design when a student did not show change in the acquisition of the target stimuli until the intervention is implemented. The intervention was replicated both across students and stimuli in an attempt to demonstrate stronger internal validity due to the target behaviors being irreversible. The intervention was implemented in a time-lagged fashion to control for variables other than the intervention (e.g., the students receiving instruction on the target stimuli in another setting) being responsible for the therapeutic change.

Reliability

Prior to implementation of the intervention, a fictional student account was created to check the reliability of the computer activities. The student account was assigned the following activities: (a) a probe, (b) a 0-s delay interval for each of the three targeted concepts (i.e., "States of Matter," "Life Cycles," and the "Food Chain"), and (c) a 5-s delay interval activity for each of the three targeted concepts. A child not in the study was asked to complete each of the activities, and reliability data were collected on the following variables: (a) directions presented, (b) correct trials were presented, (c) correct delay interval was used, (d) correct screens were presented each trial, (e) correct feedback was given, and (f) the student response was recorded correctly. This was done twice, and the data showed 100% accuracy on all variables for both dependent and independent reliability.

Prior to implementing the program, the investigator loaded each program on one computer in each classroom. The investigator then created accounts for each student on the program and assigned each student the appropriate activities (e.g., probe, 3 sessions 0 s delay interval "Life Cycle"s, and 5 s delay interval "Life Cycle"s sessions). The investigator went through each assignment for each student to ensure the program was working correctly. This was done each time new activities were assigned to a student for a new set of stimuli. No procedural errors were found in the activities when they were assigned.

Reliability data were collected on both computer sessions and teacher probes once the study began. Reliability data for both were collected on the independent and dependent variables (Billingsley, White, & Munson, 1980; Tawney & Gast, 1984) a minimum of once per condition by the researcher who had experience in data collection. The researcher collected these data on the same data sheet.

Independent variable reliability. Independent variable reliability data were collected for the computer sessions on the following variables: (a) directions given, (b) correct screen presented each trial, (c) correct number of trials presented, and (d) feedback presented. Independent variable reliability agreement was calculated by dividing the number of observed behaviors by the number of planned behaviors and multiplying by 100 (Billingsley et al., 1980). Independent variable reliability data were collected on 18 probe sessions and 37 instructional sessions on the computer. A 100% agreement on all variables was reached on both probe and instructional computer sessions.

Teacher probe reliability data were collected four times for 3 of the students, three times for 1 student, and one time each for the 3 students at Cohen Elementary for a total

of 18 sessions. Independent reliability data were collected on the following variables: (a) Were the materials ready? (b) Was student attention gained before presenting the trial? (c) Was the trial presented? and (d) Was verbal praise delivered on a VR3 schedule? A copy of the data sheet can be found in Appendix B.

Independent reliability data across the 7 students ranged from 95% to 100% with an average of 99% across the 18 teacher probes in which reliability data were collected. The error that occurred most often was that the teacher did not deliver praise on the VR3 schedule that was highlighted on their data sheets. This occurred eight times where the teacher reinforced on-task related behaviors either more than scheduled or for one student less than was scheduled for that probe session. This error occurred a maximum of two times in a single probe session. The remaining eight errors were due to not gaining the student's attention before delivering the trial.

Dependent variable reliability. Dependent variable reliability data were collected at the same time as independent variable reliability data. A point-by-point method was used to compute the dependent variable reliability on participant responses. The following formula was used to compute percentages of agreement: number of agreements divided by the sum of agreements plus disagreements and multiplied by 100 (Tawney & Gast, 1984). There was a 100% agreement on student responses for all of the 18 computer probe sessions. With the exception of one session, there was 100% agreement on all responses for the instructional sessions for an average of 99.7%. For the one session where there was 92% instead of 100% agreement, the computer recorded a "no response after the prompt" and the researcher recorded a "correct response after the prompt." It was determined that the student clicked the correct response at the end of the 5-s interval, and, therefore, the computer did not record the response after the prompt.

The student still had to click on the correct response so that a correct response was practiced before the screen changed to the instructional feedback screen. Since it is important for the students to respond correctly within a certain amount of time, it was decided that no changes needed to be made. It is important to note that this occurred with Elijah from Blue Elementary who was able to master all three tiers of stimuli.

During the study, the investigator examined each student's data on the computer a minimum of once per week. The computer data reported the following information: (a) the student's name, (b) title of the activity, (c) time and day of the session, (d) student response, and (e) correct response for each trial. From these data, the investigator could see how many trials the student answered correctly, incorrectly, or did not respond and if he or she did so before or after the prompt. After recording the summary of these data in the study notebook and graphing the data on each student's graph, the investigator then copied these data into a word document and saved them on a flash drive.

Upon examination of these data, there were seven occurrences where student had clicked to save the changes to the activity, the activity had been reassigned to him or her, and his or her responses had been saved to the activity so that their new responses were counted as errors. The researcher could tell this had happened when she looked at each response individually and could see there were two answers recorded. For example, the trial required the student to click on the "solid," and, the last time, the student had clicked on "water," but, this time the student, clicked on "ball." On the student response data for this question, the blank would show "ball water" with the first word being the latest response. The latest response would be used, and the researcher would correct the problem in the activity. This occurred because the students had been allowed to close out of the program once they completed it; it was determined that their practicing

independence was important, and the correct student response was still being recorded and could be easily identified. The computer program still went to the correct screen; this issue just related to how the computer program collected data and required closer examination of the data.

Dependent variable reliability data were collected on 18 of the teacher probe sessions. Reliability data were collected on four teacher probe sessions for 3 of the students, three sessions for Christian, and one session each for the students at Cohen Elementary. There were seven non-agreements across the 15 teacher probes sessions at Blue Elementary. For five of the sessions (one session each for Abbie, Blair, and Christian and two sessions for Elijah), there was one trial where the researcher and teacher did not agree on the student response. In Blair's first probe session, two non-agreements were recorded. The researcher sat in a position close enough to the teacher so that the teacher data sheet was visible. From researcher observation, five of the errors appeared to be late responses in which the teacher and researcher disagreed if the answer was given within the 5-s interval. The remaining two errors were simply disagreements on the student's response. The resulting reliability ranged from 94% to 100%, with an average of 92% across the 15 sessions in which reliability data were collected. There were nine sessions with 100% agreement.

At Cohen Elementary, there were three non-agreements across the three teacher probe sessions. All three non-agreements were on Jack's probe session. From the researcher's observation, these errors appeared at the end of the 5-s interval and the teacher and researcher disagreeing as to whether the response was before or after the 5-s had passed. The resulting reliability ranged from 92% to 100%, with an average of 97% across the three sessions. There were two sessions with 100% agreement.

During the previous summer, Christian had been allowed to stand while working on the computer and used a touch screen. The student's present classroom did not have access to a touch screen, and he would not sit or touch the mouse; so he was allowed to touch the screen, and the teacher clicked the mouse to select his answer. Due to time and money constraints, it was not possible to either replace the touch screen or teach him to use a mouse. For this student, reliability data were collected on the accuracy of the teacher clicking on the picture to which the student pointed on the screen. This was calculated by taking the number of agreements divided by the sum of agreements plus disagreements and multiplying by 100 (Tawney & Gast, 1984). These data were collected once per week and once during each probe, and the result was 100% agreement. Due to the simplicity of the program, the teacher was able to click on the student's choice within 1-s of his indicating his choice. Response latency did not become an issue due to Christian typically responding immediately following the question or waiting until the correct response was provided.

Computer Functioning

The computer program worked correctly 100% of the time for all students except for two, Christian and Jack. For Christian, the computer froze four times during the first week of instruction, resulting in his computer working correctly 97 % of the time. For three of the times, the student made it to the third trial, and, the final time, he made it only to the second trial. Each time, the teacher restarted the program and began from the beginning. Two of the sessions were 0-s delay intervals so the student had extra practice on those trials. The other two incidents were during instruction with a 5-s delay interval, which meant the data for those trials (2 for one session and 1 for the other) were lost. After the first two incidents, the researcher tried to delete and then reassign the activities

to the student's account. This did not solve the problem so all of Christian's data were recorded and saved to a word file after which the student's account was deleted, recreated, and the activities once again assigned to the student. The problem did not occur again after this was done, but a cause could never be determined. For Jack, the computer froze unexpectedly during his first 0-s delay session. The activity was restarted and the problem did not occur again.

Chapter Three

Results

In this section, mastery of target stimuli and by which participant/s/ is discussed. Any issues that arose with certain stimuli or participants are noted as well. This section will report how many sessions were needed for each student to reach criterion on each of the three tiers of stimuli. Any differences between computer and teacher probes are reported. In addition, this section will report which students were able to master the nontargeted stimuli and generalize mastered concepts to real life examples. Any noted similarities or differences between real life examples that were or were not mastered also are reported. Maintenance is not discussed, as none of the participants were able to reach criteria on all three tiers within enough time before the school year ended to assess maintenance.

The 4 participants from Blue Elementary made progress mastering the non-targeted stimuli. Blair reached and maintained 100% correct responses on the second tier for all probe sessions except the initial teacher probe session after she met criterion on the second tier. The other participants had varying degrees of mastery of the non-target stimuli, although all made progress compared to the data from their initial probe sessions.

For the generalization of concepts to real objects, the participants from Blue Elementary all had higher percentage of correct responses on their final probes compared to their first set of probes. The range of correct responses on the probes for all participants ranged from 0% to 100%. Abbie and Blair had a 100% average of correct responses for Tier 2 after intervention and maintained 100% correct on their final probe sessions. Abbie also had three other sessions at 100% on the last set of probes across the Tier 1 and Tier 3 real object probe sessions. Elijah averaged a 100% on Tier 3 on his final

probe sessions. Elijah had a total of six individual sessions across tiers and probe sessions where he had 100% correct responses. Christian's highest average score on a real object probe was 89% with the range during that group of probe sessions being from 66% to 100%. Generalization was not able to be assessed for the students at Cohen Elementary as none of the students reached criterion on Tier 1 before the school year ended.

In regard to teacher- versus computer-probes, the data were inconsistent. For the non-targeted stimuli, many of the students had higher probe scores on the first set of teacher probes when compared to the computer probes for nontargeted stimuli. After the first set of probes, the data were either not consistent or varied from student to student. In addition, there was variance from tier to tier for individual students. Some of the inconsistency may have been due to the low number of non-target and real object stimuli (i.e., 3 each per tier) for a tier. As a result, except where a student correctly identified a stimulus consistently, guessing may have played a part in the inconsistency in the data.

The sessions ranged approximately 2 min 45-s to 4 min 55-s with the average session taking approximately 3 min 45-s once the computer program was started. Teacher probe sessions lasted from 8 to 12 min with an average of 10 min. Computer probe sessions lasted from 2 min 40-s to 3 min 10-s with the average being 2 min 45-s.

Target Stimuli

The data showed positive results regarding the effectiveness of the intervention. Three out of the 4 participants at Blue Elementary mastered all three tiers. The fourth participant was able to master two tiers before the study had to be concluded due to the end of the school year. The intervention was also started with 3 students at Cohen Elementary in a nearby county. There was a difference between the ranges of intervention sessions at Cohen Elementary compared to those from Blue Elementary. The students at

Blue Elementary had a range from 24 to 46 sessions with the student having 46 sessions reaching criteria on the first two tiers. At Blue Elementary, the students had a range of 19 to 21 intervention sessions before the school year ended with one student having two sessions at 100% on Tier 1. As a result, it is impossible to know if the results from each school would have been similar if the students had been exposed to the same amount of intervention sessions. There were some interesting differences between the two schools that will be noted in the discussion for further research. These points are also noted, as they could be beneficial for classroom teachers to consider or monitor when planning or implementing instruction on the computer with students labeled as having MSD.

Blue Elementary

As reported above, 3 of the 4 participants from Blue Elementary mastered all three tiers before the end of the school year. The fourth participant mastered the second tier within 4 days of the end of the school year and, as result, was not able to start intervention on the final tier. The following gives more detail regarding what each student at Blue Elementary mastered, how many sessions were required to mastered each tier, and data from the probe sessions. See Figure 3.1 for probe session averages for the targeted stimuli for the participants at Blue Elementary.

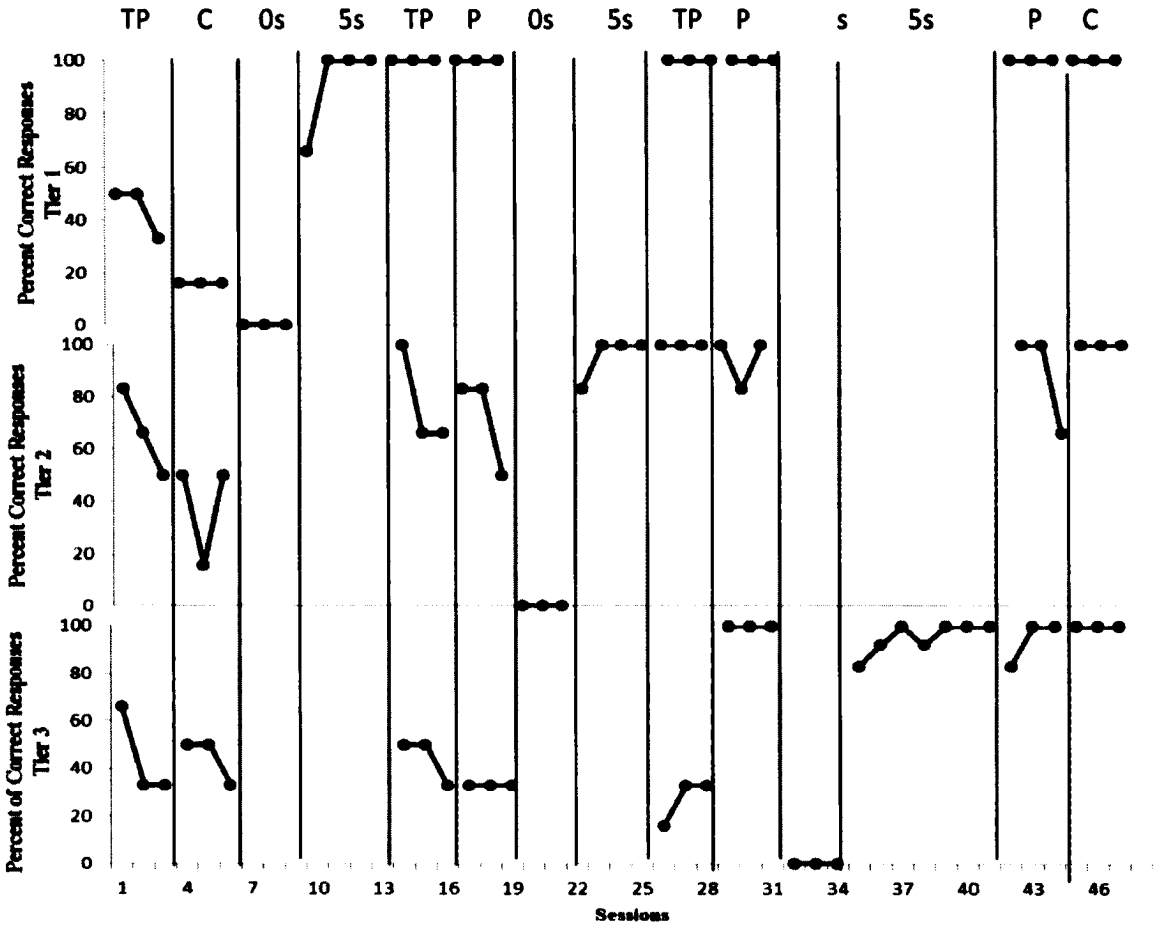
Elijah. Elijah required fewer sessions to master all three tiers when compared to the other 3 participants at Blue Elementary. He required a total of 24 sessions to reach criteria on all three tiers. On the first tier (i.e., "Life Cycles"), he required seven sessions to reach the criterion of 3 days at 100% correct responses before the prompt. He required the same amount of sessions (i.e., seven) to reach criterion on the second tier, "States of Matter." He required the most sessions (i.e., 10) on the final tier (i.e., "Food Chain"). For this tier, he had an absence before the final 0-s interval delay session and was absent for 3

Figure 3.1 Target stimuli probes for Blue Elementary

		Probe 1		Probe 2		Probe 3		Probe 4	
Student	Tier	Teacher	Computer	Teacher	Computer	Teacher	Computer	Teacher	Computer
Abbie									
	Tier 1	89 (83-100)	39 (33-50)	100	88.6 (66-100)	100	94 (83-100)	100	89 (83-100)
	Tier 2	5 (0-16)	50 (50)	83 (66-100)	78 (50-100)	100	100	100	100
	Tier 3	27 (16-33)	44 (33-50)	27 (16-33)	55 (50-66)	22 (16-33)	55 (50-66)	100	66 (66)
Elijah									
	Tier 1	44 (33-50)	16 (16)	100	100	100	100	100	100
	Tier 2	66 (50-83)	39 (16-50)	77 (66-100)	72 (50-83)	100	94 (83-100)	87 (66-100)	100
	Tier 3	44 (33-66)	44 (33-50)	44 (33-50)	33 (33)	27 (16-33)	100 (100)	94 (83-100)	100
Blair									
	Tier 1	33 (33)	16 (16)	100 (100)	88 (50-100)	87 (66-100)	91 (83- 100)	100	83 (83)
	Tier 2	27 (16-33)	33 (33)	39 (33-50)	62 (33-100)	100	95 (83-100)	100	95 (83-100)
	Tier 3	50 (33-66)	33 (33)	55 (55-66)	54 (33-66)	16 (16)	39 (33-50)	89 (66-100)	100
Christian									
	Tier 1	22 (16-33)	39 (33-50)	100	95 (83-100)	100	100	-	-
	Tier 2	16 (16)	50 (50)	33 (16-50)	33 (16-50)	100	100	-	-
	Tier 3	5 (0-16)	33 (16-50)	22 (33-16)	27 (16-33)	22 (16-33)	16 (16)	-	-

days ater the first three sessions at a 5-s delay interval. See Figure 3.2 for percentage of correct responses for Elijah for each tier.

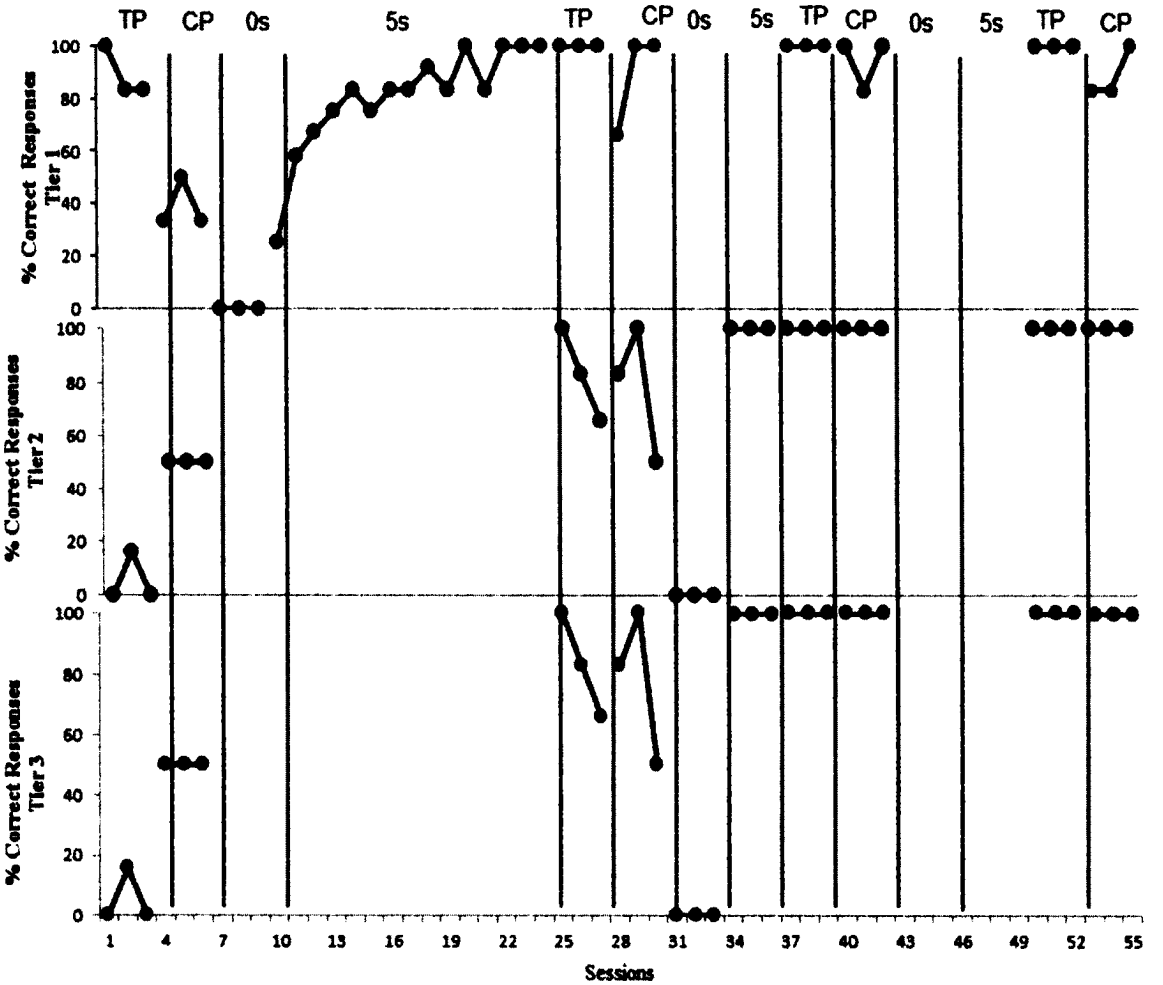
Figure 3.2 Percentage of correct responses for the target stimuli Elijah for each tier.



*TP=teacher probe, CP=computer probe, 0s- 0 second trials, 5s=5 second trials

Abbie. Abbie mastered all three tiers from the science standards. She required 31 sessions to reach criteria across the three tiers. On the first tier (i.e., "Life Cycles"), she required the most sessions to reach criterion (18). On the second tier (i.e., "States of Matter"), she required only six sessions to reach criterion. On the final tier, she required seven sessions to reach criteria on the "Food Chain." See Figure 3.3 for percentages of correct responses for Abbie for each tier.

Figure 3.3 Percentage of correct responses for target stimuli for Abbie for each tier.

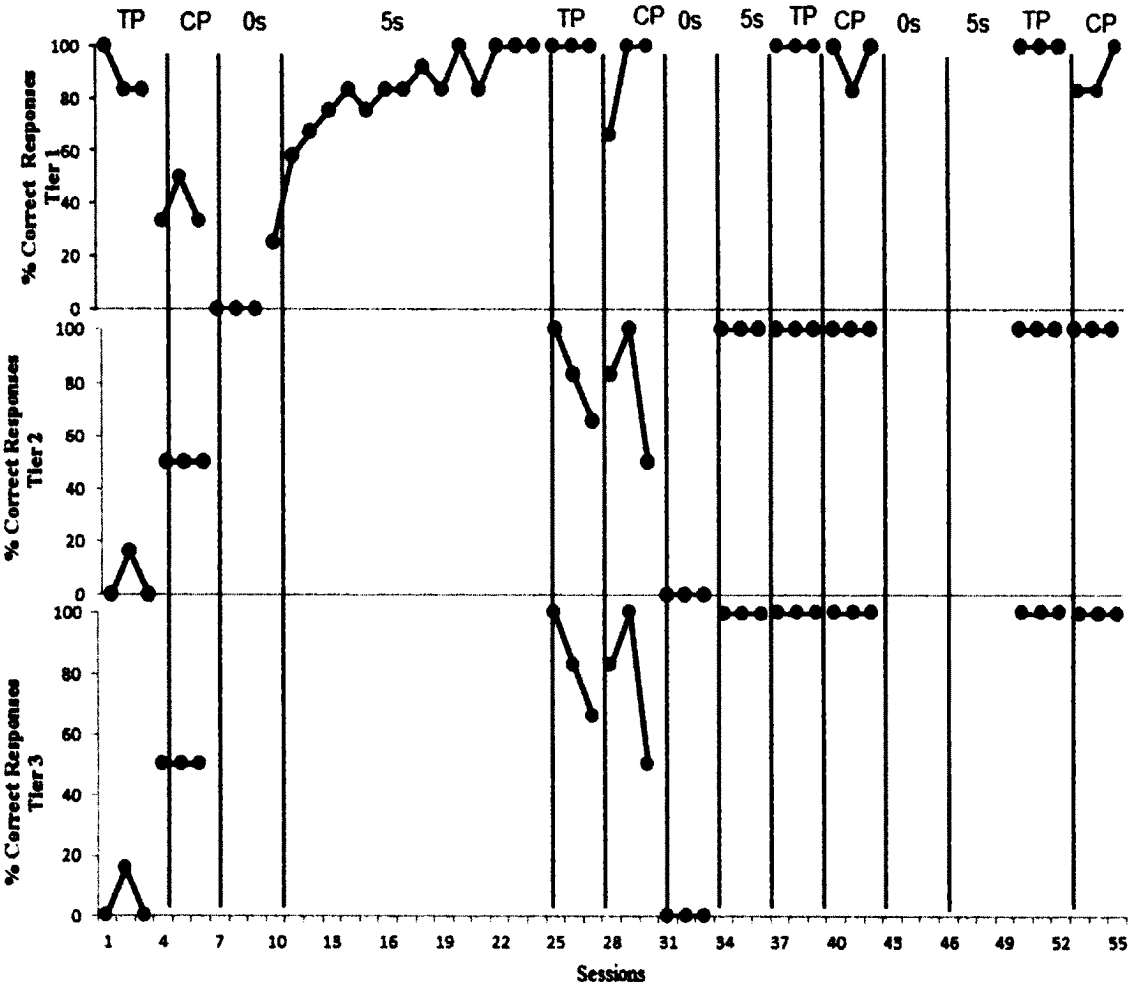


*TP=teacher probe, CP=computer probe, 0s- 0 second trials, 5s=5 second trials

Blair. Blair mastered all three tiers of science concepts. She required a total of 37 sessions to reach criteria on all three tiers. The first tier (i.e., "Life Cycles") required the most sessions (19) sessions to reach criterion. The second tier (i.e., "States of Matter") and third tier (i.e., "Food Chain") both required nine sessions each to reach criterion. See Figure 3.4 for percentages of correct responses for Blair on each tier.

Christian. Christian mastered the first two tiers of science stimuli before the school year ended. He required a total of 46 sessions to reach criteria on the first two tiers. For the first tier on "Life Cycles," it took Christian 36 sessions to reach criteria. It

Figure 3.4 Percentage of correct responses for target stimuli for Blair for each tier.



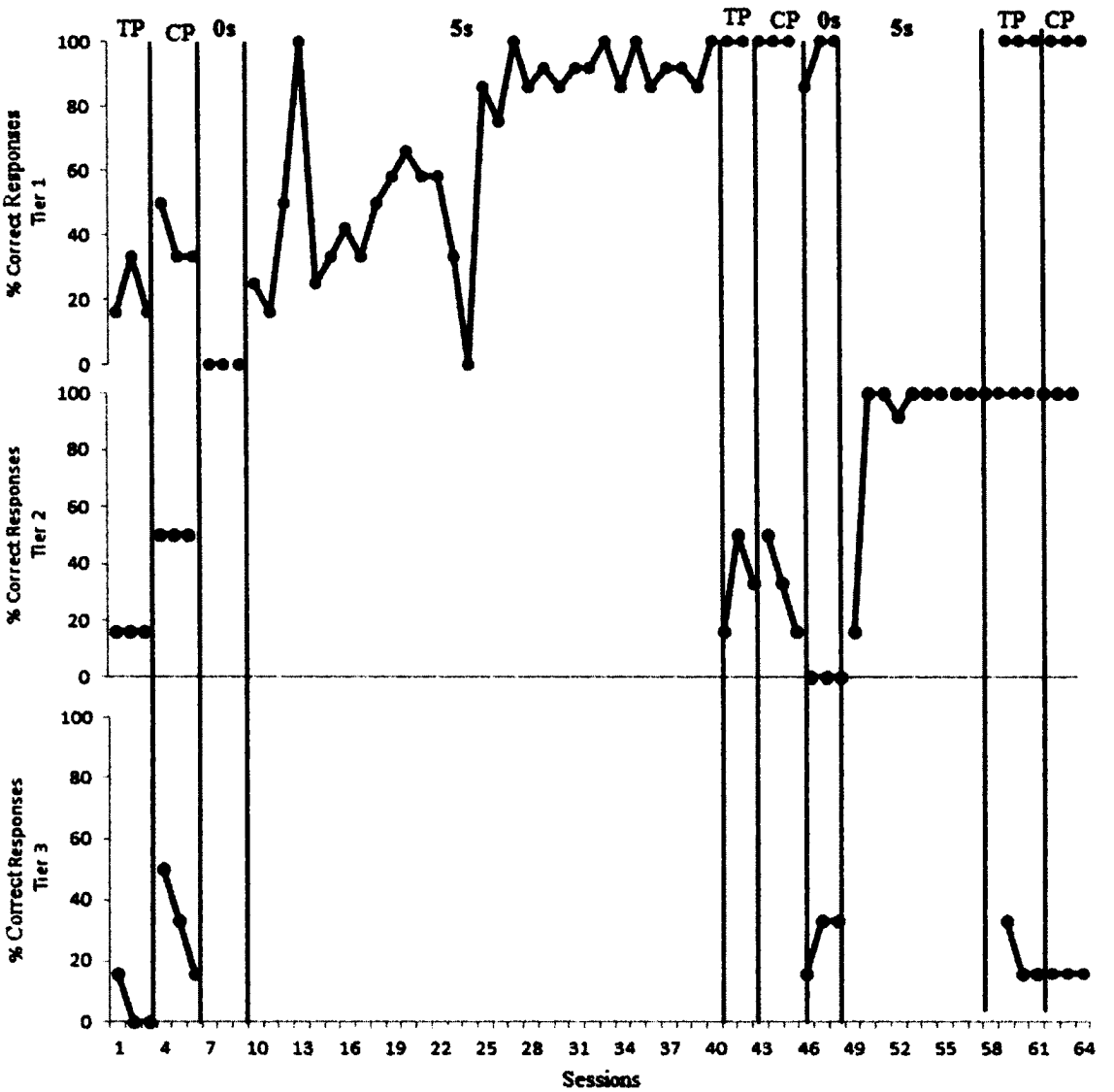
*TP=teacher probe, CP=computer probe, 0s- 0 second trials, 5s=5 second trials

only took him 10 sessions to reach criteria on the "States of Matter" examples. Due to the end of the school year, Christian did not start intervention on the final tier. Figure 3.5 for a percentage of correct responses for Christian on each tier.

Cohen Elementary

As previously noted, intervention was started at Cohen Elementary, but not enough data were collected to fully report results. None of the participants at Cohen Elementary were able to reach criterion on Tier 1 before the school year ended. The following is some information regarding student progress.

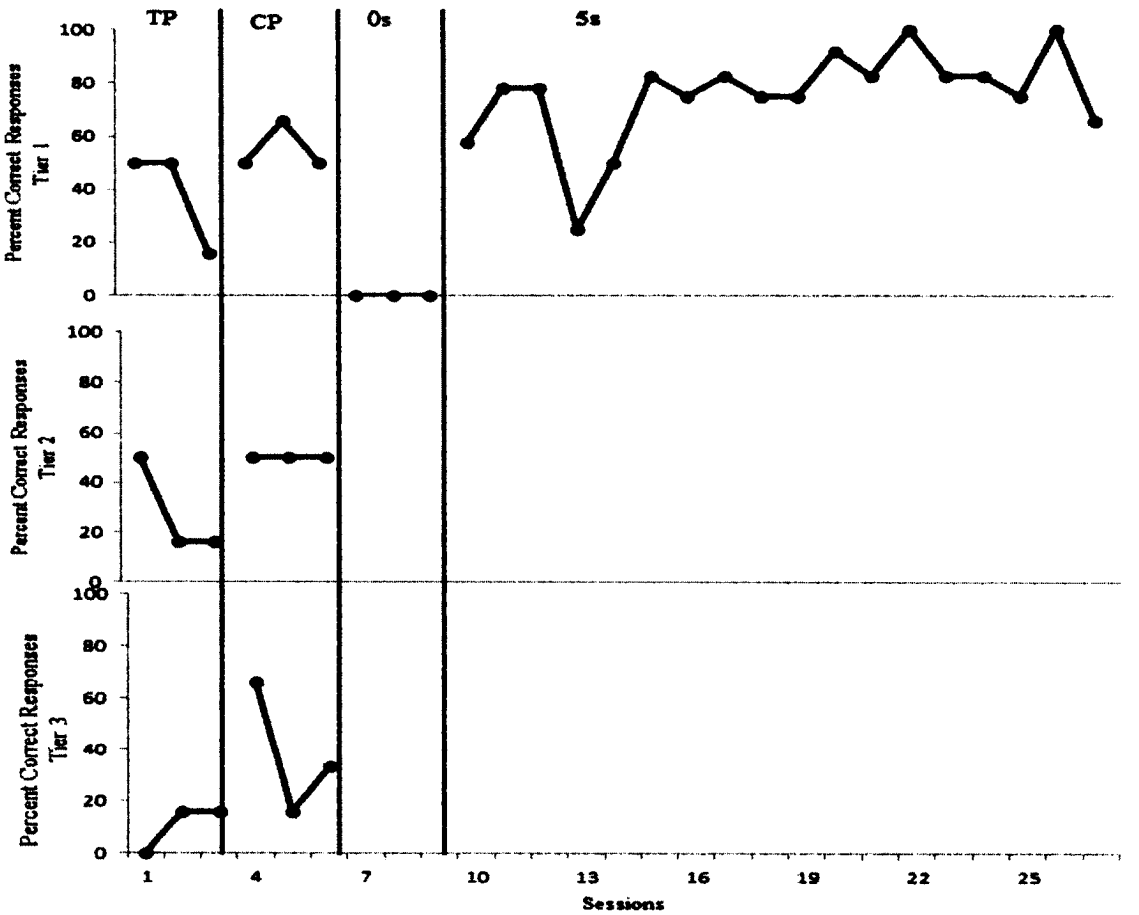
Figure 3.5 Percentage of correct responses for target stimuli for Christian for each tier.



*TP=teacher probe, CP=computer probe, 0s- 0 second trials, 5s=5 second trials

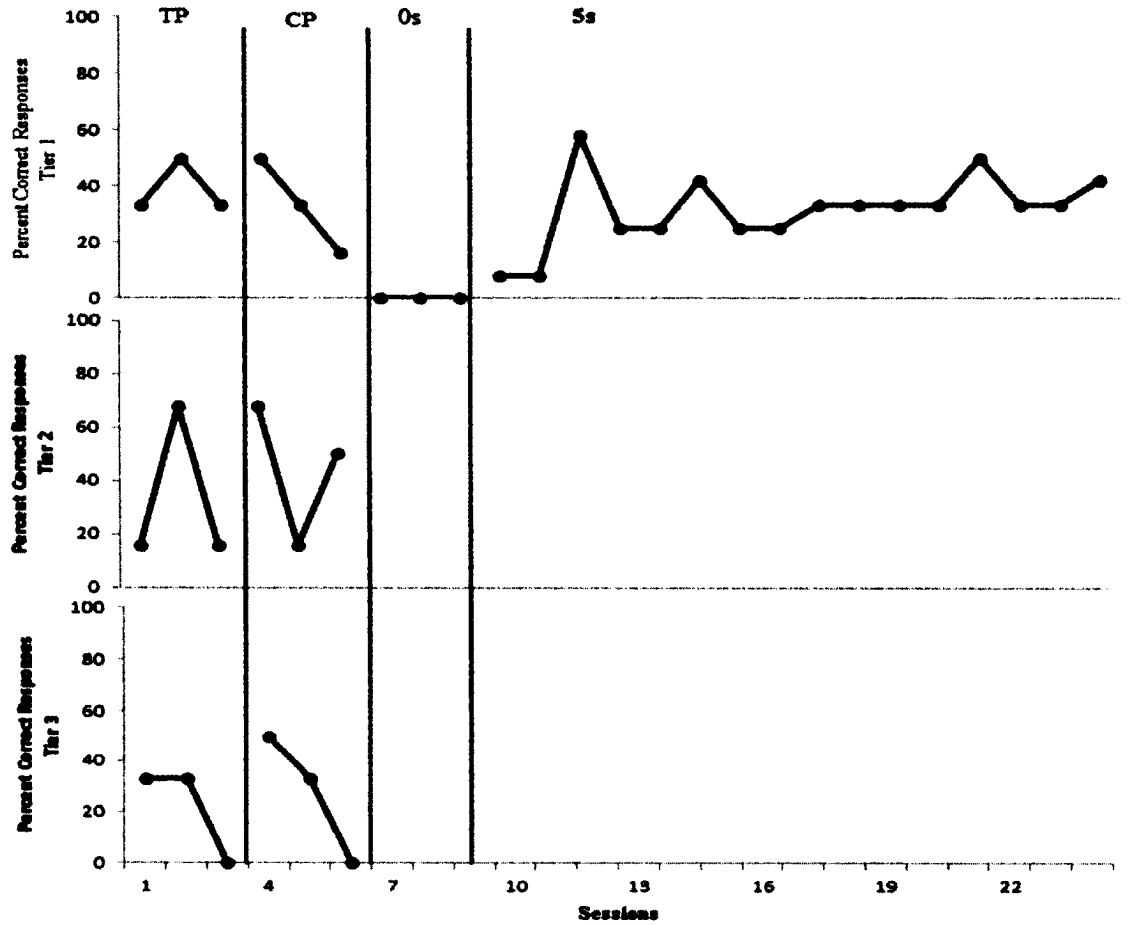
Jack. Jack was able to make progress towards mastery of the first tier. He had 3 days at 0-s and 18 sessions of 5-s in the first tier. During the last week of intervention Jack had two non-consecutive days at 100%. Intervention had to be ended due to the end of the school year. See Figure 3.6 for a percentage of correct responses for Jack on each tier.

Figure 3.6 Percentage of correct responses for target stimuli for Jack for each tier.



Derek. Derek had three sessions at 0-s and 16 sessions at a 5-s delay on Tier 1 (i.e., the "Life Cycle"). His highest percentage of correct responses before the prompt was 58% (i.e., 7 out of 12 trials correct), which was in the first week of intervention. This student had a degenerative muscle disability, and his teacher noted he was having more difficulty in all areas of instruction. When observing this student, the researcher noted that the student often responded as the screen was changing which meant his response was not counted before the prompt. Figure 3.7 for percentages of correct responses for Derek on each tier.

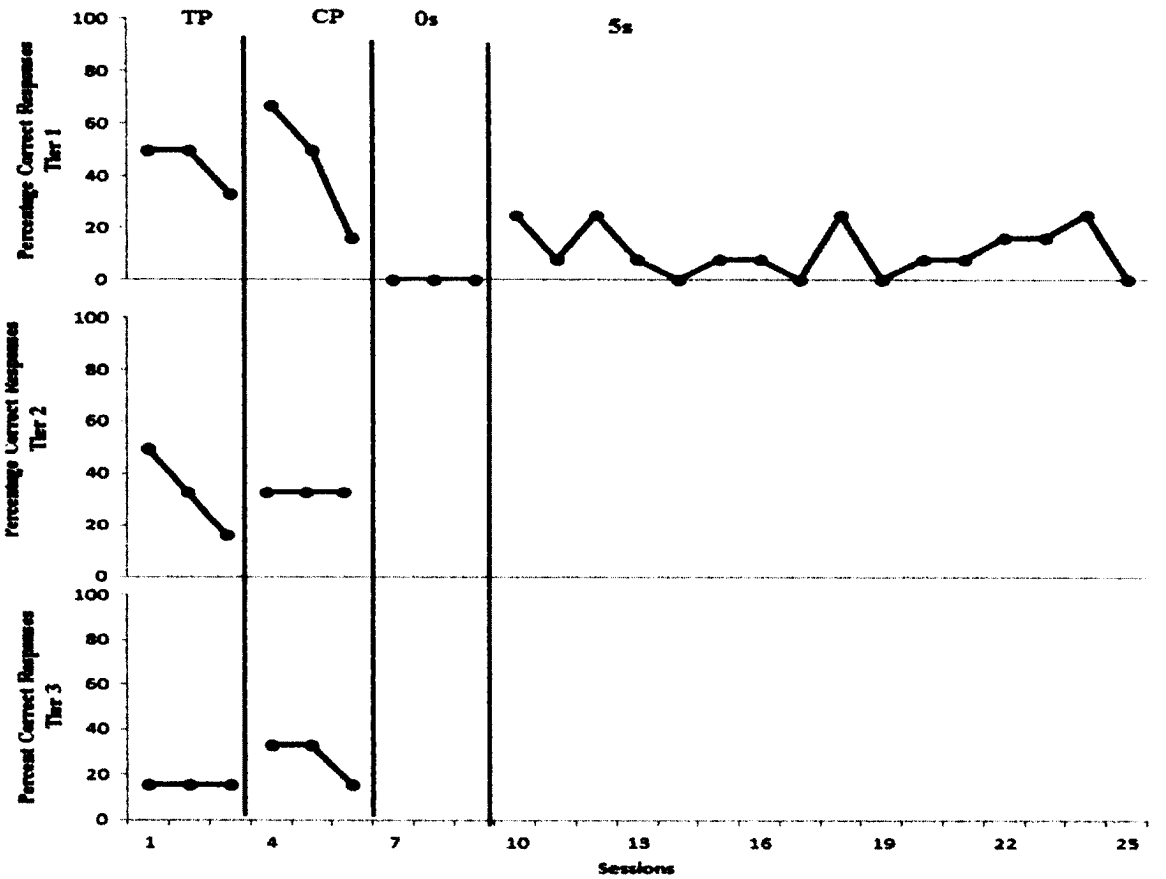
Figure 3.7 Percentage of correct responses for target stimuli for Derek for each tier.



Kenzi. Kenzi had three sessions at 0-s and 16 sessions at a 5-s delay. Her highest percentage of correct responses before the prompt was 25 % (i.e., 3 correct responses before the prompt out of 12 trials) which she got on four sessions. On four sessions, including the last session, she did not respond correctly before the prompt on any of the trials. Several changes were made to try and improve Kenzi's attention to task. After the first two sessions at 0-s, a portable classroom divider was placed behind Kenzi to reduce distractions in an attempt to improve on task behavior. After the seventh session at a 5-s delay, the teacher began to verbally cue Kenzi to stay on task every 2 min. In a final attempt to try to help Kenzi attend and hopefully improve her correct responding, the teacher started to verbally reinforce her after all correct responses. After each of these

changes, there was a slight improvement in her correct responding but the effect was only temporary and therefore it is not possible to tell if it was related to the changes or other factors. See figure 3.8 for percentages of correct responses for Kenzi on each tier.

Figure 3.8 Percentage of correct responses for target stimuli for Kenzi for each tier.



*TP=teacher probe, CP=computer probe, 0s- 0 second trials, 5s=5 second trials

Nontargeted Information

One example for each concept was used as the nontargeted information for a total of three nontargeted stimuli per tier. The computer program presented each nontargeted stimuli four times during each instructional session for the related tier. The nontargeted stimuli were presented at the end of a trial for the related concept. For example, "ball" was presented in the instructive feedback as nontargeted information for the solids examples (i.e., "books" and "apple"). The examples of "books" and "apple" were

presented two times each during a session for Tier 2 (i.e., "States of Matter"); therefore, the nontargeted information (i.e., a "ball") was presented four times during an instructional session. There were three nontargeted stimuli for each tier, and each of these stimuli would be shown to the student four times during a session. A list of the targeted and nontargeted stimuli is in Table 2.3.

Blue Elementary. The following gives more detail as to which nontargeted stimuli were mastered for each tier. Three of the students (i.e., Elijah, Abbie, & Blair) had four sets of teacher probe session data on the nontargeted stimuli while Christian had three sets of probe sessions. See figure 3.9 for probe session averages for the students at Blue Elementary.

Elijah. The data for Elijah's probe sessions showed mixed results for mastery of non-target stimuli. His initial teacher probe data showed that he had already mastered three of the non-targeted stimuli (i.e., "paint," "air," and "producing plant") before instruction began. He continued to show mastery of these stimuli for all remaining probe sessions. For the first set of computer probe sessions, Elijah had four correct responses across the tiers but none for the same stimuli. These results suggest that he had not generalized mastery of these stimuli.

On the second set of teacher probe sessions, he correctly identified "seedling" and "producing plant" on all three probe sessions for Tier 1 (i.e., "Life Cycles"). He identified with 100% accuracy the three nontargeted stimuli for Tier 2 (i.e., "States of Matter"), which had not yet been targeted for instruction. He did not identify any stimulus correctly for all three probe sessions for Tier 3 (i.e., "Life Cycles"). On the second set of computer probe sessions, his results were not similar to the teacher probes. He did not identify any

Figure 3.9 Nontargeted stimuli probes for Blue Elementary

Table Student	Tier	Probe 1 Teacher	Computer	Probe 2 Teacher	Computer	Probe 3 Teacher	Computer	Probe 4 Teacher	Computer
Abbie									
	Tier 1	22	0	100	44	77	55	55	67
	Range	(0-33)	(0)		(0-100)	(67-100)	(33-67)	(33-67)	(67)
	Tier 2	67	0	67	55	89	89	100	67
	Range	(0-16)	(0)	(67)	(33-67)	(67-100)	(67-100)		(67)
	Tier 3	67	0	11	44	0	0	89	0
	Range	(33-100)	(0)	(0-33)	(0-67)	(0)	(0)	(67-100)	(0)
Elijah									
	Tier 1	55	11	77	22	67	87	100	100
	Range	(33-50)	(0-33)	(67-100)	(0-67)	(67)	(67-100)		
	Tier 2	67	22	100	77	100	87	87	100
	Range	(67)	(0-33)		(67-100)		(67-100)	(67-100)	
	Tier 3	0	11	22	55	33	67	87	67
	Range	(0)	(0-33)	(0-33)	(33-67)	(33)	(67)	(67-100)	(67)
Blair									
	Tier 1	33	0	66	22	77	100	55	77
	Range	(33)		(66)	(0-33)	(66-100)		(33-66)	(66-100)
	Tier 2	33	0	67	0	87	100	100	100
	Range	(33)		(67)		(67-100)			
	Tier 3	33	33	11	67	22	11	66	11
	Range	(33)	(33)	(0-33)	(0-100)	(0-33)	(0-33)	(33-100)	(0-33)
Christian									
	Tier 1	33	33	100	44	100	77	-	-
	Range	(33)	(33)		(33-66)		(66-100)		
	Tier 2	11	33	33	66	100	87	-	-
	Range	(0-33)	(33)	(33)	(66)		(66-100)		
	Tier 3	11	22	11	33	0	33	-	-
	Range	(0-33)	(0-33)	(0-33)	(33)		(0-66)		

stimuli correct on all three sessions for Tier 1 (i.e., "Life Cycles") or Tier 3 (i.e., "Food Chain"). For the Tier 2 (i.e., "States of Matter"), he correctly identified "paint" as a liquid on all three probe sessions.

On the third set of teacher probe sessions, he correctly identified "seeds" and "producing plant" on Tier 1, all stimuli on Tier 2, and "people" on Tier 3 on all three probe sessions. He had four computer probe sessions (i.e., the last two sessions for Tier 1

and Tier 2) where he had 100% correct. He identified correctly on all three probe sessions, "seeds" and "producing plant" on Tier 1, and "people" on Tier 3.

On the final set of teacher probe sessions, Elijah answered 100% correct on all three sessions of the "Life Cycles" tier. He identified correctly "paint" and "air" on all three probe sessions for Tier 2 (i.e., the "States of Matter"). He identified correctly "tree" and "worms" and all three probe sessions for Tier 3 (i.e., the "Food Chain"). On the fourth computer probe sessions, he answered 100% correct for all three sessions for both Tier 1 (i.e., "Life Cycles") and Tier 2 (i.e., "States of Matter"). On Tier 3 (i.e., "Food Chain"), he correctly identified "people" on all three probe sessions. See Table 3.1 for the exact stimuli that was correctly identified each probe session. See Figure 3.10 for a summary of the correct percentages for Elijah on each tier.

Abbie. On Abbie's initial probe sessions, she had no correct responses on any tier for the computer probes. Her teacher probe data showed that she had already mastered the stimuli "ball" and "paint" from the Tier 2 (i.e., "States of Matter") before instruction had begun.

On her second set of probe sessions, she answered 100% correct on all three teacher probe sessions for Tier 1 (i.e., "Life Cycle"), and she correctly identified "ball" and "paint" from Tier 2 (i.e., "States of Matter") on all probe sessions. On her computer probe sessions, she again identified correctly "ball" from Tier 2 on all three probe sessions.

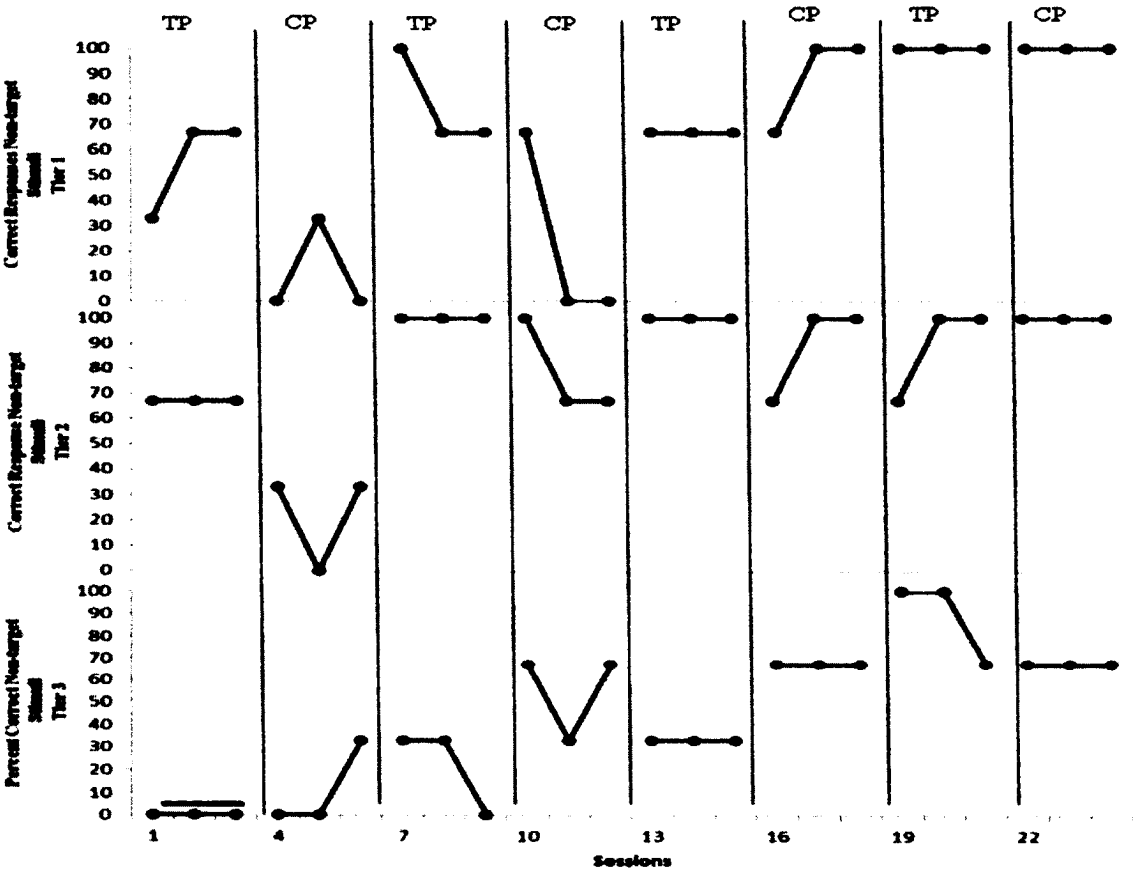
For the third set of teacher probe sessions, she only maintained "seedling" from Tier 1 (i.e., "Life Cycle"). She correctly identified "ball" and "paint" from Tier 2 on all teacher probe sessions and did not identify any stimuli correctly on Tier 3. On the computer probes sessions, she correctly identified "seeds" from Tier 1 (i.e., "Life

Cycle"), and "ball" and "paint" from Tier 2 (i.e., "States of Matter"). As with the teacher probe sessions, she did not identify any stimuli correctly from Tier 3.

Table 3.1 Nontargeted object probes for Elijah

	Probe 1	Probe 2	Probe 3	Probe 4
Tier 1 teacher probe				
seeds				
seedling				
producing				
plant				
computer probe				
seeds				
seedling				
producing				
plant				
Tier 2 teacher probe				
ball				
paint				
air				
Computer probe				
ball				
paint				
air				
Tier 3 teacher probe				
tree				
people				
worms				
Computer Probe				
tree				
people				
worms				
correct responses				

Figure 3.10 Percentage of correct responses to non-targeted stimuli on probe sessions for Elijah.



*TP=teacher probe, CP=computer probe

During the final set of probe sessions, she correctly identified "seedling" on all of the teacher probe sessions. She had 100% accuracy on all teacher probe sessions for Tier 2 (i.e., "States of Matter") and identified "tree" and "worms" correctly on all sessions for Tier 3. For the computer probe sessions, she identified correctly "seeds" from Tier 1 and "paint" from Tier 2 on all probe sessions. She did not identify any stimuli correct on all three computer probe sessions for Tier 3 (i.e., "Food Chain"). See Figure 3.11 for averages and ranges of correct percentages on the probe sessions for Abbie.

Due to the variability of her data on the probe sessions, another probe session was conducted on the computer a week later. On this probe session, she still correctly

identified "seeds" from Tier 1. She had 100% accuracy on Tier 2 (i.e., "States of Matter") and increased her score on Tier 3 (i.e., the "Food Chain") to 33% accuracy where she correctly identified "people" as a consumer. See Table 3.2 for a summary of the nontargeted stimuli Abbie identified during the probe sessions. See Figure 3.9 for a summary of the correct percentages for Abbie on each tier.

Blair. For Tier 1 (i.e., "Life Cycle"), Blair's first set of teacher probe sessions showed she had already mastered "seedling" as an example of the growth and development stage. She had 0% corrects on the first set of computer probe sessions. After she reached criterion on Tier 1 (i.e., "Life Cycle"), she correctly identified "seed" as the beginning stage and maintained "seedling" as an example of the growth and development stage on her teacher probe sessions. She did not identify any stimuli correct on all three of the computer probe sessions. On the third set of teacher probe sessions, she maintained mastery of "seed" and "seedling" and had one session at 100%. She had 100% accuracy on all three computer probe sessions. For the fourth set of probe sessions, she did not identify any Tier 1 stimuli correctly on all three teacher probe sessions. For the computer probe sessions, she identified "seeds" correctly on all probe sessions.

Her nontargeted information data were most consistent for Tier 2 (i.e., "States of Matter"). On her first set of teacher probe sessions, she had 33% correct for each session, but she did not identify the same stimulus correctly on all three sessions. She had 0% corrects on the first set of computer probe sessions. For the second set of teacher probe sessions, she identified "ball" as a solid and "paint" as a liquid on all three probe sessions. She did not identify any stimuli correctly on the second set of computer probes. On the third set of probe sessions, she had just finished instruction on Tier 2. Except for

Table 3.2 Correct Responses for the Non-targeted Object Probes for Abbie

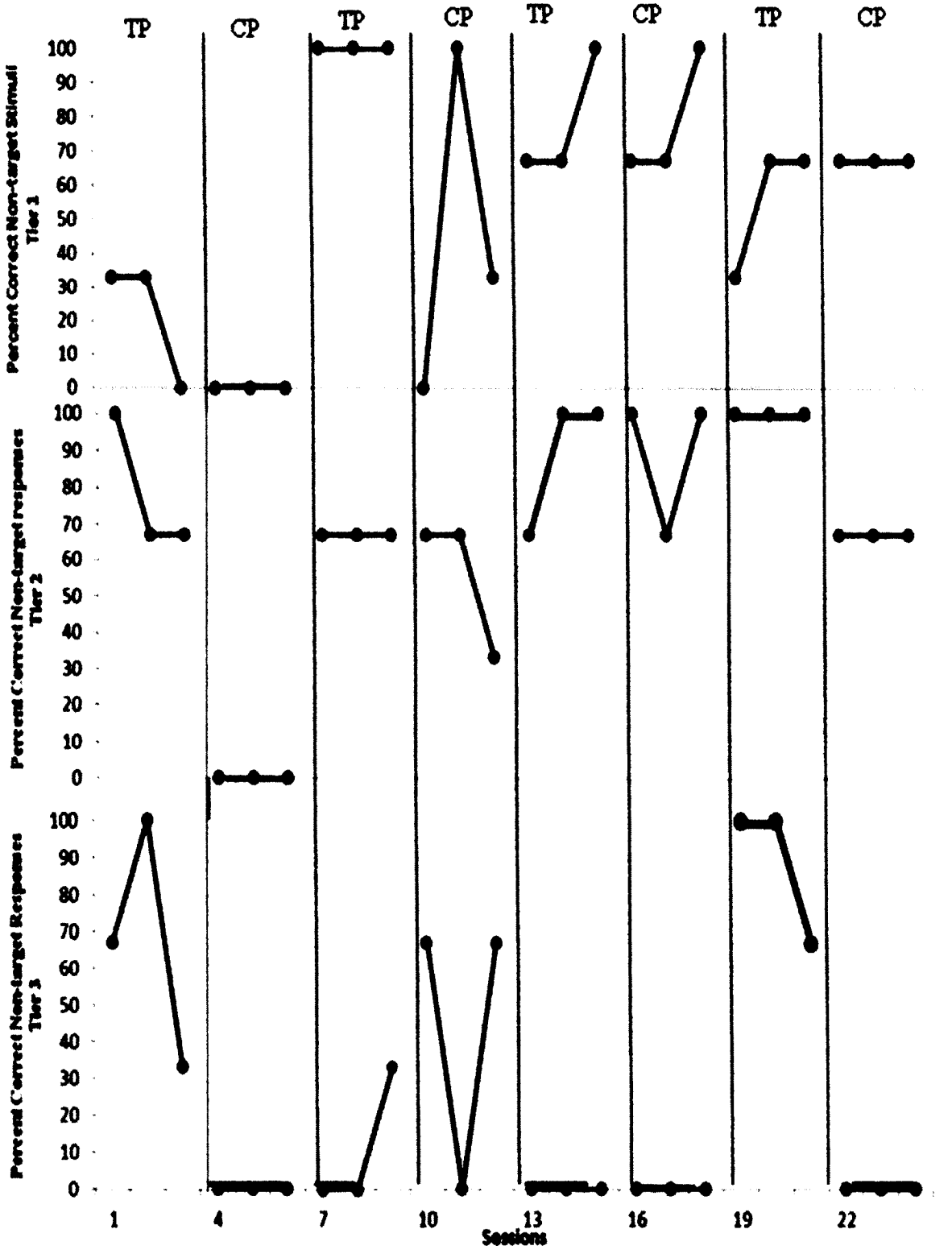
	Probe 1	Probe 2	Probe 3	Probe 4	
Tier 1					
teacher probe					
Seeds					*
Seedling producing plant					*
computer probe					
Seeds					
Seedling producing plant					
Tier 2					
teacher probe					
Ball					*
Paint					*
Air					*
Computer probe					
Ball					
Paint					
Air					
Tier 3					
teacher probe					
Tree					*
people					*
Worms					*
Computer Probe					
Tree					
people					
Worms					

* A fourth probe session was not conducted for the teacher probe sessions on the last set of probe sessions.

| Indicates correct responses

the first teacher probe session where she had 67% correct, she scored 100% correct on the remaining teacher and computer probe sessions, including all sessions of the fourth set of probe sessions.

Figure 3.11 Percentage of correct responses to non-targeted stimuli on probe sessions for Abbie.



*TP=teacher probe, CP=computer probe

Her responses for Tier 3 (i.e., "Food Chain") were inconsistent. On the first set of probe sessions, although she scored 33% correct on both the teacher and computer probes, she did not identify the same stimuli correctly for all three sessions of either set of probe sessions. She did not identify any stimuli correctly on all probe sessions on the second set of teacher probe sessions. See Figure 3.12 for a graph of Blair's correct responses on the probe sessions. On the computer probe sessions, she had 0% correct on the first session but 100% correct on the next two probe sessions. On the third set of probe sessions, she only had three sessions across the teacher and computer probes where she had one correct response each. For the fourth set of probe sessions, after receiving instruction on Tier 3, she had an average of 67% correct on the teacher probes and identified correctly that a "person" is a consumer on all three probe sessions. Her computer scores stayed similar to past scores, with the first session being 33% correct and the final two sessions staying at 0% correct. See Table 3.3 for a summary of the identified nontarget stimuli for Blair.

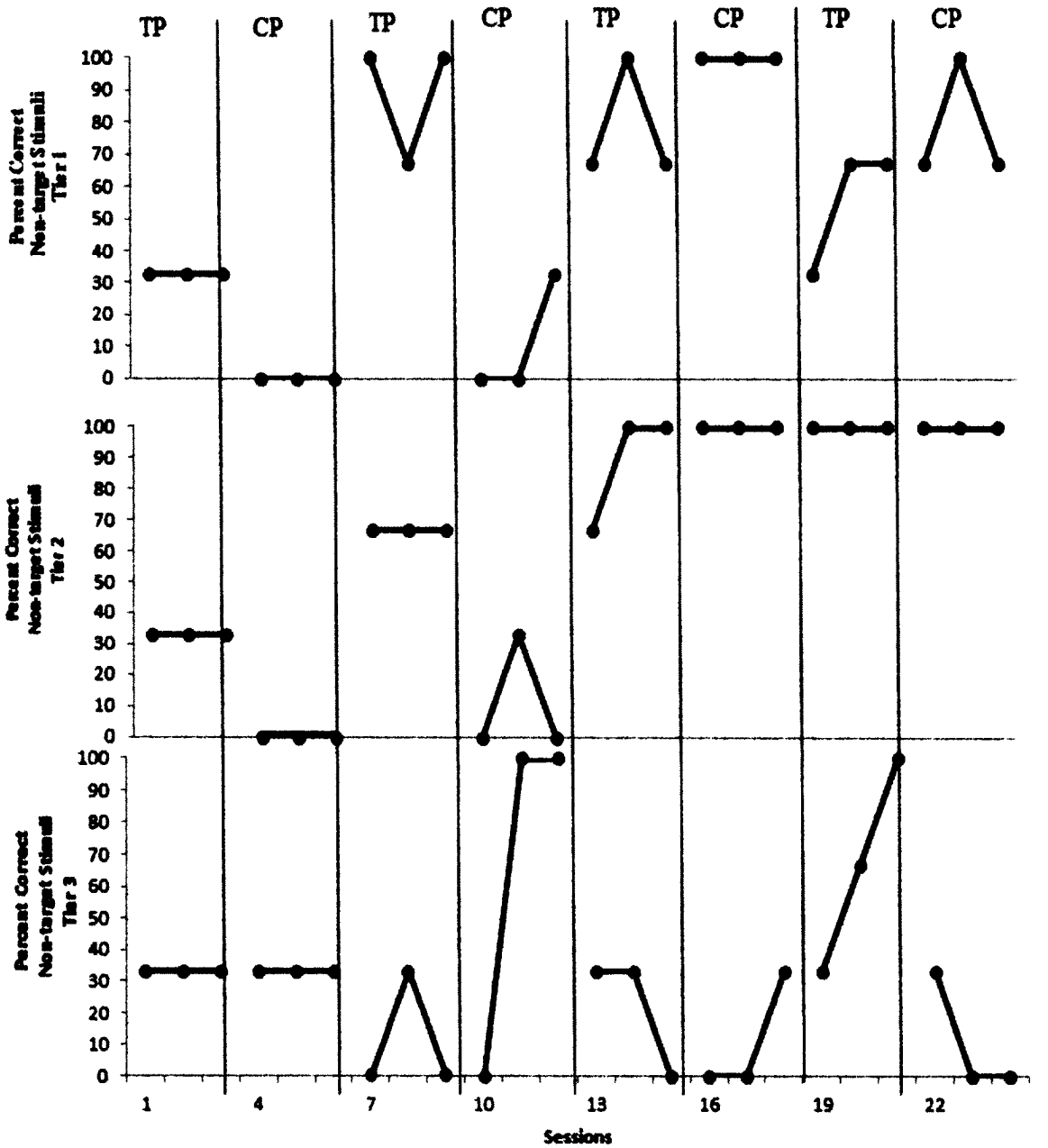
Christian. Due to the end of the school year, Christian was not able to receive instruction on the third tier and, had only three sets of probe sessions. See Figure 3.13 for a graph of the percent of correct responses for Christian for each tier. On the first set of probe sessions for Tier 1 (i.e., the "Life Cycle"), he had 33% correct on all teacher and computer probe sessions. On the three teacher and two computer probe sessions, he correctly identified "producing plant" as the example of the reproductive stage. On the second set of teacher probe sessions, he scored 100% correct on all probe sessions. On the computer probes, he had an average of 44% correct where he identified correctly a "producing plant" as an example of the reproductive stage on all three probe sessions.

On his third set of probe sessions, he again scored 100% correct on all of the teacher probe sessions and his computer probe sessions scores increased to an average of 78% correct. He correctly identified "seeds" as the beginning stage and a "producing plant" as an example of the reproductive stage on all of the computer probe sessions.

Table 3.3 Non-targeted object probes for Blair

	Probe 1	Probe 2	Probe 3	Probe 4
Tier 1				
teacher probe				
seeds				
seedling				
producing plant				
computer probe				
seeds				
seedling				
producing plant				
Tier 2				
teacher probe				
ball				
paint				
air				
Computer probe				
ball				
paint				
air				
Tier 3				
teacher probe				
tree				
people				
worms				
Computer Probe				
tree				
people				
worms				
correct responses				

Figure 3.12 Percentage of correct responses to non-targeted stimuli on probe sessions for Blair.



*TP=teacher probe, CP=computer probe

On the first set of teacher probe sessions for Tier 2 (i.e., "States of Matter"), he did not identify any stimuli correctly on all three probe sessions. On the computer probe sessions, he scored 33% correct on all three sessions, but he did not identify any stimulus correct for more than one session. On the second set of probe sessions, Christian correctly

identified a "ball" as a solid on all three teacher and computer probe sessions. For his third and final set of probe sessions, he scored 100% correct on all teacher probe sessions and identified correctly "ball" and "paint" on all computer probe sessions.

On Tier 3 (i.e., "Food Chain"), Christian did not receive instruction on this tier and there was little change in his data. He had 10 correct responses across the three sets of teacher and computer probe sessions. He had no more than two correct responses in consecutive probe sessions, and this was for "people" on the second set of computer probe sessions. See Table 3.4 for a summary of the identified non target stimuli for Christian.

Cohen Elementary. Mastery cannot be discussed since none of the students at Cohen Elementary were able to master Tier 1 before the end of the school year. Below is a brief description of what nontargeted stimuli appeared to be mastered before instruction began.

Jack. Jack correctly identified "worms" as an example of a decomposer on all three teacher probe sessions for Tier 3 (i.e., the "Food Chain"). He did not correctly identify any other stimuli on all three of the teacher probe sessions. He did correctly identify "ball" on Tier 2 as an example of a solid on all three computer probe sessions.

Derek. Derek only identified one stimulus correctly on all three of either the teacher or computer probe sessions. He correctly identified "paint" on Tier 2 as an example of a liquid on each of the three teacher probe session. He identified "paint" as an example of a liquid on two of the computer probe sessions.

Kenzi. Kenzi had two nontargeted stimuli she identified correctly on all three teacher probe sessions. On Tier 3 (i.e., the "Food Chain) Kenzi had 67% correct on all three sessions. She correctly identified "people" as an example of consumers and

"worms" as an example of decomposers in each of the sessions. She also correctly identified "people" as consumers on the last two computer probe sessions.

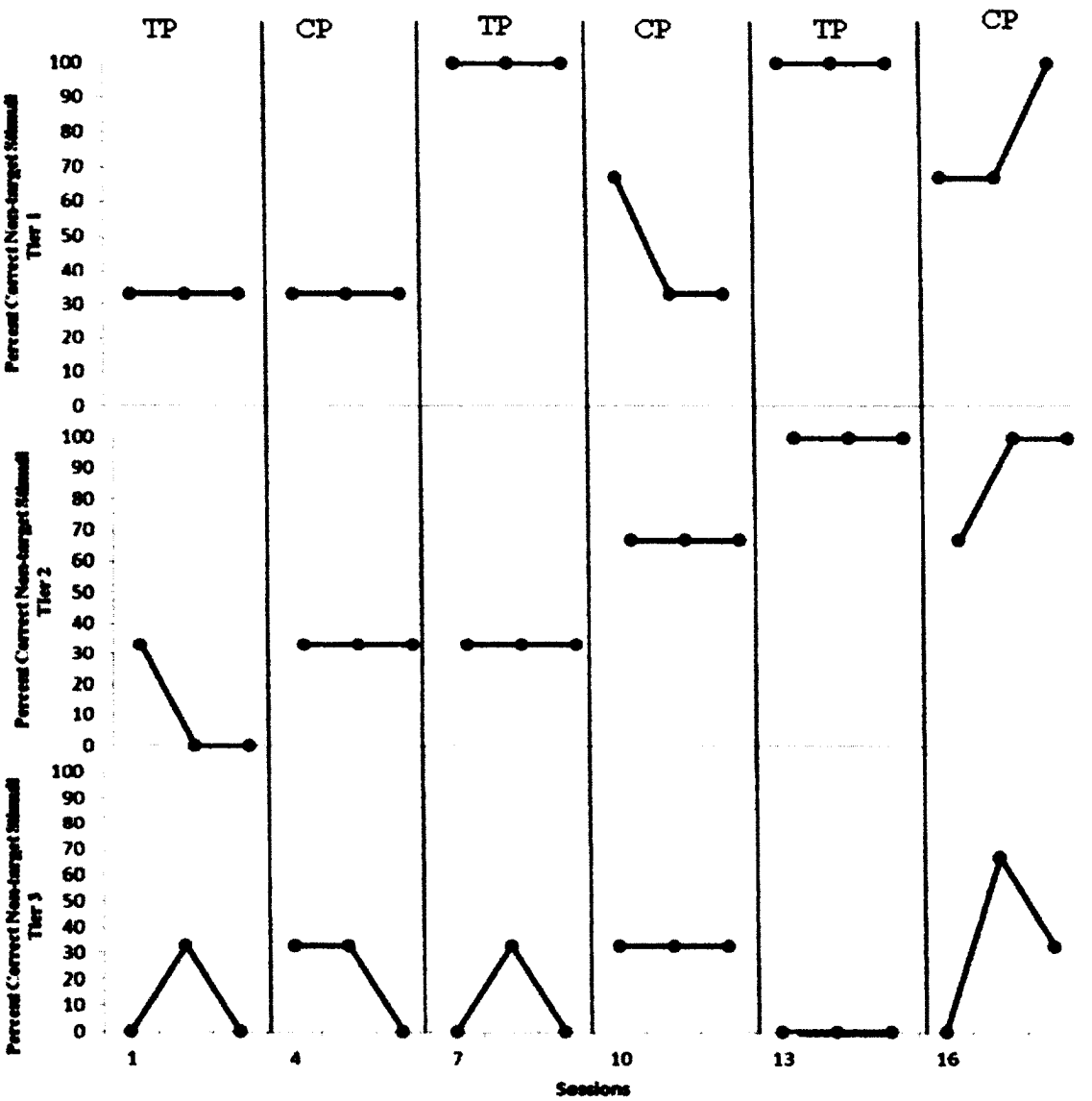
Table 3.4 Non-targeted object probes for Christian

	Probe 1	Probe 2	Probe 3	Probe 4
Tier 1				
teacher probe				
seeds				
seedling				
producing				
plant				
computer probe				
seeds				
seedling				
producing				
plant				
Tier 2				
teacher probe				
ball				
paint				
air				
Computer probe				
ball				
paint				
air				
Tier 3				
teacher probe				
tree				
people				
worms				
Computer Probe				
tree				
people				
worms				

Christian did not have a fourth set of probe sessions due to the end of the school year.

correct responses did not probe

Figure 3.13 Percentage of correct responses to non-targeted stimuli on probe sessions for Christian.



*TP=teacher probe, CP=computer probe

Real Objects

Each student was probed by the teacher using real objects. The only exception was for Tier 1 (i.e., "Life Cycle"), where age appropriate replicas of the "Life Cycle" of a praying mantis were used since it was not probable to obtain real versions each time a student was probed. For a full list of the objects used, see Table 2.3.

Blue Elementary. Three students at Blue Elementary had four sets of probe sessions on the real objects to check for generalization. Since Christian did not have a chance to start intervention on Tier 3, he only had three sets of teacher probe sessions on the real objects. See Figure 3.14 for probe session averages for each student.

Figure 3.14 Real object generalization probes for Blue Elementary

Table		Probe 1	Probe 2	Probe 3	Probe 4
Student	Tier	Teacher	Teacher	Teacher	Teacher
Abbie					
	Tier 1	**33**	11	55	66
	Range	**(33)**	**(0-33)**	(33-67)	(33-100)
	Tier 2	**77**	**67**	100	100
	Range	**(67-100)**	**(67)**		
	Tier 3	**55**	**55**	11	89
Elijah					
	Tier 1	**44**	33	44	77
	Range	**(33-57)**	**(33)**	(33-67)	
	Tier 2	**0**	**77**	89	77
	Range		**(67-100)**	**(67-100)**	(67-100)
	Tier 3	**67**	**55**	**77**	100
	Range	**(67)**	**(33-67)**	**(67-100)**	
Blair					
	Tier 1	**33**	22	33	44
	Range	**(33)**	**(0-33)**	(33)	(33-67)
	Tier 2	**44**	**67**	100	100
	Range	**(0-100)**	**(67)**		
	Tier 3	**33**	**44**	**55**	44
	Range	**(33)**	**(33-66)**	**(33-66)**	(33-66)
Christian					
	Tier 1	**0**	66	11	-
	Range		**(33-100)**	(0-33)	
	Tier 2	**22**	**67**	89	-
	Range	**(0-67)**	**(67)**	**(67-100)**	
	Tier 3	**22**	**33**	**67**	-
	Range	**(0-33)**	**(33)**	**(67)**	

Elijah. For Tier 1 (i.e., "Life Cycle"), Elijah did not respond correctly on any two consecutive probes during the first set of probe sessions. On the second set of probe sessions, he identified correctly the "praying mantis" as an example of the reproductive stage on all three probe sessions. On the third set of probe sessions, he correctly identified the "mantis eggs" as an example of the beginning stage on each of these probe sessions. For the fourth probe sessions, Elijah again identified correctly "mantis eggs" as an example of the beginning stage on all three probe sessions. The other correct responses were inconsistent.

For Tier 2 (i.e., "States of Matter"), Elijah did not identify any stimuli correctly on the first set of probe sessions. On the second set of probes sessions, he had an average of 78% correct. He correctly identified "milk" as an example of a liquid and "cup" as an example of a solid on all three sessions. On the third set of probes, he again identified "milk" and "cup" correctly on all three probe sessions. On the final set of real object probes, he identified "cup" correctly on all three probe sessions.

For the first set of real object probes for Tier 3 (i.e., "Food Chain"), Elijah identified 67% correct on all sessions. He identified "plant" as an example of a producer correctly on all three probe sessions. For the second set of probe sessions, he again identified a "plant" as an example of a producer on all three probe sessions. On the third set of probe sessions, Elijah once again consistently identified a "plant" as an example of a producer in addition to identifying a "fish" as an example of a consumer. On the final set of real object probes, which were done after he had mastered the "Food Chain" tier stimuli, he had a 100% on all probe sessions. See Table 3.5 for the specific real object examples Elijah identified each probe session.

Abbie. On the first and second set of real object probe sessions for Tier 1 (e.g., "Life Cycles"), Abbie did not identify any stimuli correctly on all three probes. On the third set of probe sessions, she identified correctly "eggs" as an example of the beginning stage of a life cycle on all three probe sessions. On the fourth and final set of probes,

Table 3.5 Real- object generalization probes for Elijah

	Probe 1	Probe 2	Probe 3	Probe 4
Tier 1				
teacher probe				
eggs				
larvae				
praying mantis				
Tier 2				
teacher probe				
cup				
milk				
air from balloon				
Tier 3				
teacher probe				
plant				
fish				
moldy bread				

correct responses

Abbie again identified correctly "eggs" as an example of the beginning stage of a life cycle on all three probe sessions.

Her scores on the probe sessions for Tier 2 (i.e., "States of Matter") were high on the first set of probe sessions. She had 100% correct on the first probe and 67% correct on the following two probes. She correctly identified "milk" as a liquid and "air" as a gas on all three probe sessions. For the second set of probe sessions, she again identified correctly "milk" as a liquid, but, this time, correctly identified "cup" as a solid correctly

on all three probe sessions. On the last two sets of probe sessions, which were after reaching criterion on Tier 2, she had 100% on all sessions.

Abbie had mixed results on the probe sessions for Tier 3 (i.e., Food Chain). On the first set of probe sessions, she had an average of 56% correct, but she did not identify any stimuli correctly on all three probe sessions. On the second set of probe sessions, Abbie identified correctly "fish' as an example of a consumer on all three probe sessions. For the third set of probe sessions for Tier 3, she did not identify any stimuli correctly on all three probe sessions. On the final set of probe sessions she showed an increase to an 89% average. See Table 3.6 for the specific real object examples Abbie identified each probe session.

Table 3.6 Real- object generalization probes for Abbie

	Probe 1	Probe 2	Probe 3	Probe 4
Tier 1				
teacher probe				
eggs				
larvae				
praying mantis				
Tier 2				
teacher probe				
cup				
milk				
air in balloon				
Tier 3				
teacher probe				
plant				
fish				
molded bread				

correct responses

Blair. On Tier 1 (i.e., "Life Cycle"), Blair made little progress over her initial probe data. Although she did identify some stimuli correctly, she did not identify the

same stimulus correctly on all three probe sessions. This was true for all four sets of probe sessions.

On Tier 2 (i.e., "States of Matter"), Blair averaged 44% correct on the first set of probe sessions, but did not identify any stimulus correctly on all sessions. On the second set of probe sessions, she had 67% correct on all three sessions and correctly identified "milk" as a liquid in each of the probe sessions. On the third set of probe sessions, which were after she had met criterion for Tier 2, Blair had 100% correct on all probe sessions. She again had 100% correct on all sessions of the fourth set of probe sessions.

On Tier 3 (i.e., Food Chain), Blair did not identify any stimuli correctly on all three probe sessions of the first and second set of probe sessions. She identified correctly "plant" as a producer on all three sessions of the third set of probe sessions. On the final set of probes, Blair again correctly identified "plant" as a producer on all three probe sessions. See Table 3.7 for the specific real object examples Blair correctly identified each probe session.

Christian. As previously stated, Christian only had three sets of probe sessions due to the end of the school year. For Tier 1 (i.e., "Life Cycle"), he had 0% correct on the first set of probe sessions. On the second set of probe sessions, he correctly identified "eggs" as an example of the beginning of a life cycle on all three probe sessions. He did not identify any stimuli correctly on all three sessions of the last two set of probes sessions.

On the first set of probe sessions for Tier 2 (i.e., "States of Matter"), he did not identify any stimuli correctly on all three sessions. On the second set of probe sessions, he identified correctly "milk" as an example of a liquid on all three sessions. On the final

set of probe sessions, Connor again identified correctly "milk" as an example of a liquid, and "air" as an example of a gas on all three probe sessions.

Table 3.7 Real- object generalization probes for Blair

	Probe 1	Probe 2	Probe 3	Probe 4
Tier 1				
teacher probe				
eggs				
larvae				
praying mantis				
Tier 2				
teacher probe				
cup				
milk				
air from balloon				
Tier 3				
teacher probe				
plant				
fish				
moldy bread				

correct responses

Christian's data improved on Tier 3 even though he did not receive instruction on the "Food Chain." On the first set of probe sessions, he did not correctly identify any stimulus correctly on all three probe sessions. On the second set of probe sessions, Connor correctly identified "fish" as an example of a consumer on all three probe sessions. On the final set of three probe sessions, he again correctly identified "fish" as an example of a consumer and identified correctly a "plant" as an example of a producer. See Table 3.8 for the specific real object examples Christian identified each probe session.

Cohen Elementary. The students at Cohen Elementary only had one set of teacher probe sessions on the real object to check for generalization. The following gives information regarding what stimuli were mastered before intervention began.

Jack. Jack did not identify any stimuli correctly on all three probe sessions for Tier 1 and Tier 3. He correctly identified "milk' as a liquid, and "cup" as a solid on all three probe sessions for Tier 2 (i.e., "States of Matter").

Table 3.8 Real- object generalization probes for Christian

	Probe 1	Probe 2	Probe 3	Probe 4
Tier 1				
teacher probe				
eggs				
larvae				
praying mantis				
Tier 2				
teacher probe				
cup				
milk				
air from balloon				
Tier 3				
teacher probe				
plant				
fish				
moldy bread				

correct responses did not probe

Derek. Derek also did not identify any stimuli correctly on all three probe sessions for Tier 1 and Tier 3. He correctly identified "milk" as an example of a liquid on all three probe sessions for Tier 2.

Kenzi. As with Derek and Jack, Kenzi did not identify any stimulus correctly for Tier 1 and Tier 3 on all three probes sessions. Like Derek, she correctly identified "milk" as an example of a liquid on all three probe sessions for Tier 2 (i.e., "States of Matter").

Efficiency

The efficiency data varied per student per tier. The students from Blue Elementary required 6 to 36 sessions to master the first tier, with only one student needing less than 15 sessions. For the second tier, the students needed 6 to 10 sessions to reach criterion. The 3 students who reached criterion on Tier 3 needed from 7 to 10 sessions. See Figure 3.15 for more details.

Figure 3.15 Number of sessions to criteria at Blue Elementary

	Elijah	Abbie	Blair	Christian	Average Number of Sessions
Tier 1	4	15	16	33	17
Tier 2	4	3	6	7	5
Tier 3	7	4	6	-	6

Chapter Four

Discussion

The purpose of this study was to evaluate the effectiveness of using CAI to teach students with MSD science facts from the general education curriculum. The target and non-target stimuli were from three standards: (a) "Life Cycle," (b) "States of Matter," and (c) "Food Chain." This section discusses the findings from this investigation, what effect the findings might have on future research, and what implications the results have for classroom teachers. How efficient the intervention was and for which students also will be discussed. In addition, the weaknesses of the study and what areas and aspects should be investigated further in the future will be discussed. Teacher opinions about the intervention and the perceived benefits or lack thereof will be presented. Finally, how the results are relevant to the classroom teacher also will be addressed.

General findings

The overall findings for the study were positive. Of the 4 students from Blue Elementary who participated, 3 mastered all three tiers. The fourth participant mastered two tiers before the study had to be concluded due to the end of the school year. There was also an increase in the participants' data from the first set of probe sessions to their last set of probe sessions for the nontargeted information and the real object generalization probe sessions.

Christian's data on the target stimuli were the most stable in that he identified 50% or less correct on all probe sessions before instruction began on that stimuli. Once he mastered a tier, he never missed more than one during the remaining set of probe sessions for that tier. The other students' data had more variability. For Abbie and Elijah, some of their probe scores improved before receiving instruction on that tier.

For the non-target stimuli, Connor again had more stable data in that he was below 33% correct responses before instruction on a tier and his data improved only after receiving instruction on that tier. Overall, his teacher probes were higher than his computer probe for the first two tiers. For Abbie, Elijah, and Blair, their data seemed to vary depending on the stimuli. The non-target stimuli for the "Food Chain" seemed to be hardest in that none had 3 days at 100% correct on the last set of either the teacher or computer probes. This was the only tier where this occurred. The 3 students' data show they had mastered two stimuli on the teacher probes, but this was not consistent with the computer probes. Abbie and Blair had two sessions at 0% on the computer probes, suggesting it was not just a compliance problem. On the teacher probes, Blair mastered "people" as an example of a consumer, and Elijah and Abbie mastered "trees" as an example of a producer and "worms" as an example of a decomposer. When looking at the data, there were lower rates of mastery on the Tier 3 when compared to the other two. The teachers stated that none of the students that participated in the study had worked on any of the targeted concepts during that school year. To see if there could be a difference in how often the students might have been exposed to the concepts in previous school years, the researcher looked at the schools' curriculum maps. Curriculum maps are guides created by the school districts in the state where the study took place which show what concepts are to be targeted at each grade level in each subject. When looking at the maps, some of the difference in mastery could be due to the high probability that Tier 1 (i.e., "Life Cycles") and Tier 2 (i.e., "States of Matter") were more apt to have been introduced in previous classes according to the district's curriculum maps which showed that Tier 3 (i.e., the "Food Chain") was not targeted until third grade. Tier 1 was listed on the

curriculum maps to be taught in second and third grades and Tier 2 for first through third grades.

There was more inconsistency with the real object generalization probes. Although none of the participants had a 100% average for all three tiers in Probe 4, 3 participants did have 100% average on at least one tier from either Tier 2 or Tier 3. This indicates that the participants at Blue Elementary had difficulty generalizing the targeted concepts to real life examples. The students' ability to generalize concepts to real life examples ranged from 2 to 6 real object examples. More research is needed to see if this was due to the real object examples chosen or the amount of information provided about the targeted concepts in the instructional activities. See Tables 11-14 for more information about which students identified which real life example correctly during the probe sessions.

The study was started with enough time before the end of the school year for the students to master all three tiers with two sessions per day. Although the students at Blue Elementary did not always have two sessions every school day, 3 of the students reached criteria on all three tiers. As previously noted, limited data were collected at Cohen Elementary, making it impossible to say if the intervention would have been effective or not given more time. The reasons why there were not more data collected is discussed later in the section on consistency of scheduled sessions. That being said, there were some interesting points to consider when looking at the participants and data from the two schools and how the two teachers implemented the program. There were 3 students from Cohen Elementary whose demographics and cognitive functioning abilities were comparable to the students from Blue Elementary. None of the 3 students from Cohen Elementary had reached criterion on Tier 1 before the study was concluded due to the end

of the school year. Their data can be found in Table 15. One of the students had 2 days at 100% correct after 21 sessions. When looking at the data from Blue Elementary, it took the participants from 7 to 36 sessions to reach criterion on Tier 1. Since it took 3 of the 4 participants from Blue Elementary 15 or more sessions to master this tier, this strongly suggests there was a possibility this student may have mastered Tier 1 given more time to do so. The other 2 students from Cohen Elementary did not have similar data. It is not possible from looking solely at the data to ascertain if these 2 students just needed more time, a change to the instructional program either with the activity or more instruction using the computer, or that they could not learn within this format.

Efficiency

The efficiency data varied per student per tier. The students needed more time to master Tier 1 than the other two tiers. This discrepancy could suggest several things. It could suggest Tier 1 was the hardest for students to master since 3 out of 4 of the students needed more than twice as many sessions to reach criterion on this tier. It also could be a result of the students' needing more time to adjust to learning on the computer or the activity itself. If the students just needed time to adjust to learning on the computer or to the activity itself, this might indicate that the efficiency would improve over time since some students only needed six sessions to master a tier of six target stimuli. It must be kept in mind that the data show testing effects may have occurred. This concept will be addressed in the following section.

There were a number points for discussion, which either did or may have negatively impacted the results. Some of these points are a result of there being little research with students with moderate to severe disabilities being taught academic content on the computer. There is useful information that can be gleaned from the results, as

well important considerations for research in this area. The results and considerations can be used to guide teachers in planning academic instruction using the computer until more research in this area is published.

Time Factor

As previously noted, the researcher and her co-chairs decided the students should have two instructional sessions per day to allow the students plenty of time to reach criteria before the end of the school year. Although both teachers agreed to do so, neither teacher was able to schedule computer sessions at a specific time each day. Teachers were asked to have a morning session and an afternoon session so that the sessions were not close together. Both participating teachers made sure there was at least 3 hrs between sessions.

The students at Cohen Elementary did not have sessions twice a day on a regular basis or a regular daily session due to several reasons, according to the teacher. These reasons included teacher availability, student absences, student schedules, school wide activities, and teacher priorities. Although the researcher made frequent contacts and visits and the teacher appeared eager to participate, there was a less than desirable schedule of implementation. If the students at Cohen Elementary had sessions more consistently, there would have been more data to analyze for results. Although the students at Blue Elementary did not have two sessions every day, the students typically had at least one session per day on a regular basis. This variance could have resulted in more students from Blue Elementary reaching criteria compared to none of the participants from Cohen Elementary making it through criterion on Tier 1.

Since 3 participants reached criteria on all three tiers, more time would have shown whether the other participants could have done so as well. Christian reached

criteria on the first two tiers, but was not able to start Tier 3. Jack from Cohen Elementary had one session at 100% on Tier 1 by the end of the study, but had not gotten through criteria (i.e., 3 sessions at 100%). More time would have shown if he could get through criteria on Tier 1 and possibly the other tiers.

Number of Mastered Stimuli Prior to Intervention

The data from the initial probe sessions showed that the students had mastered some of the stimuli before the intervention had been implemented. Elijah identified 7 and Abbie identified 6 target stimuli correctly on the first set of probe sessions, while the other students did not consistently identify more than 3 stimuli correctly from the following: (a) targeted stimuli, (b) non-targeted stimuli, or (c) real life objects. There was no pattern across stimuli or students. In some cases, the student's data from the teacher probe sessions showed the student had mastered a stimulus, but the data on the computer probe did not show the same result. As a result of the lack of pattern of mastered stimuli across students and due to limited time and difficulty of recreating the computer activities, a decision was made to not change any of the stimuli. In the following instance, it provided some interesting information.

Abbie's initial teacher probes revealed she had already mastered 5 out of the 6 concepts for Tier 1, but, on the computer probes, she never had a session above 50%. Looking at her teacher probes, one might assume she would master the Tier 1 quickly, but, in reality, it took her 18 sessions to master the stimuli on the computer and only 6 and 7 sessions, respectively, to master the next two tiers where her initial probe data were below 33%. Since the exact same pictures were used to probe the students during the teacher and computer probe sessions, this suggests that she needed to either get familiar with the program or working on the computer.

Narrow teaching on concepts

Stimuli were chosen based on how well they related to the concepts being targeted. An attempt was made to choose concepts and stimuli that were as concrete as possible. As with gases for Tier 2 (i.e., "States of Matter"), this was not always possible. This was done to reduce the chance that the students did not learn the stimuli as a result of it being too hard or abstract for them to learn versus having difficulty learning it on the computer. Stimuli were also chosen that the students most likely would recognize. This was done so that the students could apply a new concept to that stimulus versus learning to both identify what the stimulus was and learning the concept to which it was related.

This was problematic in several ways. First, several of the students already connected some of the stimuli to the related concept before instruction was implemented. Second, the teachers stated that, at times, the students identified or chose a picture due to its familiarity. For example, the teachers said for more than one student, "They love dogs, they'll always pick the dog," and they often did. This seemed to be more of a problem if people or animals were involved versus objects.

The researcher and her dissertation committee co-chairs decided that just examples of a concept would be taught versus providing more information about the concept either in the antecedent or as feedback. This was done to see if the students could learn basic examples of the concepts and if any generalized occurred before trying to teach more information about the concept itself. The data show that the 3 students who mastered all three tiers did not master all of the related non-target or generalize the concept to the real object examples. This could have been due to either poor choices for these stimuli or that the students needed more information on the concept before they could generalize the information. Several of the students had more sessions at 100% for

the "States of Matter" tier for the non-target stimuli and/or the real object probe sessions, suggesting that this tier may have been easier to generalize either due to the concept itself or the examples chosen.

Testing Effects

For each of the probes, the students were shown all of the stimuli twice. They saw them once during the teacher probes and again during the computer probes. The students were probed for three sessions before intervention began and a minimum of three sessions after reaching criterion on a tier. This meant that the students were exposed to the stimuli six times each time they were probed. The one exception was for the real object probes to test for generalization which were only probed by the teacher, and, as a result, the students only saw them three times each time they were probed. Being exposed to the stimuli that many times could have led to testing effects wherein the students began to learn the information from repeated exposure. This could be why Elijah had 100% accuracy on the computer probes before he began intervention on Tier 3 (i.e., the "Food Chain"). Although it was necessary to probe the students on and off the computer to assess the effects of using the computer on the student's behavior, it also may have led to the students learning the information before intervention, and as such became a limitation.

Inconsistent Data

The data patterns were not the same for all students and, as a result, were difficult to interpret. Some of the students scored higher on the teacher probes than the computer probes; others scored higher on the computer probes. This variance was not consistent across students or tiers. Some students mastered the non-target and real object examples; others did not. Some students mastered concepts on certain tiers and not on others. Lack

of consistency between, teacher vs. computer probes, tiers, students, and maintenance of mastered stimuli made it difficult to make generalizations beyond noting that all of the students' data improved after the intervention was implemented. If anything, it seems to reaffirm the individuality of each student as a learner.

History

History was a limitation regarding the stimuli, and possibly was also a difference between the schools. History could have been a weakness related to past exposure to the stimuli. Many of the students answered at least one question correctly during the initial probes on each tier suggest they already had been exposed to the content at some time. It is also not possible to rule out that the students may have guessed on some of the answers. The teachers indicated that the content had not been targeted for direct instruction for any of the students during the current school year. Even so, the content was chosen due to age appropriateness, reasonable simple concepts, concepts the students might relate to, and, as such, the concepts were ones that might have been covered in past educational experiences. This may have resulted in the students remembering information previously taught after multiple exposures on the probes. This was not seen at both schools, suggesting that either the exposures were not the same or other factors played a more important role in the outcomes.

Another way that history may have had an effect was with computer familiarity. Both teachers indicated that the students were familiar with using the computer and doing activities on the computer. Both teachers also indicated that their students used an Edmark reading program on the computer. The students from both schools also performed similarly on the initial computer activity to check their ability to complete an activity similar to the instructional activities and the probes used in the study. The

difference was that, during the probe and instructional activities, there was an observable difference in how the students from each school responded to the program. The students from Cohen Elementary often started clicking before the complete question had been asked. They also would click more than once so that, at times, the screen would change in response. They would still be clicking and clicked on the correct answer, but it was done so quickly that it was doubtful they knew what they had clicked on. On the other hand, the students from Blue Elementary would wait until a question had been fully stated before responding, and then clicked once, pausing and then clicking a second time, if needed. By doing so, they appeared to be listening attentively to the questions and heard all of the instructive feedback. This indicates that students with less history learning on the computer might need to be taught to wait and only click once before starting a computer instructional activity. This is a basic skill that all students need to master due to the amount of technology an individual encounters on a regular basis in our society.

Maintenance

It was not possible to collect maintenance data after the participants had mastered all three tiers. As a result, no statement can be made regarding the students maintaining the information they learned over time, which is critical information. Some maintenance data were collected through regular probes for the students at Blue Elementary who had mastered tiers. Christian and Elijah's probe data suggest that they tended to maintain both target and non-target mastered stimuli more consistently than the other 2 participants. Abbie's and Blair's data were not as consistent throughout the study. Blair dropped to 83% correct on some of the target stimuli probes and down to 66% on non-target information, indicating she had missed at least one concept during those probe sessions. Abbie dropped to 83% correct on some of the probes after reaching criterion on a tier and

down to 66% on the final computer probe for Tier 3 for the target stimuli. For the non-targeted stimuli, she did not stay at 100% accuracy on all probe sessions for any tier after reaching criterion on that tier. Future research should include more maintenance data to evaluate students' mastery over time.

Disability Related Concerns

One student from each school that participated in the study had been diagnosed as having autism. Both students were verbal, could follow directions, and could memorize facts well. When creating these activities, the investigator hypothesized that a student with autism would like the structure of the activity, like that it was on the computer, and like the computer-generated voice. According to their teachers and some observation, this was not the case. Christian from Blue Elementary was able to master the first two tiers, but his teacher noted that he became frustrated easily with the program and tended to guess the first picture in the row of three until he began to learn the correct answer. Kenzi from Cohen Elementary did not master any tiers, and her data show she made little progress during the intervention. She had difficulty attending and tended to continuously click the mouse even when not looking at the screen and always picked an animal if it was a choice. In an attempt to improve her attending behavior, two strategies were used. The teacher gave her verbal cues to stay on task and verbal praise for clicking the correct answer even if it was during the instructive feedback screen. A portable divider was placed behind her in an attempt to reduce classroom distractions. No difference was observed in her behavior after each strategy had been implemented. This suggests it is critical to make ongoing decisions relating to how a certain student is reacting to and performing on CAI. In the future, it would be beneficial to look at whether the visual or

auditory changes make a difference in the students' attending, such as using line drawings or comparing computerized speech to recording a human voice.

Another student from Cohen Elementary had little change in his data at the end of the study. At the beginning of the study, the teacher thought he would be a good candidate; he had all of the prerequisite skills, and he did well on the sample activity created by the researcher. After a few weeks into the study, the teacher noted that this student had a degenerative disease and, based on her observations, it had become worse. She was concerned it was affecting his ability to answer the questions correctly and within the allotted amount of time. The teacher and the researcher decided to keep him in the study and noted her concerns since participating in the study was not having a negative impact on the student and he had not expressed that he did not want to participate.

Social Validity

When speaking with the teachers, they were both excited about the possibilities of the study and in finding another way they could support their students that would not involve more staff. At the end of the study, both teachers indicated by email that they liked the program and the possibility of having a program they could adapt for individual student needs.

The teachers were also asked if they thought the students liked the computer activities. The teacher from Cohen Elementary noted that Jack attended to the program and indicated he enjoyed it. Although Derek and Kenzi did not always attend once they began a computer activity, they appeared happy (i.e., smiling, and quick to comply) to work on the program when asked. The teacher from Blue Elementary indicated that, with the exception of Christian, her students were excited to work on the computer and often

asked if they could do more. Christian was compliant in going to the computer to work, but, as previously noted, could become agitated when starting a new tier where he did not know the correct response.

The researcher asked the students near the middle of the study if they liked working on the computer activities and they all indicated that they did. The students often asked the researcher once they finished their activity if they could do more science activities on the computer.

Classroom Implications

The results were mixed, and there are several limitations of the study to consider. At the same time, this study can provide classroom teachers with important considerations to consider when planning computer instruction for their students. Although the teachers picked students they believed were suited for the content and presentation format, all students did not perform or attend in a similar manner. All students had performed in a similar fashion to the shortened computer activity they completed prior to the intervention. As previously noted, the students from Cohen Elementary had difficulty waiting for the questions. They also had a difficult time clicking only once and waiting before clicking again, if needed. This indicates that teachers need to observe students over time working on the computer and provide instruction, as needed, to improve the student's computer skills. This might mean the students need more support from classroom staff until they have learned to navigate a program appropriately. Teachers also need to keep in mind that just because students with MSD can interact correctly on one computer program does not mean he or she will generalize those skills to other computer programs.

Teachers also should be aware that students might not generalize information they know to the computer. This was seen in teacher probes versus computer probes even though the exact same pictures were used. Teachers need to be aware that it might take the students longer to learn something on the computer initially, but this time might be reduced as they become more familiar with the computer program. This was indicated by 3 of the students taking longer to master Tier 1 than the other tiers. Also, teachers should be aware that students with MSD can learn core content on the computer as indicated by 4 students mastering two tiers and 3 of these students mastering all three tiers. More research needs to be done to thoroughly investigate what type of content and how much content students with MSD can master on the computer.

Implications for Future Research

As previously noted, research has shown that students with MSD can learn a variety of skills, including sight word identification and communication skills, when taught using the computer. The data from this study suggest that students also can learn academic content on the computer. This study offers several areas that need to be investigated further. The two broad areas that will be addressed include changes needed in replication and implementation and stimuli considerations.

Replication and Implementation Considerations

Initially, the study should be replicated to see if the results of the 4 students from Blue Elementary could be replicated with the students participating in future studies mastering some or all of the science content presented. Due to the end of the school year, it was not possible to tell if the students from Cohen Elementary would have reached criterion on the first tier if given more instructional sessions. Jack from Cohen Elementary had two non-consecutive sessions at 100% within his18 intervention sessions

he had before the school year ended. It took Christian from Blue Elementary took 33 sessions to reach criterion on the first tier, but we do not know if Jack would have reached criterion given more instructional sessions. Therefore, future research should plan to implement the study for a longer period of time. To do this, it would be helpful if the study started closer to the beginning of the school year to increase the chance that all of the participants would have time to master some or all the tiers. This also would allow for maintenance data to be collected to ensure the students maintained the stimuli after the intervention has been completed.

Future research also should put more emphasis on when and how often the intervention sessions occurred. In this study, Blue Elementary had a more consistent schedule for implementation. This was the school where more students reached criteria on all three tiers. Without more data, it is impossible to tell which factors may have had more effect on the students who reached criteria and those who did not reach criterion on any tier. Controlling for this factor will reduce the limitations in future research.

Stimuli considerations. Several of the students were not consistent but did have some correct responses on the initial probes. In future research, content should be identified which is still appropriate for the students but where the students have lower rates of correct responses on the initial probes. This would help rule out that the students had previous knowledge of the content information but had forgotten it versus they learned the information from the program.

This study only examined if it was possible to teach a few examples of a broad concept. This was done to see if the students could learn basic information related to science content before trying to teach broader concepts. The idea was that, if the study was successful, teachers could use the intervention to teach students basic terms to build

a foundation before the broad concept was taught. Once the intervention has been shown to be effective, future studies could examine if more in-depth academic content could be taught using CAI. Future research could look at adding instructive feedback that teaches key characteristics that make up the concept instead of just teaching examples of the concept. For instance, when teaching examples of a solid the instructive feedback could be "you cannot put your hand through a solid." By increasing the level of learning in each study, it will be easier to identify how much and what type of information students with MSD can learn through CAI.

The other issue relating to stimuli that needs to be addressed in future research is the number of stimuli. Since the students were identifying the stimuli receptively, there was more of a chance that the students guessed on some of the answers, which could account for some of the variability in the data. Although it is recommended that only a few stimuli be taught at a time to students with MSD, more non-target or real life examples could be used. Increasing the number of stimuli used in these areas would give more information as to whether the student could truly acquire the non-target information or generalize the concept versus the possibility that the example used was one they already knew. It also would give more information as to whether the stimuli chosen were bad examples due the picture or the real object used, or to the students experience with the example.

Conclusion

Overall, the results from the study are promising. The 4 students from Blue Elementary were able to reach criteria on two tiers, and 3 of those students were able to reach criteria on all three tiers. These students also had an increase in their probe data for the nontargeted and real life examples probe sessions when compared to their initial

probe sessions. Although none of the participants from Cohen Elementary mastered Tier 1 before the end of the study, Jack showed promise in that he had two sessions at 100% before the end of the study. Both teachers and students had positive comments regarding using the computer for science instruction. With teacher time limited and students having diverse educational needs and goals, using CAI to teach academic content may offer an equitable solution to better meeting students' educational needs.

Appendix A

Sample of Permission Form

Parental Consent for a Child to Participate in a Research Study

Teaching Students with Moderate to Severe Disabilities

Science Content Using Computer Assisted Instruction

WHY ARE YOU BEING INVITED TO TAKE PART IN THIS RESEARCH?

Your child is being invited to take part in a research study about learning science content using computer assisted instruction where the student is taught the content by the computer. Currently in Kentucky the state science standards are required to be taught to all students. Your child is being invited to take part in this research study because of their qualification for special education services. Your child also meets the other qualifications for this study which include being able to participate independently in an activity for 5 min or more, and the ability to use a mouse to make choices on a computer. If you allow your child to participate in the study, they will be one of approximately six students who will participate.

WHO IS DOING THE STUDY?

The person in charge of this study is Amy Berrong a doctoral student at the University of Kentucky Department of Special Education and Rehab Counseling. She is being guided in this research by Dr. John Schuster and Dr. Belva Collins. There may be other people on the research team assisting at different times during the study.

WHAT IS THE PURPOSE OF THIS STUDY?

Similar research has shown that computers can successfully teach students with moderate to severe disabilities other skills such as communication and shopping skills. The goal of this study is to see if students with moderate to severe disabilities can learn science content from the Kentucky standards when they are taught using the computer. If this study shows positive results it could allow teachers to have more options to better individualize instruction to meet individual student needs more efficiently.

WHERE IS THE STUDY GOING TO TAKE PLACE AND HOW LONG WILL IT LAST?

The study will take place in your child's classroom and last until the students participating have mastered the targeted science content or until the conclusion of the study.

WHAT WILL YOUR CHILD BE ASKED TO DO?

The researcher will check to see how much of the science information your child has already mastered. Then your child will be asked to complete computer activities created by the researcher (Amy Berrong), which takes 10 min or less to complete. They will complete these activities 5 times each week until they reach criteria at time decided upon by your child's teacher. The researcher will then check to see how much of the science information they can recall both on paper and on the computer to see how much of the information they retain after the intervention has been completed.

ARE THERE REASONS WHY YOUR CHILD SHOULD NOT TAKE PART IN THIS STUDY?

Your child will not be asked to do anything that has not already been approved as academic content for all students. Standard instructional procedures will be used that are proven to be successful with other special education students.

WHAT ARE THE POSSIBLE RISKS AND DISCOMFORTS?

To the best of our knowledge, the things your child will be doing have no more risk of harm than they would experience in everyday life.

WILL YOUR CHILD BENEFIT FROM TAKING PART IN THIS STUDY?

There is no guarantee that your child will get any benefit from taking part in this study. However, many students have learned new skills and information or improved their skills when using computer-assisted instruction and errorless learning procedures. Your allowing your child to take part, may in the future, help society as a whole better understand this research topic.

DOES YOUR CHILD HAVE TO TAKE PART IN THE STUDY?

If you allow your child to take part in the study, it should be because you really want them to participate. They will not lose any benefits or rights they would normally have if you choose for them not to participate. You can choose for them to stop at any time during the study and still keep the benefits and rights they had prior to participating in this study. If you decide for your child to not to take part in this study, your decision will have no effect on the quKenzity of care, services, etc., your child receives.

IF YOU DON'T WANT YOUR CHILD TO TAKE PART IN THE STUDY, ARE THERE OTHER CHOICES?

If you do not want your child to participate in the study, there are no other choices except not to take part in the study. Your child will continue to receive the instruction they are currently receiving whether or not you choose to allow your child to participate in this study.

WHAT WILL IT COST YOU TO PARTICIPATE?

There are no costs associated with taking part in this study.

WILL YOU RECEIVE ANY REWARDS FOR TAKING PART IN THIS STUDY?

Neither you nor your child will receive any rewards or payment for taking part in the study.

WHO WILL SEE THE INFORMATION COLLECTED ON YOUR CHILD?

Your child's information will be combined with information from other students taking part in the study. When we write about the study to share it with other researchers, we will write about the combined information we have gathered. Your child will not be personally identified in these written materials. We may publish the results of this study; however, we will keep your child's name and other identifying information private.

We will make every effort to prevent anyone who is not on the research team from knowing personal information about your child. Only initials or a fictitious name will be used to identify your child and during the study your child's data will be stored in their classroom at school or in the researcher's office at the University of Kentucky.

We will keep private all research records that identify your child to the extent allowed by law. Also, we may be required to show information which identifies your child to people who need to be sure we have done the research correctly; these would be people from such organizations as the University of Kentucky.

CAN YOUR CHILD'S TAKING PART IN THE STUDY END EARLY?

If you decide to allow your child to take part in the study you still have the right to decide at any time that you no longer wish your child to participate in the study. Your child will not be treated differently if you decide that your child should stop taking part in the study.
The individuals conducting this study may need to withdraw your child from the study. This may occur if your child has already mastered the information being taught, they refuse to follow directions related to the study.

WHAT HAPPENS IF YOUR CHILD GETS HURT OR SICK DURING THE STUDY?

There is nothing related to this study that might cause your child to get hurt or sick during the study. If your child is hurt or gets sick during the study and can no longer continue, you should call Amy Berrong at 859-245-0563 immediately.

WHAT IF YOU HAVE QUESTIONS, SUGGESTIONS, CONCERNS, OR COMPLAINTS?

Before you decide whether to accept this invitation for your child to take part in the study, please ask any questions that might come to mind now. Later, if you have questions, suggestions, concerns, or complaints about the study, you can contact the investigator, Amy Berrong at 859-245-0563. If you have any questions about your child's rights in this research, contact the staff in the Office of Research Integrity at the University of Kentucky at 859-257-9428 or toll free at 1-866-400-9428. We will give you a signed copy of this consent form to take with you.

WHAT ELSE DO YOU NEED TO KNOW?

You will be told if any new information is learned which may affect or influence your willingness to continue taking part in this study.

You do not give up your legal rights by signing this form.

_____ _____
Signature of person agreeing for their child to take part in the study Date

_____
Printed name of person agreeing for their to take part in the study

_____ _____
Name of [authorized] person obtaining informed consent Date

Appendix B

Teacher Probe Data Sheet

Student: _____

Key	
+	Correct
-	Incorrect
NR	No Response

Date					
Initials of instructor					
Targeted Stimuli					
Solid- Apple					
Books					
Liquid- Water					
Orange juice					
Gas- Steam from pot					
Steam from tea kettle					
Begin stage Butterfly eggs					
Frog eggs					
Growth/develop Caterpillar					
Pollywog					
Reproduction Butterfly					
Frog					
Producer-Grass					
Plant					
Consumer- Dog					
Cow					
Decompose- Mold					
Fungi					
Total Correct					
Total Incorrect					
% Correct					

Date					
Initials of instructor					
Non-targeted Stimuli					
Solid- ball					
Liquid -paint					
Gas- air					
Begin- plant seeds					
Growth- seedling					
Repro- producing plant					
Producer- tree					
Consumer- people					
Decomp-Worms					
Total Correct					
Total Incorrect					
% Correct					
Milk					
Cup					
Air in balloon					
Plant					
Fish					
Moldy Bread					
Mantis					
Eggs					
Larvae					
Total Correct					
% Correct					

Appendix C

Reliability Data Sheet

Teacher Probe Session

Probe Reliability Sheet
Materials ready _____
Student _____

Key

+	Correct
-	Incorrect
0	Verbal praise

Date	A	P	R		
Targeted Stimuli					
Apple					
Books					
Water					
Orange juice					
Steam from pot					
Steam from tea kettle					
Butterfly eggs					
Frog eggs					
Caterpillar					
Pollywog					
Butterfly					
Frog					
Grass					
Plant					
Dog					
Cow					
Mold					
Fungi					
Total Correct					
Total Incorrect					
% Correct					
Observed/planned					

	A	P	R		
Non-targeted Stimuli					
Ball					
Paint					
Air					
Plant seeds					
Seeding					
Producing plant					
Tree					
People					
Worms					
Total Correct					
Total Incorrect					
% Correct					
Milk					
Movie Box					
Air in balloon					
Plant					
Fish					
Moldy bread					
Mantis					
Eggs					
larvae					
Total correct					
% correct					

attention – A /1 present trial- P /36 student response – R FRS= /12

Dependent reliability: ____ x 100 =
36

Appendix D

Reliability Data Sheet

Computer Session

Computer Probe Reliability Sheet
Directions given:_____
Student _____

Key

+	Correct	√	Sequence correct
-	Incorrect	X	Sequence incorrect
0	Verbal praise		

Date	Screen 1	R	P		
Targeted Stimuli					
Apple					
Books					
Water					
Orange juice					
Steam from pot					
Steam from tea kettle					
Butterfly eggs					
Frog eggs					
Caterpillar					
Pollywog					
Butterfly					
Frog					
Grass					
Plant					
Dog					
Cow					
Mold					
Fungi					
Total Correct					
Total Incorrect					
% Correct					
Observed/planned					

	Screen 1	R	P		
Non-targeted Stimuli					
Ball					
Paint					
Air					
Plant seeds					
Seedling					
Producing plant					
Tree					
People					
Worms					
Total Correct					
Total Incorrect					
% Correct					

Screen 1 (correct screen) /25 student response - R /16 / 9 P (praise) FR3= /12

Appendix E

Reliability Data Sheet

Instructional Session

Reliability data sheet for computer sessions

Student _____ Key : Computer Trial (C Trial)= √ correct sequence X incorrect seq.

Computer on: Y / N Activity on: Y / N Student response: + = correct - = incorrect N/R= no response

O = verbal reinforcement

Data	C Trial screen 1	Screen2	Screen 3	Student response Before prompt	After prompt	Feed-back
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
Total observed						
Total planned						
Total correct						

Notes:

Appendix F

On-task/Computer Functioning

Data Sheet

Student ____________________________

Key

+	Working correctly	S	Problem w/ sound
-	Not working Correctly	P	Problem w/ page
0	On task	A	Problem w/ activity
/	Off task		

Date:		*		
		**		
Computer			Student	
Computer			Student	
Computer			Student	
Computer			Student	
Computer			Student	
Total				

Date:		*		
		**		
Computer			Student	
Computer			Student	
Computer			Student	
Computer			Student	
Computer			Student	
Total				

Date:		*		
		**		
Computer			Student	
Computer			Student	
Computer			Student	
Computer			Student	
Computer			Student	
Total				

Date:		*		
		**		
Computer			Student	
Computer			Student	
Computer			Student	
Computer			Student	
Computer			Student	
Total				

* Initials of data collector
** list problem with computer

Appendix G
Data Print Out from an Instructional Session

Berrong, E

Science information data **Turned in 01/02/10**

Elapsed time: 02:41

Score:	**50%**	**Correct on first try:**	**3 / 6**
		Total correct	**3 / 6**

Page 1, Text Box

Question:

Correct answer(s): apple

✗Response 1: appleapple 01/02/10, 3:45:03 PM

solid, Text Box

Question:

Response 1: solids 01/02/10, 3:45:03 PM

Page 2, Text Box

Question:

Correct answer(s): water

✗Response 1: Left Blank by Student 01/02/10, 3:45:03 PM

liquids, Text Box

Question:

Response 1: liquids 01/02/10, 3:45:03 PM

Page 3, Text Box

Question:

Correct answer(s): steam

★Response 1: steam 01/02/10, 3:45:03 PM

Gas, Text Box

Question:

Response 1: Gas 01/02/10, 3:45:03 PM

Page 2 #3, Text Box

Question:

Correct answer(s): juice

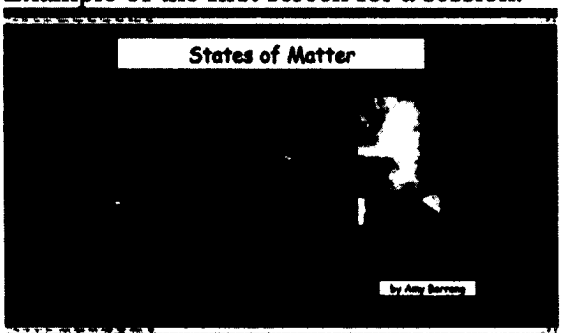
✗Response 1: Left Blank by Student 01/02/10, 3:45:03 PM

	liquids #2, Text Box	
Question:		
Response 1:	liquids	01/02/10, 3:45:03 PM
	Page 1 #3, Text Box	
Question:		
Correct answer(s):	books	
★Response 1:	books	01/02/10, 3:45:03 PM
	solid #2, Text Box	
Question:		
Response 1:	solids	01/02/10, 3:45:03 PM
	Page 3 #3, Text Box	
Question:		
Correct answer(s):	steam	
★Response 1:	steam 01/02/10, 3:45:03 PM	
	Gas #2, Text Box	
Question:		
Response 1:	Gas	01/02/10, 3:45:03 PM

Appendix H

Screen Shots

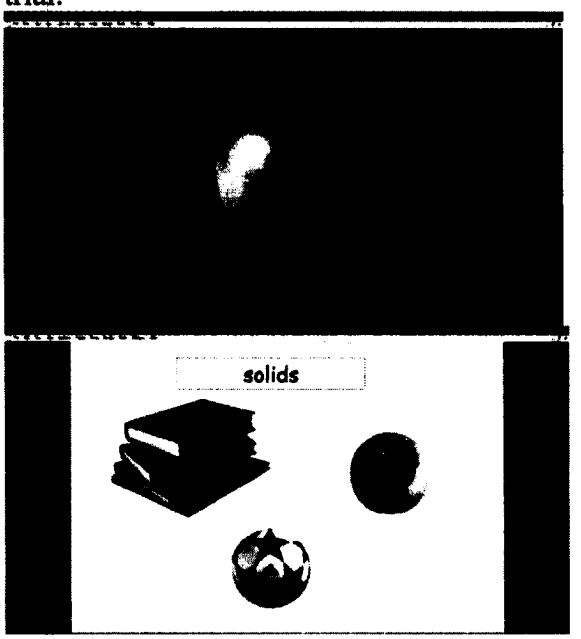
Example of the first screen for a session.



1. Example of the first screen of trial

2. Example of a screen for an incorrect response.

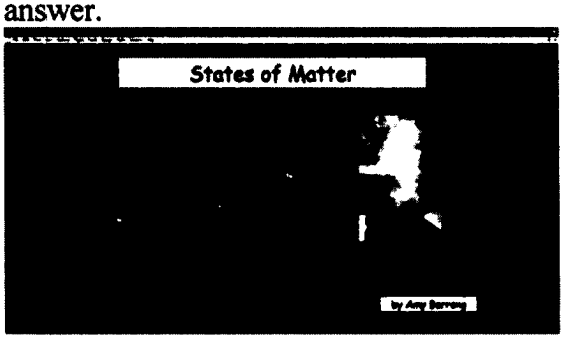
3. Example of the final screen for each trial.



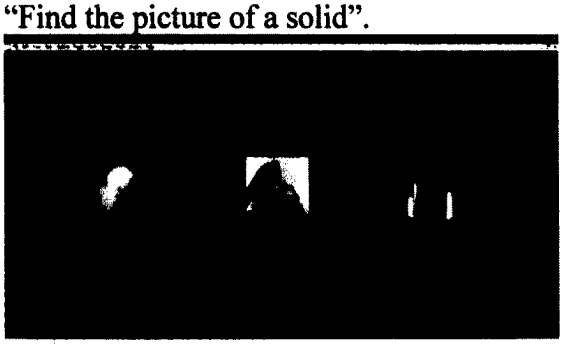
Appendix I

Example Trial Script

Beginning of Session The student will see this screen and hear: Today we are going to learn about the "States of Matter". "States of Matter" are solids, liquids, and gases. You will be shown 3 pictures and asked to find a state of matter. You need to click on the correct picture or wait if you do not know the answer and the computer will give you the answer.



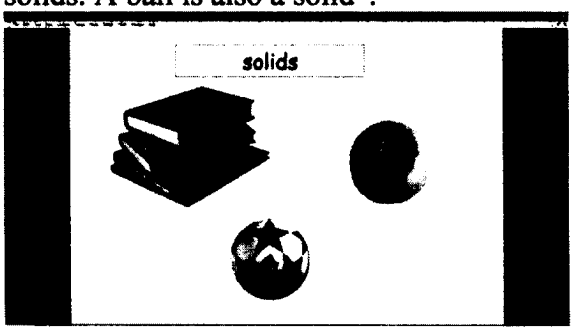
An example of a trial The student will see a screen with 3 pictures and be asked to "find the picture of _____." Below is an example of what the students will see when they hear: "Find the picture of a solid".



If they click on the wrong answer, a screen will come up which shows only the correct answer and they will hear "A ____ is a _____". Below is an example of what the student will see if they choose the wrong picture for solid. They will hear " An apple is a solid. Click on the apple".

Example of a trial

When the student clicks on the correct answer (in either of the above 2 screens) they will be shown a screen which shows the 2 correct answers from the trials and a third example. For the below example they would "Good you found the solid. Books and apples are solids. A ball is also a solid".

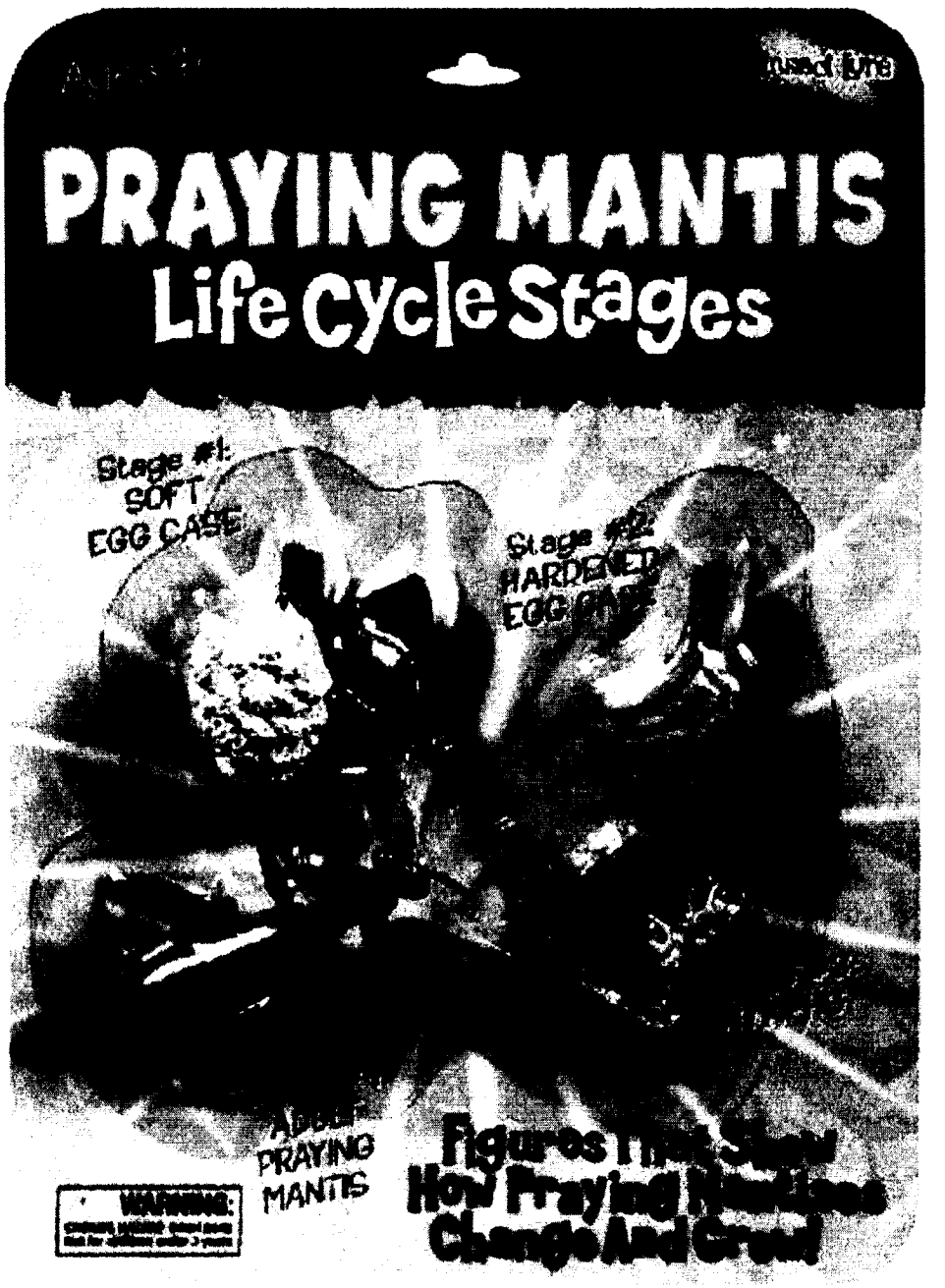


This above sequence will be used for all trials with only the pictures changing depending on the target stimuli.

Appendix J

Picture of the Praying Mantis Pieces used for

Generalization Stimuli for the "Life Cycle" tier.



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*Indicates an article noted in the literature review in Table 2.1.

VITA

NAME:	Amy Ketterer Berrong
DATE OF BIRTH:	January 3, 1973
PLACE OF BIRTH:	Lexington, KY

EDUCATION:

2004	NBC – National Board Certification, Special Education
1998	M.A. – University of Kentucky, Lexington, KY, Special Education Moderate to Severe Disabilities, Emphasis in Applied Behavior Analysis
1995	B.S. – University of Kentucky, Lexington, KY, Speech-Language Pathology

PROFESSIONAL EXPERIENCE:

2006 - present	Consultant, Central Kentucky Cooperative, Lexington, Kentucky.
2006 - 2008	Consultant, Bourbon County Schools, Paris, Kentucky.
1998 – 2005	Teacher, Cane Ridge Elementary, Paris, Kentucky.
1997	Adult Support Aide, ARC of the Bluegrass, Lexington, Kentucky.
1995 – 1998	Instructional Assistant, Tates Creek Elementary, Lexington, Kentucky.

LICENSURES/CERTIFICATIONS:

Distance Education Graduate Certificate

Kentucky Teaching Certificate - Moderate and Severe Disabilities (K-12)

National Board Certification- Special Education (K-12)

UNIVERSITY TEACHING:

University of Kentucky

EDS 530 Introduction To Moderate & Severe Disabilities (co-taught)

EDS 630 Methods for Teaching Students with Disabilities (co-taught)

EDS 651 Distance Education: Delivery (co-taught)

HONORS AND AWARDS:

2005 Teacher of the Year, Central Kentucky Cooperative, Kentucky.

2002 Teacher of the Year, Central Kentucky Cooperative, Kentucky.

PUBLICATIONS:

Articles in Refereed Journals

Berrong, A. K., Schuster, J. W., Morse, T. E., & Collins, B. C. (2007). The effects of response cards on active participation and social behavior of students with moderate and severe disabilities. *Journal of Developmental and Physical Disabilities, 19,* 187-199.

Pennington, R., Horn, C., & **Berrong, A.** (2009). An evaluation of the differences between big city and small town special education services for students with low incidence disabilities in kentucky. Rural Special Education Quarterly, 28, 3 – 9.

PROFESSIONAL ACTIVITIES:

Professional Memberships

Council for Exceptional Children (CEC)

Teacher Education Division (CEC-TED)

American Council for Rural Special Education (ACRES)

SELECTED CONSULTATIONS (since 1986):

2006 Bourbon County Schools, Lexington, KY.

SELECTED CONFERENCE PRESENTATIONS:

"Evidence-Based Practices in Education Intervention for Students with Autism Spectrum Disorders." With Melinda Ault, Ann Katherine Griffen, Channon Horn, and Robert Pennington, March 2009, Denver, CO.

"A Model for Mentoring Distance Educators." with Belva Collins, Constance Baird, Melinda Ault, Jason Gibson, Channon Horn, and, Robert Pennington, American Council on Rural Special Education National Conference, March 2009, Denver, CO.

"Perceived Differences Between Rural and Urban Special Education", with Channon Horn, and Rob Pennington, American Council on Rural Special Education National Conference, March 2007, Billings, MO.

SELECTED OTHER PRESENTATIONS and INSERVICES:

"Errorless Learning Strategies" Central Kentucky Special Education Cooperative, Lexington, KY, April 2011.

"Behavior Interventions for Students with Autism" Central Kentucky Special Education Cooperative, Lexington, KY, March 2011.

"Including Students with Autism" Central Kentucky Special Education Cooperative, Lexington, KY, February 2010.

"Building Statewide Capacity in ASD". Central Kentucky Special Education Cooperative, Lexington, KY, January 2010.

"Serving Students with Low Incidence Disabilities in the General Education Settings", Guest Lecture EDC 330, University of Kentucky, September 2009.

"Using TEACCH and Systematic Instruction" Low Incidence Cadre, CKSEC, January 2009.

"Using Communication, Preference Assessments, and Assistants to Enhance Your Classroom" Low Incidence Cadre, CKSEC, September 2008.

"Data Collection" Summer Institute, Central Kentucky Special Education Cooperative, Lexington, KY, June 2008

Poster Presentation at the American Council on Rural Special Education National Conference, "The effects of response cards on active participation and social behavior of students with moderate and severe disabilities", Billings, MO, March, 2007.

Poster Presentation at the National CEC Conference, "The effects of response cards on active participation and social behavior of students with moderate and severe disabilities", Boston, MA, April, 2007.

"The Effective Use of Instructional Assistants in Special Education Programs", Central Kentucky Special Education Cooperative, Lexington, KY, June, 2006.

"Planning for Students with Special Needs ", Bourbon County Preschool, Paris, KY, March, 2001.

Group workshop at the Office for the Education of Exceptional Childrne state Conference, Louisville, KY. with Belva Collins, Meada Hall, Ann Katherine Griffen, and graduates of the UK MSD Master's degree program : "Curriculum for Students with Functional Mental Disabilites".

OTHER SERVICES:

1999 – 2005	County Special Olympics Coordinator
	Bourbon County, Paris, Kentucky
2003 – 2005	Religious Instructor For Special Needs Students
	Christ the King Cathedral, Lexington, Kentucky
2001 - 2003	Sign Language Instructor, Adult Education Programs,
	Bourbon County Schools, Paris, Kentucky.
1996-1998	Volunteer for Horseback Riding for the Handicapped, Kentucky
	Horsepark, Lexington, Kentucky