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Teaching a Science Unit to Students with Disabilities

Utilizing Direct Instruction Methods

Natalie Ann Holt

Utah State University

ABSTRACT

Students with mild to moderate disabilities have consistently struggled to make progress in academic areas, including science. One instructional method which has been shown to help these students make gains across a variety of academic areas is direct instruction (DI). Utilizing DI, this project designed a unit of science instruction for third and fourth grade students with disabilities. A pretest and posttest was given to measure the effectiveness of the instruction. The results showed that for the majority of the students in the study, significant progress was made when DI methods were applied to science curriculum.

CHAPTER I

INTRODUCTION AND RESEARCH BACKGROUND

National legislation has focused teachers' and educational researchers' interest on the importance of instruction in various fields of science. This interest is largely due to the passage of the Elementary and Secondary Education Act of 2001 (ESEA) which mandates that all children grades 3 through 12 will be assessed in mathematics, reading, and science beginning in the 2007-2008 school year. ESEA mandates that by the year 2014, every student, regardless of ethnicity, socioeconomic status, or disability, should be proficient in each of these three academic areas, thus requiring schools to prove that they help students make adequate yearly progress (AYP) (Elementary and Secondary Education Act, 2001).

ESEA has a safe-harbor provision allowing for a percentage of growth each year instead of requiring all students to reach mastery. The safe-harbor relieves some of the pressure on teachers to ensure that students reach mastery. However, many children with disabilities continue to struggle with meeting these standards. While in the past, special education has mostly focused on instruction in reading, writing, and mathematics, huge benefits can be gained by specific science instruction for individuals with disabilities, including increased problem solving and reasoning skills, a greater understanding of their world, and building cause-and-effect relationships, which leads to better decision making skills (Mastropieri & Scruggs, 1992). However, students with disabilities generally receive no specialized science instruction. Most students with disabilities are mainstreamed for science instruction. The only services they receive are accommodations

such as peer buddies, clarified directions, and extra time to complete assignments and tests (Atwood & Oldham, 1985; Steele, 2008). This lack of specialized instruction may account for why students with disabilities perform significantly below their peers on standardized science tests.

An example of one of these standardized tests, The National Assessment of Educational Progress (NAEP), is known as the Nation's Report Card. The NAEP is given each fall nationwide to 4th, 8th, and 12th-grade students, and assesses the areas of reading, mathematics, and science, as well as several other content areas. Because it is administered across all states, the NAEP is considered a satisfactory indicator of overall student performance. The data from the NAEP is disaggregated in a variety of ways and is available to the public (see <http://nationsreportcard.gov>).

Based on the 2005 NAEP results, students with disabilities were much less proficient on the test when compared to their peers without disabilities (NAEP, n.d.). As shown in Figure 1, students with disabilities (SD) master the science portion of the NAEP far less frequently than their non-disabled peers. Although the gap between the achievements of the two groups is at its minimum in the fourth grade year, students with disabilities still lag significantly behind in basic proficiency compared to their peers. This gap increases substantially in Grades 8 and 12.

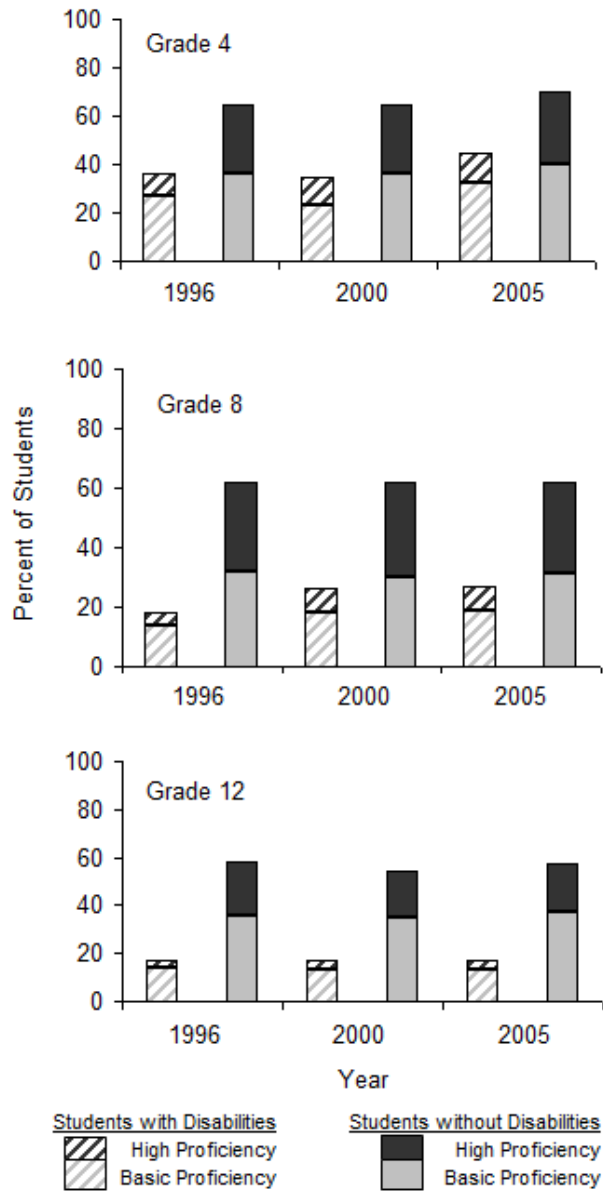


Figure 1. Trend in 4th, 8th, and 12th-grade NAEP science achievement-level performance, by students with and without disabilities.

The Government Accountability Office report found that 37-43% of students with disabilities were excluded or exempted from taking the NAEP in 2002, the year for which the most recent data is available (Shaul, 2005). As it is most likely that proficient students are not the ones being excluded from the tests, it is reasonable to assume that students with disabilities perform even lower and master much less science material than previously reported. This indicates a serious need for improved science instruction for students with disabilities.

Although students in Utah generally perform better than the national averages on standardized tests, state science proficiency rates for students with and without disabilities mirror the NAEP results. Utah students' proficiency levels for AYP are determined by the Utah State Office of Education (USOE). These results are reported on the state website (see <http://www.schools.utah.gov/assessment/>). About 50% less students with disabilities reach proficiency on the state criterion-referenced test (CRT) for science as compared to students without disabilities (see Figure 2 and USOE, 2008). Clearly, more specialized instruction needs to take place to ensure that all students receive appropriate instruction in science each year.

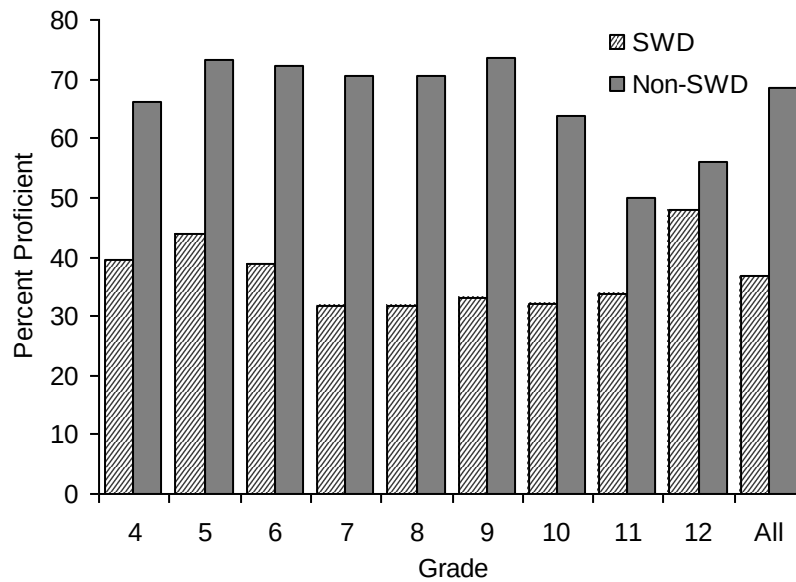


Figure 2. Percent of students with and without disabilities proficient on the 2008 Utah Science CRT, based on data reported by the USOE.

In order to address low levels of proficiency of students with disabilities in the science curriculum, researchers have begun to examine current educational practices in the classrooms and how these practices align with proposed methodologies from national science organizations. As described below, studies are beginning to emerge comparing the effectiveness of different instructional methodologies in science.

Literature Review

Multiple sources were searched for articles relating to teaching science to students with disabilities, including the EBSCO Host database (which also includes ERIC and Academic Search Premier), Google Scholar, college textbooks on instructional methods, articles recommended by committee members, and reference sections from relevant

articles.

Adaptations to traditional methods. Researchers have conducted studies involving adaptations in the science classroom for students with disabilities. A literature review by Mastropieri and Scruggs (1992) covered all studies involving students with disabilities and science. The authors found 66 articles on the topic and separated the articles into those reviewing specific curriculum and those implementing instructional strategies.

The specific curriculum studies reviewed were mostly focused on curriculum developed for students with hearing and vision disabilities. However, seven studies were conducted involving interventions implemented for a variety of students with mild disabilities, including students with learning disabilities, emotional disturbances, and mild mental retardation. These studies, conducted in the 1970s, had sample sizes ranging from a single subject up to 126 participants, but most had 10 to 20 participants. The interventions focused on increasing the number of hands-on activities students participated in. Several methods were employed to assess the studies' effectiveness—some were experimental versus control (Humphrey, 1972; Scruggs et al., 1993), some used a pre-/post-test design (Bennett, 1978; Esler, Midgett, & Bird, 1977), and some recorded observations throughout the studies (Lamendola, 1976; Wilson & Koran 1973). All of these studies reported positive findings for students in the experimental conditions.

Studies involving instructional strategies were separated by several distinguishing features. Most adapted the current text in use or else taught strategies to help students retain more information. Text adaptations included guided notes, dropping the readability level, and increasing the number of diagrams and labels used (e.g., Ferraro, Lee, & Anderson, 1977; Lovitt et al., 1986). Mnemonic devices and specific study skills

instruction were among the strategies used to improve retention (e.g., Holloway, 1989; Scruggs et al., 1987). As in the previous studies, a variety of methods were used to measure the effects of the interventions. Again, all of the instructional strategies implemented showed gains in learning for the participants involved.

Overall, the major finding of Mastropieri & Scruggs (1992) was that any method or adaptation employed for students with disabilities in science improved student learning versus the traditional classroom techniques currently in place.

Constructivist methods. The guiding concept on what good science instruction should look like is based on a series of papers published by the American Association for the Advancement of Science [AAAS]. In 1990, in response to national concerns that American students were not meeting world standards in the realm of science, the AAAS published “Project 2061,” their vision of what quality science instruction should look like (Rutherford & Ahlgren, 1991). Some features of the instructional design concept are that: (a) science is a process which should be discovered through careful observation, (b) scientific inquiry should be used to discover knowledge, (c) no one inquiry approach or set of fixed steps will ever lead unerringly to knowledge, and (d) logical reasoning and inference should be used to seek out knowledge, truth, and understanding.

The methods to be developed based on these principles are interchangeably called constructivism, inquiry methods, experiential, or discovery learning. These methods focus on minimal guidance from the teacher. Learning is primarily the responsibility of the student, and the majority of the class time is spent in students completing authentic experiments relative to the topic. The teacher's role is to guide the students, through questioning, to reach appropriate conclusions based upon the students' experiments, thus

enabling students to “acquire scientific habits of mind” (Schwartz, Abd-El-Khalick, & Lederman, 2000).

Scruggs, Mastropieri, Bakken, and Brigham (1993) compared student learning using constructivist methods versus traditional textbook-based instruction and found significant results. Twenty-six junior high students with learning disabilities were involved in the study. Each of the students was enrolled in one of four special education science courses. Two units were designed, a magnetism and electricity unit and a rocks/geology unit. The unit concepts were aligned across both methodologies, with identical vocabulary and key concepts. A crossover design was used so that all students received both conditions—the activity-based condition and the textbook condition. Students were assigned to the conditions based on their class enrollment. Conditions were chosen by a coin toss. The teachers practiced all lessons ahead of time, under supervision.

Both conditions began and ended identically. Each began with a 5-10 min review of previous material and vocabulary taught. The lessons ended with a 5-10 min summary of concepts covered that day.

In the textbook condition, the remaining 30-40 min of instruction was spent in teacher lecture, reading from the text, and completing paper and pencil activities. The text had been adapted to the students' reading levels and also contained pictures of the experiments being tested in the activity-based condition. Teacher questions were limited to knowledge and direct recall of facts.

In the activity-based condition, students were placed in groups of 3-5, given materials for the experiments, a handout to record their observations, and a goal for the day (e.g., “Find out which of these rocks is the hardest.”). The teacher's role was to coach

and provide procedural information as needed.

Each condition ran for three days, followed by a 24-question test on the fourth day, and an identical delayed test one week later. Results were reported as mean scores, shown in Table 1 below.

TABLE 1
Average Test Results by Condition

	Immediate Test	Delayed Test
Textbook	10.96	11.74
<i>SD (n=22)</i>	5.6	5.5
Activity-based	13.31	14.43
<i>SD (n=25)</i>	4.8	5.8

Note. Maximum score = 24.
Data from Scruggs et al. (1993).

Overall, students scored better in the activity-based learning condition than in the textbook condition. Students reported overwhelmingly to prefer the activity-based condition. These results clearly show that students make more progress using well-designed activity-based lessons than traditional teaching methods.

However, it is concerning that, regardless of condition, neither group really mastered the material presented—the average percent correct was only 60% on the activity-based delayed test, which is barely passing in most junior high classrooms. Also, the standard deviations were very broad for such a small group of students, which implies that student learning was not consistent. While statistically significant progress was made in the activities-based condition, it begs the question, “Was it significant enough to make a difference in the classroom for these students with disabilities?”

In addition, teachers and researchers have voiced concerns about discovery learning. Because there is no set path for learning and because students lead themselves to knowledge, teaching using constructivist methods are difficult, even for experienced teachers. One case study comparing elementary science classroom instruction found that, based on rubrics from the AAAS standards of good science teaching, even the teacher who thought that she was using good methodology implemented it marginally at best. Also, her classroom was just as punitive as the traditional textbook/worksheet-based classroom, with 35% of her student interactions related to discipline (Jeanpierre, 2004). Another case study found that when a teacher does implement constructivist methods faithfully, although student achievement gains are apparent, she spends significantly more time in preparation for the lessons and increased classroom time implementing the lessons (Smith, 2005). In addition, although many teachers of discovery learning classrooms indicate that it is the optimal place to mainstream students with mild disabilities, they also indicate concerns about increased behavior problems due to lack of structure, the need for language skills (reading, writing, and following directions), and the amount of individual help necessary for these students to succeed (Atwood & Oldham, 1985; Scruggs et al., 1993).

Although constructivist methods are supported by national science organizations, and students with disabilities do show progress over traditional methods, these methods are not a practical solution for reaching the majority of students with disabilities. Because of the difficulty of implementing the methods with fidelity, the marginal results when implemented correctly, and the lack of structure within the lessons, it is not a sufficient methodology to ensure that all students with disabilities will make progress.

DI. *DI* may be one potential solution the science community is seeking to help all students achieve success. This methodology has proven effective for helping students with disabilities progress in reading and math, teach higher-order thinking skills, and aid students with generalization of skills to other school and community environments (see Carnine, Silbert, & Kameenui, 1997; Kolstad & Briggs, 1992).

As explained by Magliaro, Lockee, and Burton (2005), “*DI* is a viable, time-tested instructional model that plays an important role in a comprehensive educational program” (p. 41). Explicit instruction and effective teaching models are refinements and outgrowths of these essential components. *DI* focuses on high rates of student engagement and time on-task through explicit instruction, scaffolded practice opportunities to provide ongoing support, and immediate performance-based feedback to students (Magliaro et al., 2005).

These authors delineated the main components of *DI* into six fundamental steps:

1. Materials and curriculum are broken down into small steps and arrayed in what is assumed to be the prerequisite order.
2. Objectives must be stated clearly and in terms of learner outcomes or performance.
3. Learners are provided with opportunities to connect their new knowledge with what they already know.
4. Learners are given practice with each step or combination of steps.
5. Learners experience additional opportunities to practice that promote increasing responsibility and independence (guided and/or independent; in groups and/or alone).
6. Feedback is provided after each practice opportunity or set of practice

opportunities. (p.44)

Hofmeister, Engelmann, and Carnine (1989) successfully integrated these components into a series of lessons incorporating videodiscs to teach high school chemistry and earth science concepts. In this study, videodiscs were used to present science concepts to the students. However, the teacher still played a critical role in monitoring student learning, selecting and directing appropriate practice and review activities, and providing feedback.

The researchers found that by implementing good DI practices in conjunction with well-designed materials, significant progress could be made by struggling learners. In the evaluation phase of their project, 15 students (5 with learning disabilities and 10 enrolled in remedial classes) were chosen to field-test the chemistry materials. On the pre-test, this group's mean score was 17% correct. After instruction, the group's mean score was 75%. The same posttest was given to a group of nine advanced placement (AP) chemistry students in their second year of study. The AP group's mean score was 71% correct. This effectively demonstrated that good DI practices in science "could make a major instructional impact with students who had [previously] failed" (Hofmeister et al., 1989, p. 674).

While not extensively researched in regards to elementary science practices, DI has a long history of evidencing academic gains in other instructional areas. In addition, even though it has not been specifically researched in science, DI is able to meet the intended academic outcomes for science based on USOE standards. The USOE Core Curriculum emphasizes that students should connect science learning to their prior knowledge in life and in other curricular areas (USOE, 2002, p. 5). Also, students should

be given many opportunities to practice and actively engage in authentic learning experiences (USOE, 2002, p. 4). Both of these expectations are specifically designed into DI lessons, as described above (Magliaro et al., 2005).

Additionally, general science standards set by the USOE have been successfully taught using DI in other curricular areas. For example, one expected outcome for students in elementary science is to compare, classify, and sort data, events and objects (USOE, 2002, p. 6). DI strategies have been designed and successfully implemented to help students complete these types of tasks (see Carnine et al., 1997; Kameenui & Simmons, 1990; Stein, Silbert, & Carnine, 1997).

Other expected outcomes are that students are to explain science concepts and principles in their own words, and know science information and scientific language appropriate for their grade level (USOE, 2002, p. 6). Because of DI's high rates of student engagement and oral response, it helps students learn to “use language as an adjunct to thought and reasoning” (Engelmann, 1999). DI gives students multiple opportunities to use scientific language and provide explanations with “the clear goal to develop mastery and automaticity of the target skills [and] knowledge” (Magliaro et al., 2005, p. 44).

But it is not just the extensive practice and the engagement with language which helps students to master knowledge and vocabulary when taught with DI methods. In a very early study of science instruction, Ferraro et al. (1977) studied the amount of recall of basic facts. The researchers presented two different lectures to different groups of students. The students were assigned to a condition so that the comparison groups had similar age and ability levels. The experiment was completed three times—first with a group of typically functioning 15- and 16-year-old students, second with a group of 15-

and 16- year-old students who were educably mentally retarded' (average IQ score=66), and finally with a group of typically functioning 7- and 8-year-old students. Half of each group was assigned to each condition.

In the first condition, a 5-min narrative lesson on paleontology was presented using highly structured language, linking concepts together in a predetermined order where they built upon one another. In the second condition, the same 5-min narrative lesson was presented, but the structure was reduced by systematically rearranging concepts within the main topics and removing the transitions and linking words which helped organize the ideas. Otherwise, the content was identical to the first condition. After hearing the presentations, students were asked to recall as much of the information as possible.

All of the students in the highly-structured condition were able to recall more information than those in the low-structure comparison group, even though it was not a significant difference for the typical 15- and 16-year-olds. However, the study found that the highly structured and organized presentation of science content was absolutely necessary for the learners with disabilities. Given the highly structured and organized presentation, the students with disabilities achieved on average higher than the 7- and 8-year-old students with similar mental chronological ages. This suggests that when structure and organization are present in lessons, students with disabilities can perform beyond their IQ-tested abilities to retain and recall scientific knowledge. DI has this high structure and organization built into its lesson plans.

Because of the features listed above—organized content; structure; extensive practice; and high rates of engagement, activity, and oral responding—DI is a viable

option to help students with disabilities master science content.

Comparing DI and constructivist methods. Although both DI and constructivist methods meet the definitions of quality instruction under AAAS, because of contrasting philosophies, contention has arisen. Several studies have tried to compare the two methods in an effort to find which produces the best results for students with disabilities. These studies have had mixed results.

Bay, Staver, Bryan, and Hale (1992) compared student learning under DI and discovery teaching methods. This study comprised of 107 students in grades 4-6. Ten students with learning disabilities and six students with behavior disorders were also included. Students were randomly assigned to a triad with others in their grade. Each triad was randomly assigned to an experimental condition—DI or discovery learning.

In each condition, students were taught the same content: how to control an experiment by manipulating only one variable at a time. They did this through using rafts to understand displacement and flotation. Students received four treatment sessions. All sessions were presented by the same male experimenter, one triad at a time, and lasted 40-60 min.

In the discovery teaching condition, students were given materials and a problem, and directed to solve it. The experimenter aided students in gathering data, brainstorming solutions, manipulating materials, and observing consequences.

In the DI condition, students received an advanced organizer, reviewed concepts, demonstrated the new concept using the materials, and then students practiced the concept on worksheets. The amount of guidance students received from the experimenter faded as they progressed through the worksheets.

The effectiveness of each method was measured with a paper-and-pencil test. Prior to treatment, all students received the 20-question test with true-false, matching, and multiple-choice items. At the end of the fourth session, the same 20-question test was administered as a post-test. The experimenter returned two weeks later and administered the retention and generalization tests.

The retention test, given two weeks after the last session, was identical to the pre- and posttest. The generalization test was administered one-on-one with the experimenter. The experimenter made a pendulum using a pencil, masking tape, string, and metal washers. Students were instructed to state the variables that might make a difference in the number of oscillations in a given time span. If none were mentioned, after a predetermined number of probes, the student was told the correct answers. Students were then asked to test the effect of each of these variables, and assigned a score for each experiment based on a rubric of how well they understood the concept of controlled experimentation. Each test administered had a maximum score of 20. The results are listed in Table 2.

TABLE 2
Mean Performance Scores of Students by Treatment and Type of Group Membership

Membership	n	Direct				n	Discovery			
		Pretest	Posttest	Retention	Gen.		Pretest	Posttest	Retention	Gen.
Learning disabled	6					4				
mean		8.33	9.67	10.00	5.83		8.50	13.50	14.25	10.75
SD		1.97	2.42	2.97	1.94		1.73	3.69	1.71	2.06
Behavior disordered	2					4				
mean		8.50	13.50	12.00	9.00		9.25	16.00	16.00	7.75
SD		0.71	0.71	2.83	5.65		0.96	0.82	1.41	1.26
Nonhandicapped with LD partner	12					9				
mean		9.08	15.50	15.82	6.75		9.44	15.89	16.22	8.67
SD		2.19	2.91	3.31	2.80		2.29	2.93	3.15	1.73
Nonhandicapped with BD partner	4					7				
mean		7.75	12.50	13.00	8.00		8.57	13.86	15.00	6.00
SD		2.22	1.92	0.82	1.15		3.04	3.39	2.61	4.24
Nonhandicapped	25					34				
mean		9.96	15.16	15.48	8.76		10.00	15.38	16.12	8.47
SD		2.30	2.49	2.40	1.79		3.47	2.92	2.92	1.81

See Bay et al., 1992, p. 564.

The researchers found that students in the discovery learning condition scored higher than their comparison peers on the post-test and retention test. Nearly all groups improved on the retention test from the post-test. Also, the four students in the discovery learning condition with learning disabilities and their partners scored substantially higher on the generalization test compared to their peers in the DI group.

While Bay et al. (1992) does show some significant findings in favor of discovery learning, it also presents some dilemmas when translating these findings into classroom practice. One is the impracticality of teaching students in triads. The researchers have shown that, when very small groups of students receive 100% of the instructor's time, discovery learning can produce better results than DI. However, teaching three students at a time as the main form of instruction is neither practical nor efficient in the classroom setting.

Also, in designing the two conditions, experimenters seemed to assume that activities cannot occur in DI, and that practice must be done using paper and pencil. On

the contrary, authentic practice is highly valued in DI, but under the conditions that first students receive all information necessary to master the activity, then students practice with the instructor, then are guided through it and closely supervised, providing feedback to ensure students maximize their success. The DI method, as designed in this experiment, more closely resembles traditional textbook learning, with the added provision that students' worksheet answers were corrected immediately by the experimenter. This study does not truly expand the literature, but just reiterates, as mentioned earlier, that any method is more effective than traditional methods currently in practice (Mastropieri & Scruggs, 1992).

Another point these researchers were quick to indicate was that students with learning disabilities generalized much better when taught using discovery learning. However, in the discovery condition, the sample size of students with learning disabilities was four. The only students who generalized better in the discovery condition were these four students and their partners (see Table 2). For all other students in the study, the DI group generalized better than their comparison group, indicating that for 31 of the students, this study's version of DI still facilitated more generalization than discovery methods.

In another article examining the effect of DI and discovery learning over time, Dean and Kuhn (2006) found a large amount of variability in their results. This study, completed with 3 groups of 15 fourth-grade students, intended to find out the most effective method for teaching science concepts to students over time, and how well students could transfer this learning to novel situations.

Researchers set up three separate conditions—DI, DI plus practice (DI + PR), and

practice (PR). The intent was to show that, although initially DI produced effective results, over time those gains are not maintained. The expected learning outcome was that, when students were given a list of variables and the results of an experiment, students would manipulate variables in a controlled way (one at a time) to determine which variables impacted the experiment's outcome. The instruction was done using a computer program with multiple scenarios (e.g., earthquake prediction), each with multiple factors (e.g., seismic activity, soil type, snakes' activity levels, water quality).

In the DI condition, students received one 45-min teacher-directed lesson on what does/does not make a good comparison. After the teacher's initial instruction, students were given four practice opportunities to make their own comparisons. The mean score of the students' practice opportunities was 1.76 of a possible 4. Nothing further was done at this time. Eleven weeks later, and again after 17 weeks, students were presented with the comparison task again, as well as a novel task to generalize to, and asked to make comparisons.

In the DI + PR condition, students received the same 45-min instruction time as the DI group. Their initial instruction score was factored in with the DI group, for a mean score of 1.76. Following that, once per week students used the computer program to practice making comparisons. As with the DI group, the initial comparison task and a novel task were presented as a posttest. Then, students practiced for five more weeks using new scenarios and were assessed again after week 17.

In the PR condition, the only difference was that, instead of initial instruction, students were given the materials to manipulate for 35 min and then asked to make comparisons. Their mean score, with no instruction, was 1.0 out of 4. This group

followed the same schedule as the DI + PR group as far as practice with the computer program, followed by assessment. Results for all of the conditions are shown below.

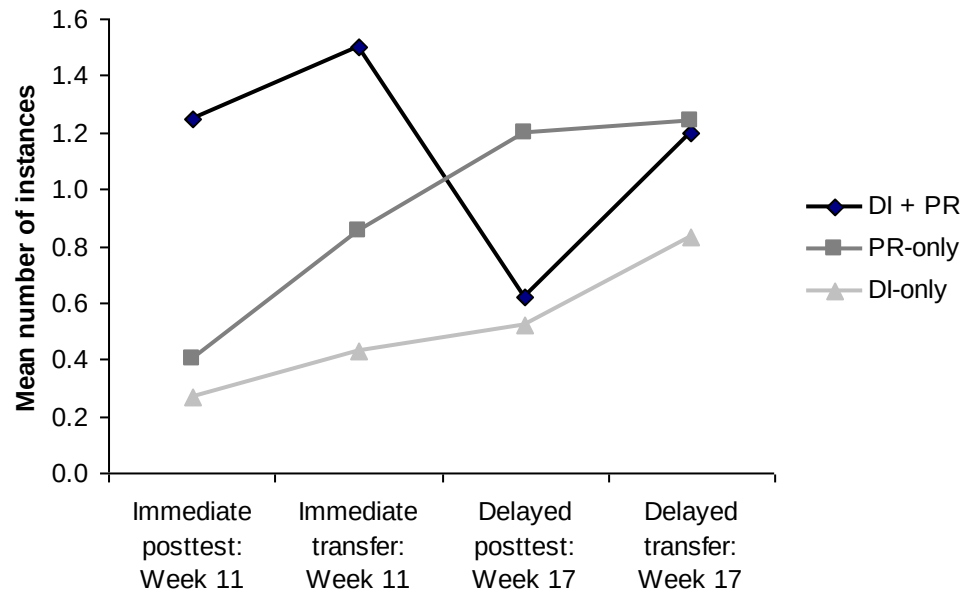


Figure 4. Means for valid strategy + inference by group. Maximum score = 3. (Dean & Kuhn, 2006, p. 392)

The results found by the researchers were that, based on the initial assessment immediately following instruction, “brief [DI] is capable of producing a significant level of correct performance” (Dean & Kuhn, 2006, p. 394). They also found that “competency remains fragile at this age level. . . . [W]ork with this age group shows negligible spontaneously emerging competence at this age, even among academically able children” (Dean & Kuhn, 2006, p. 395). None of the groups showed anything approaching mastery on even these brief post-tests, even after 17 weeks of practice.

Researchers also pointed out that the DI group continually scored lower than any

other condition. However, as with the Bay et al. (1992) study, researchers failed to understand the nature of DI when designing their DI condition. In Dean and Kuhn's study (2006), students were given one 45-min lesson, then taught nothing for the next 10 weeks. Learning and retention were lower than the other groups, obviously. Perhaps a more accurate comparison could have taken place if researchers had continued providing instruction to the DI group, through even 15 min per session, and that same instruction to the DI +PR group before their computer practice. Results might have depicted a more realistic picture of the efficacy of the methods, as well as their maintenance over time.

Although the authors claim that their study clearly indicates that “[DI] appears to be neither a necessary nor sufficient condition for robust acquisition or for maintenance over time” (Dean & Kuhn, 2006, p. 385), it appears, based on their results, that practice without instruction, or discovery learning, is also neither necessary nor sufficient to aid student mastery of science concepts. Although the PR only group continued to make progress with each assessment given, no group mastered the content presented. Even after 17 weeks of practice with the skill, no group achieved an average of even 50% correct. Again, this leads to the implication of the efficiency of the inquiry method. If at least 17 sessions of practice are necessary for mastery of a single science concept using discovery methods, how many concepts will be able to be mastered throughout a school year? Also, what implications does this have for students with disabilities already academically behind upon their entrance into the curriculum?

Another comparison study looked at this issue of mastery for all students, as well as at-risk students, and found promising results for DI. Klahr and Nigam's (2004) study bore no resemblance to the previous studies discussed. In this study, both learning paths

were active, both conditions allowed students to manipulate materials. The only variable adjusted was the type of instruction which the students received.

Overall, 104 students in the third and fourth grade were randomly assigned to either the DI condition or the discovery learning condition. Students were asked to design experiments which rolled a ball down a ramp. The ramp could vary in surface texture, steepness, and length. Also, different balls could be used.

Prior to instruction, students were pre-assessed by presenting them with the materials and directing them to design different experiments to test what would make the ball roll the farthest. To assess their knowledge, participants were given four opportunities to design their own experiment. The mean number of correct responses for all participants was just under one.

Both groups of students then received the instruction phase of the study. The DI group watched their teacher model examples and non-examples of good experiments. The students were asked if the experiments were good or bad, and then heard the instructor explain why. Then these students were guided through designing experiments of their own.

The students in the discovery condition were given access to all the materials for an identical length of time as the other group, and directed to design their own experiments, but received no teacher feedback or instruction on how to design a good experiment.

After the instruction phase, students were given the same test as the pre-assessment. Mastery was counted as designing at least 3 out of 4 experiments correctly. The results are seen in Figure 5. The next day, students were asked to generalize their

skill by evaluating a set of science fair posters as to whether the experiments explained on the posters were good or not. These results are shown in Figure 5.

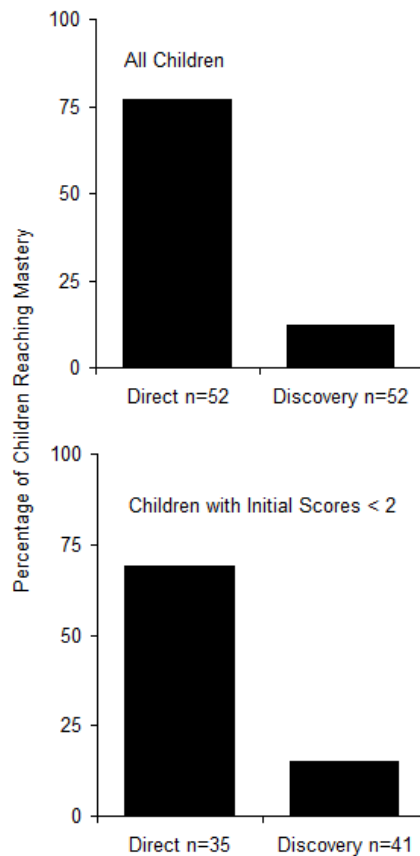


Figure 5. Percentage of children who reached mastery on posttest, by condition (Klahr & Nigam, 2004, p. 665)

As seen in Figure 5, both groups showed gains, but DI methods had 77% of students reach mastery compared to 23% of inquiry methods students. Also significant, of the students who initially had less than two correct answers (representing the at-risk population), 69% of those students reached mastery under DI, while only 15% mastered the concept through discovery learning. This demonstrates that to help the majority of the students reach mastery of science concepts, regardless of their initial ability level, DI produces significantly greater results.

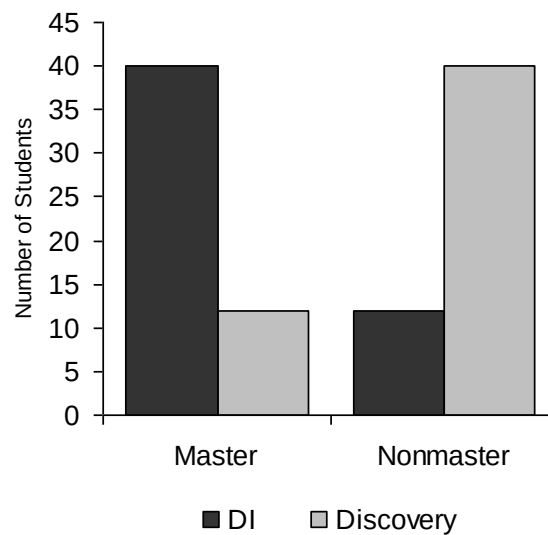


Figure 6. Mastery levels on generalization task by condition (see Klahr & Nigam, 2004, p. 666).

Klahr and Nigam (2004) also found significant results following the generalization task. Again, students were designated as reaching mastery if they scored 75% or better on the task. Forty of the 52 children who received DI mastered the generalization task, while only 12 of the 52 in discovery learning did the same. These results mirror those of the initial task, indicating that, for the most part, mastery of an academic topic is mastery, regardless of method of instruction. Also, as in the Bay et al. (1992) article, the majority of students who receive DI generalize better to novel tasks than students in constructivist method conditions.

Overall, DI has been found more useful than other methods in teaching science to students with disabilities because it helps the majority of students master the material, it increases the likelihood of generalization for most students, it is a more efficient use of time, and it meets the standards of quality instruction as defined by the AAAS and the

USOE.

Purpose Statement

The purpose of this project was to design and carry out a science unit using DI principles which will effectively help 3rd and 4th grade students with disabilities master the content presented, and to assess the effectiveness of the designed DI unit by comparing performance on a pretest and posttest.

CHAPTER II

CURRENT STATE STANDARDS AND LOCAL CLASSROOM METHODS

Current State Standards

Presently, Utah science instruction is driven by the USOE Elementary Core Curriculum. This curriculum was designed “by a community of Utah science teachers, university science educators, State Office of Education specialists, scientists, [and] expert national consultants” (USOE, 2002, p. 1). For each grade, the core lists five to six science benchmarks, or topics, the students should master. The benchmarks contain standards, objectives, and indicators, as well as a list of science words which students are expected to know and use. Each indicator was designed to be “measurable or observable student action that enables one to judge whether a student has mastered a particular objective” (USOE, 2002, p. 1). The Core was designed to help standardize science instruction across the state, as well as to set clear expectations of what should be taught and mastered at each grade level. An example standard, from the Utah Third Grade Science Core Standard 2 is listed in Figure 7 (USOE, 2002, p. 8).

Science Benchmark

For any particular environment, some types of plants and animals survive well, some survive less well and some cannot survive at all. Organisms in an environment interact with their environment. Models can be used to investigate these interactions.

Standard 2: Students will understand that organisms depend on living and nonliving things within their environment.

Objective 1: Classify living and nonliving things in an environment.

- a. Identify characteristics of living things (i.e., growth, movement, reproduction).
- b. Identify characteristics of nonliving things.
- c. Classify living and nonliving things in an environment.

Objective 2: Describe the interactions between living and nonliving things in a small environment.

- a. Identify living and nonliving things in a small environment (e.g., terrarium, aquarium, flowerbed) composed of living and nonliving things.
- b. Predict the effects of changes in the environment (e.g., temperature, light, moisture) on a living organism.
- c. Observe and record the effect of changes (e.g., temperature, amount of water, light) upon the living organisms and nonliving things in a small-scale environment.
- d. Compare a small-scale environment to a larger environment (e.g., aquarium to a pond, terrarium to a forest).
- e. Pose a question about the interaction between living and nonliving things in the environment that could be investigated by observation.

Science language students should use:	environment, interaction, living, nonliving, organism, survive, observe, terrarium, aquarium, temperature, moisture, small-scale
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Figure 7. USOE Third Grade Science Core Curriculum, Standard 2 (USOE, 2002).

In addition to being designed with feedback from local and national experts, the Core Standards were designed based on the current philosophy and has also been endorsed by the AAAS and the Utah Science Teachers Association (USOE, 2002). As explained in the Introduction, these organizations heavily favor an inquiry approach; therefore, the language, standards, and objectives used are based on experimentation and investigation rather than mastery of specific skills or knowledge. However, the indicators for each objective are still “observable or measurable” (USOE, 2002). Therefore, these indicators were the foundation of what was measured in the pre- and posttests, as well as the basis of the designed lesson plans as described in further detail in Chapter III.

Davis School District (DSD) has further refined the Core Standards. Because of

the size of the Core Standards, especially when looking at the scope of subjects covered (i.e., language arts, math, science, social studies, fine arts, healthy lifestyles, and technology), DSD narrowed the Core Standards to the most essential knowledge students need to master by the end of the school year. This synopsis version of the Core Standards is known as the Davis Essential Skills & Knowledge (DESK) pamphlet.

The DESK summarizes all of Standard 2 in the 3rd-grade science Core in the words, “Understand and classify living and nonliving things in an environment” (DSD, 2009). Based on the DESK, DSD’s main concern in this area is that 3rd-grade students master Objective 1 of Standard 2 in the state science Core, to “classify living and nonliving things in an environment.” The DESK pamphlet de-emphasizes Objective 2 in an effort to focus on what is the most vital knowledge for students.

Because the project took place within a DSD classroom, and because Objective 1 is what has been viewed as critical knowledge by DSD, mastering this objective, that students will ‘classify living and nonliving things in an environment’ (USOE, 2002, p. 8), was the basis for this study.

Current Classroom Materials and Practices

Pursuant to this project, I went to my school’s third-grade teachers and asked what practices were currently used in their classrooms, materials available, and which standard currently needed additional curriculum materials. The science teacher indicated that Standard 2 was an area where she had few resources and was unsure how to teach the concepts to the students.

With that information in hand, and after speaking with the other third- and fourth-

grade teachers at our school, I found a wide variety of resources and differing amounts of materials present in each classroom. There were state-approved materials, district-provided materials, and resources which teachers had created or purchased. One teacher had nothing but the science textbook to teach from, while another teacher had nine crates of materials, one or two for each standard. In sum, these teachers had a variety of diverse materials from which to teach science with little commonality or consistency.

Some materials are supplied to all teachers in the school. One of these resources is the student text from Harcourt Science (Frank et al., 2000). This program is complete with teacher's editions, student workbooks, assessments, and videos on the topics (see www.harcourtschool.com for more information). The third grade Harcourt Science edition has four separate chapters having application to the third grade Science Core Standard 2: "How Plants Grow," "Types of Animals," "Where Living Things are Found," and "Living Things Depend on One Another" (Frank et al., 2000). Also, the book addresses vocabulary words, but covers only 3 of the 12 vocabulary words listed under Standard 2: environment, interact, and temperature. The text does not talk about characteristics of nonliving things, help students discriminate between living and nonliving, compare small-scale environments to larger environments, or discuss the impact of changes in light, temperature, or moisture on an environment. Based on the Core Standard, the provided science textbooks do not adequately cover the topics necessary for third-grade students to master.

Another resource available is the Utah Test Item Pool Server, or UTIPS (USOE, 2007). This test pool gives sample items for each Core Standard, to help teachers know expectations for the end-of-year criterion-referenced tests. A search of UTIPS yielded six

questions based on Standard 2 of the third grade Science Core. Four of the questions linked to Objective 1, and two questions linked to Objective 2. These sample questions from UTIPS can be seen in Appendix 1. These questions help give an understanding of the depth needed to be taught and the type of questions on which students will need to show mastery.

A final resource is a kit of materials provided by DSD. Knowing that the text does not fully cover the required components of Science Core, DSD put together teams of science teachers to create these kits with activities to teach the concepts not covered by the text. These kits are given to the teachers upon attendance at the District Core Academy. The Academy is a three- to five-day training workshop designed to help teachers know how to use the materials in the kits. Our school's third grade team has all of the kits, but no one has received the training because the kits were inherited from previous teachers. The kit for Standard 2 includes a poster of animals from all over the world, two flower presses, a file folder with 10-15 activities, short articles for students to read, and science projects focused on living and nonliving things and environments. (For samples of these materials, see Appendix 2.) Additionally, the teachers have obtained two books to help teach Standard 2: *The Usborne First Encyclopedia of Animals* (Dowswell, 2006) and *Living Things* (Allen & Heisler, 2002).

As a preliminary investigation to my project, I interviewed the third grade science teacher as to what methods she used in her classroom. She explained how, since the science Core is not tested in third grade yet, science instruction as a whole was not very consistent. She was unaware of the objectives and indicators for science instruction. When she teaches her unit on living and nonliving things, she has students name animals,

identify different environments such as desert, tundra, ocean, and rainforest, and then match the animals to their environment. She also has each student grow a cabbage plant. The teacher emphasizes living things and their environments, but no instruction is presented concerning the characteristics of organisms or how they differ from nonliving things. Also, assessment of skills taught was not standard-based or documented.

Across classrooms in the school, methods and materials for delivering instruction on topics related to science were not consistent, but mostly relied on traditional methods such as reading assignments and lectures. One viable alternative to these traditional methods is DI, which has been empirically validated in other subject areas, as described previously.

CHAPTER III

DESIGN AND METHODS

Product Design

Based on current classroom practices reported by the teacher, students are not receiving instruction using effective, research-based instructional methods. Also, the instruction and materials in use are not aligned with the state standards. Finally, no assessments directly aligned to the Core Standards are available to determine how well students are mastering the content. While some students may make progress regardless of these factors, as discussed in Chapter I, students with disabilities have been found to need more structure, directness, and practice opportunities in order to reach mastery on a given skill (Ferraro et al., 1977; Kameenui & Simmons, 1990; Klahr & Nigam, 2004).

Because of these factors, a unit of lesson plans was designed that focused on Standard 2, Objective 1 of the Third Grade Core Curriculum. This unit was designed using expert feedback to ensure its consistency with the State Core Standards and DI methods.

The materials designed became a Living/Nonliving Science Kit. The main components of the kit are a standards-based pre- and posttest, scripted lesson plans which fade from more to less teacher direction, and all the materials necessary to implement the lessons. Samples of these materials can be found on in Appendix C, and a complete copy is available from the author.

These materials were field tested with third and fourth grade students with disabilities, and the results are reported below.

Throughout the development of the product, feedback was solicited from multiple relevant sources. These were a DSD Science Implementer, a current third-grade teacher, and an instructional expert in the field of Special Education at the university level. Feedback was documented through anecdotal notes of conversations and comments provided. Interestingly, each expert had a different focus.

The DSD Implementer spent a lot of time focused on the assessment and the accuracy of the questions. When asked for feedback about the lessons, no response was received back. This could have been because she felt that consistent instructional methodology was not a critical component in the science classroom. But it could also have been that, due to the timeline of this project, solicitation of her comments for the lessons came right at the beginning of the school year when her time and efforts were increasingly demanded to complete her own job.

The third-grade teacher was very interested in the overall presentation of the lessons—how did they flow together, what came next, what would implementation in the classroom look like? Also, her feedback focused on accurate and clear presentation of ideas for the students. This proved valuable in aiding and directing the development of the materials to be teacher- and student-friendly.

Finally, the university professor gave critical feedback as to the organization of content within the lessons. This feedback proved useful in determining the presentation order of the content as well as ensuring that lessons were designed using good DI principles. Both of these were necessary to ensure the validity of the method being used and tested in this study.

Participants and Setting

The participants in this study were four third-grade and two fourth-grade elementary students with disabilities. Five participants were males, while one participant was female. The third-grade students were all eight years old. Thomas was classified as having an autism spectrum disorder. Barb was classified as receiving services for specific learning disabilities in reading, written language, and math. Michael was classified as having a communication disorder; however, he had several other factors which impact his academic performance. Michael had two IQ test results in his file. In 2004, his full-scale IQ was 72. In 2007, his full-scale IQ was 68. On behavioral checklists, Michael had clinically significant scores in the areas of affective problems, anxiety problems, pervasive developmental problems, AD/HD problems, and oppositional defiant problems. Additionally, on adaptive rating scales, he achieved standard scores of 63 and 75. Michael also receives occupational therapy services. The final third-grade student was Jeremy. He was classified as receiving services for emotional disturbance. This classification was based on a psychological and neuropsychological evaluation conducted at a state hospital in 2007. This evaluation diagnosed Jeremy with AD/HD, oppositional defiant disorder, and a cognitive disorder which affects his reading, writing, and math. It also reported concerns about possible Tourette's syndrome and bipolar disorder. The fourth-grade students were both nine years old. Nick was classified as receiving services for emotional disturbance, but he performed academically on grade level. Chris was classified as receiving services for a specific learning disability in reading, written language, and math, as well as receiving English language learner services. Additionally, all the students except Barb receive speech services for expressive language concerns.

These students' disabilities qualify them for special education services as defined by the USOE Rules and Regulations (USOE, 2009).

These participants were systematically selected by the researcher in conjunction with input from their classroom teachers and special education servers. They were chosen because the severity of their disability limited their participation and success in the general education science curriculum. Barb and Michael struggle with academic achievement. Thomas and Nick were excluded from full participation in general education because of behavioral disruptions. Chris and Jeremy have both behavioral and academic concerns. Prior to participating in the study, consent was received from the participants and their legal guardians.

The field test took place in a special education classroom located in a Title I school in DSD. The lessons were presented and data were kept by the researcher.

Procedures

The field test took place over five sessions. Sessions 1-4 were one hour long. Session 5 was 15 min. These sessions spanned five consecutive school days. The first session began with the pretest, which lasted about 15 min. It was administered in accordance with the students' IEPs such that the test was read to the students and administered in a small group setting. Immediately following the pretest, and for the next 3 sessions, students were taught the content in the Living/Nonliving Science Kit using DI methods. During Session 5, the posttest was administered. The lesson plans can be found in Appendix C, and a complete copy of materials can be obtained by contacting the author.

Each session followed the same format. First, the concepts taught the previous day were reviewed. This was done by the teacher holding up flashcards and asking questions such as, “Is this an organism?” All students responded in unison. If there were any errors, some brief reteaching was done, then more examples from the flashcards were presented to check for student understanding.

Following the review, the objectives and new material were presented. This was done using PowerPoint slideshows (see Appendix C). For the first few examples, the teacher modeled the correct response. After that, the teacher would ask a question and the students would respond orally in unison. Feedback, either praise or correction, was given to the students after each question.

After the students were firm on the new material presented, a less-guided practice activity was assigned. This usually involved students working in small groups or with partners to practice the new concepts taught. Finally, an independent assignment was given, followed by the Test Prep activity. The teacher monitored student work during these final phases, offering correction and guidance where needed.

Lessons were given as designed except that the Test Prep activities were given prior to the next lesson instead of at the end of the lesson as stated. This occurred because of time constraints—the first session took longer than designed because the pretest was given prior to the lesson starting. The only other session not run as planned was Lesson 2. It took longer than planned and had to be stopped short because of recess. Because of this, the students did not receive feedback on the independent practice activity. To adjust for this, the final portion of the guided practice was used to begin session 3. This served as a review and an opportunity to provide that feedback to the students.

One tenant of DI that did not occur was the teaching to mastery for every student involved. In the ideal DI lesson, if a student struggles with a concept, they are pulled aside individually at a later time and given extra practice opportunities and review until mastery is reached. Because the students in this study were being pulled from several different classrooms to participate, and because the researcher had to teach her class the rest of the day as well, there was not an opportunity to pull the struggling students aside to provide them with extra practice. Two of the students, Thomas and Michael, should have received this extra practice because, based on their independent practice work after Lesson 2, they had not reached mastery and were struggling with some of the concepts. The ramifications of this are discussed in more depth in Chapter V.

Measurements

The main measurement used to show student progress was the standards-based pre- and posttest. However, independent practice work, anecdotal, and observational data were also gathered to monitor student progress, to aid in instructional decision-making, and to help evaluate the effectiveness of the designed materials.

Performance was calculated as the percent of questions correct on the pre- and posttests. Also, the number of questions correct was monitored for each indicator to demonstrate whether each objective was taught effectively. These results are discussed in further detail in Chapters IV and V.

CHAPTER IV

RESULTS

Overall results from pre- to posttest are displayed in Figure 8. The mean score on the pretest was 55.6% correct. The mean score on the posttest was 79.6% correct, showing a gain of 24% after 4 DI lessons. In addition, five of the six participants showed improvement from pre- to post-, with four of those reaching a mastery level of 80% or higher. Although Thomas did not reach mastery, he showed the most significant increase in score from pretest to posttest, increasing his score by 40%. Only one student's scores decreased. Michael answered 11 of 18 correct on pretest and 9 of 18 correct on post.

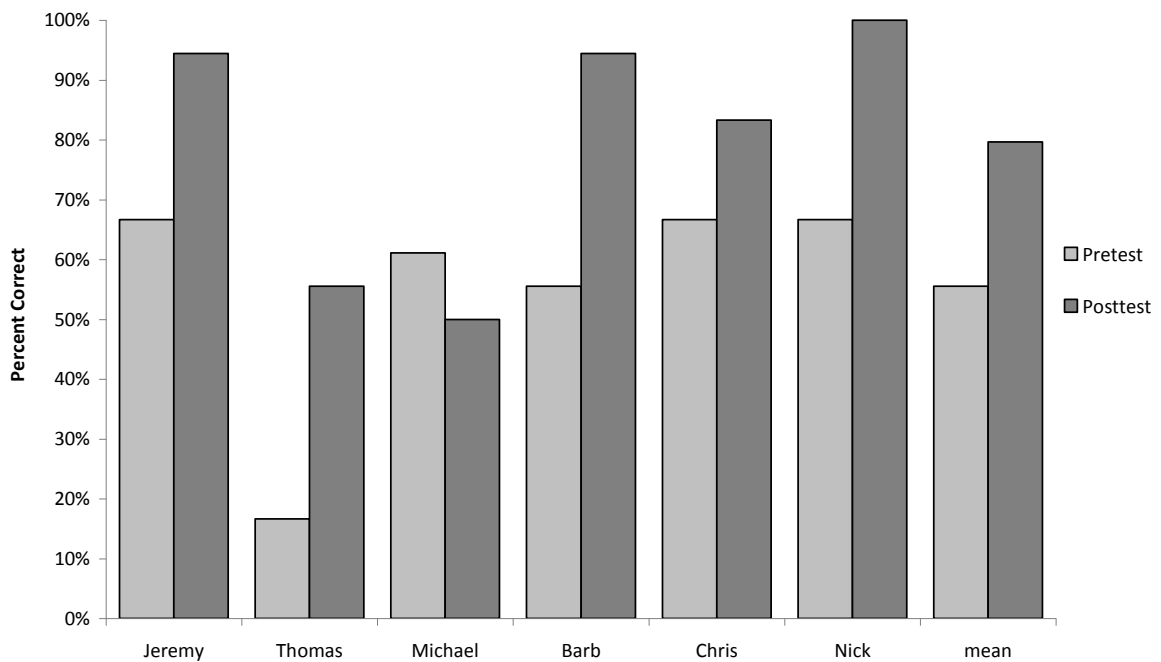


Figure 8. Overall scores for pretest and posttest, by individual student.

Each item on the test measured specific objectives aligned with the Core Standards. Each objective was measured by five questions. Mastery was considered as at least four of the five questions correct. By objective, gains were also seen, as demonstrated in Figure 9. Overall, mean scores improved for every objective, with the highest increase observed on Objective 4—Vocabulary, and the lowest increase observed on Objective 2—Identifying nonliving things and their characteristics.

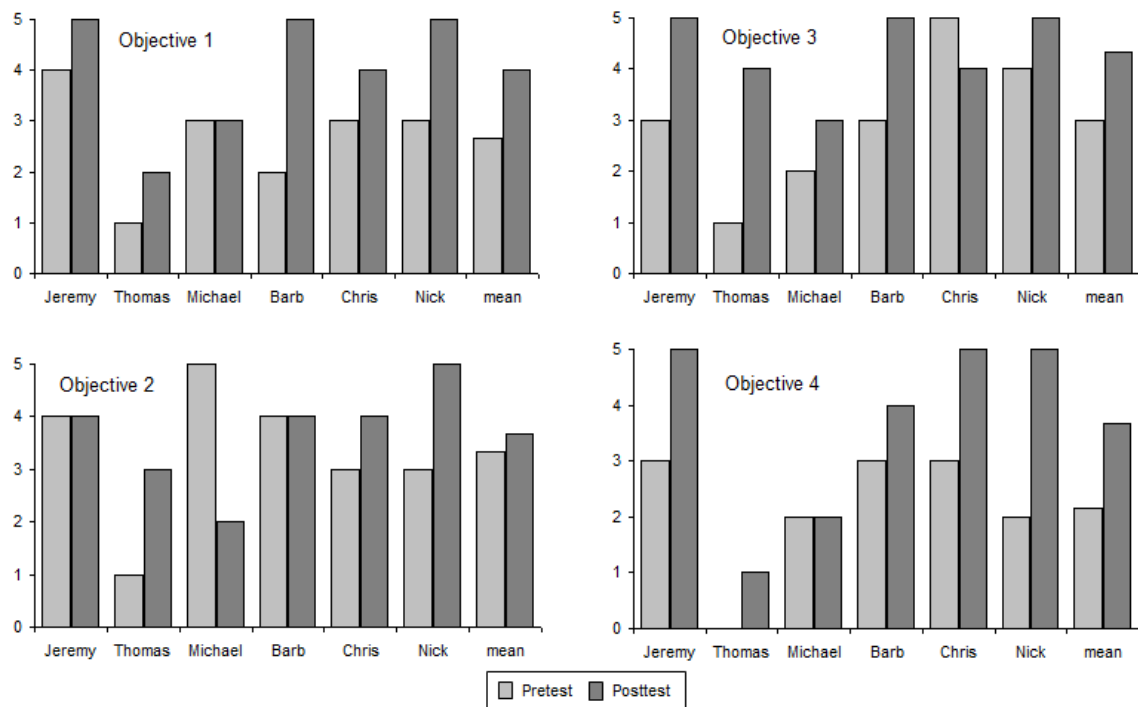


Figure 9. Student results for pretest and posttest by objective.

Objective 1 called for students to identify organisms and their key characteristics (i.e., that they grow, eat, and move). This objective may have presented challenges to all participants due to language level. On the tests, sometimes ‘organisms’ was used, sometimes ‘living things.’ The most-missed questions were those containing ‘organism,’

indicating that probably it was the vocabulary, not the concept, may have confused the students. Regardless, large amounts of growth were seen. On the pretest, only Jeremy had mastered this concept. By the posttest, four of six students had mastered it, with all students maintaining or improving their scores.

Objective 2 was closely linked to Objective 1 and required that students identify nonliving things and their key characteristics (i.e., that they do not engage in one or more of the following behaviors: grow, eat, move). This objective had the highest mean performance on the pretest and showed the least growth overall. Jeremy, Michael, and Barb showed mastery of this concept prior to it being taught. On the posttest, Jeremy, Barb, Chris, and Nick reached mastery levels, while Thomas showed significant growth. However, Michael went from 100% mastery on pretest to answering only 2 of 5 questions correctly on the posttest. This finding is difficult to reconcile. Perhaps Michael, aware of his mastery on the pretest, provided less attention to the same questions on the posttest.

Objective 3 asked students to identify living and nonliving things in an environment, and to determine which organisms were most likely to survive in a given environment. From pre- to posttest, this objective showed a commensurate amount of growth with objective 1, about 25% increase. On the pretest, two students had prior mastery of the concept. By posttest, five of the six students had mastered it, with even Michael making gains. The only student to evidence a decrease in performance was Chris. However, he still demonstrated mastery with 4 of 5 questions correct.

Objective 4 called for demonstrating an understanding of the vocabulary words in the unit: living, nonliving, organism, environment, and survive. This objective had the lowest mean score on the pretest with only 2.2 of 5 questions correct (44%). Students

showed the highest increase on this objective and ended with an average of 3.7 questions correct on posttest (75%). Five of the six students improved their scores from pretest to posttest whereas Michael remained the same. Mastery of this objective was highly correlated with mastery of all the concepts. The four students who mastered the vocabulary mastered all the other learning objectives of the posttest as well.

The two students who performed lowest on the posttest were Thomas and Michael. However, Thomas improved in every objective and increased his overall score by 38.89%, demonstrating the highest increase in scores of any student. However, he mastered only Objective 3—identifying things in an environment. On the pretest, Michael demonstrated mastery of Objective 2, getting 100% of the questions correct. On the posttest, Michael had no objectives mastered.

CHAPTER V

DISCUSSION

This study took place over four days, with the posttest being administered in a separate fifth session. Five of the six participants made significant progress following minimal instructional time. The structure, high rates of interaction, pacing, and focus on mastery, which are all components of DI, probably lent to the overwhelming effectiveness seen in the project. All of the students with mild disabilities succeeded in this small group setting when provided with science instruction which used proven research-based components. Additionally, these results probably indicate a low estimate of what could be achieved if excellent DI principles were applied to science education. While good practices were used in this study to achieve striking results, if all students had been taught to mastery by providing extra practice for the ones who struggled in the less-guided and independent phases, even better results might have been seen. However, the outcome of this study still contributes significantly to current research.

These findings extend the strong literature base of DI into the field of science, showing that DI is an effective method of science instruction for students with disabilities. DI allowed these students to master the curriculum in a very short period of time, suggesting it to be an effective and efficient methodology.

Another significant result was the role that mastery of vocabulary plays in mastery of the content. Teaching content-specific language is always a concern for classroom teachers. These results seem to provide additional support that understanding of the language is highly correlated to success in the subject matter. It suggests that

comprehension of vocabulary might be a greater indicator of actual student knowledge than any test results.

These results lead to interesting implications in the classroom. DI has previously been highly discouraged as a recommended methodology for science instruction by national science organizations. However, this project, in conjunction with Klahr and Nigam's study (2004), supports DI's use to help students master science curriculum. If these results can be extended to the majority of the special education population, implications are that current national trends could be reversed, and these students might easily demonstrate mastery on standards-based assessments.

This study also has many implications for special education students currently participating in the general education curriculum. It demonstrates how explicit instruction may be a necessary component for students with disabilities to master science concepts. Since the general educator is responsible for student mastery, these results suggest that a paradigm shift in current science methodology might be necessary if teachers are truly to reach all of their students. However, it also suggests that special educators may be able to play a significant role in reinforcing these students' knowledge through explicitly teaching content-specific vocabulary and using DI methods to reinforce concepts originally taught in the classroom.

However, all of these conclusions are drawn from this project and a small body of research. Much more research should be concluded to support or disprove these assumptions. This study has many strengths. The majority of students involved showed significant progress and mastered the materials, after only four hours of instructional time. Also, the sample size used included a broad range of disabilities and special factors,

i.e., specific learning disabilities, autism, communication disorders, emotionally disturbed, English language learners, and Title I students. Even though the sample size was only six students, significant results were seen. Additionally, the results suggest that as the severity of the disability increases, the level of structure and number of practice opportunities also need to increase.

Potential future research could address many of these issues in applying DI to science curriculum. Because the sample size was so small and DI has not been extensively researched in the area of science, replication studies should be conducted to verify these results. Also, studies should be conducted extending this research into the regular classroom. Research should analyze how effective DI is for students without disabilities, as well as examine the effectiveness of these methods for students with disabilities when the instruction is presented in larger groups. Additionally, studies should consider what adjustments should be made to the design of the content to make it functional in the general education setting. Finally, these same factors should be researched for different age groups to extend these findings across school-aged populations.

Additional research should also focus on student retention after mastery is reached. As one purpose of this study was to show that students with disabilities could master standards-based assessments, and the primary measurements used to show mastery are year-end tests, retention of knowledge over time is a key component. While this study found that students with disabilities were able to master science concepts when taught using DI, retention over time was not tested. Maintenance studies should be done, adding the component of retesting at 1 or 2 months after completion of the unit to see the

effect of time on student knowledge. Also, these studies should address what amount and schedule of review is necessary for students to retain these levels of mastery over time.

Finally, additional research should be done comparing methodologies.

Constructivist methods are strongly supported by the AAAS, while DI methods are not.

While some comparison studies have been done, most do not accurately reflect both methodologies, and no comparison studies have focused on results specifically for the students with disabilities. Also, in comparison studies so far, mastery levels, time to reach mastery, and retention over time have only been sparsely touched upon. These factors speak greatly to the effectiveness of instruction. Additionally, while stand-alone studies have been done demonstrating student progress using a specific method, none have blended different methods to see what results could be produced. All of these factors should be researched further and addressed before support of any one method is advocated for general use in the classroom.

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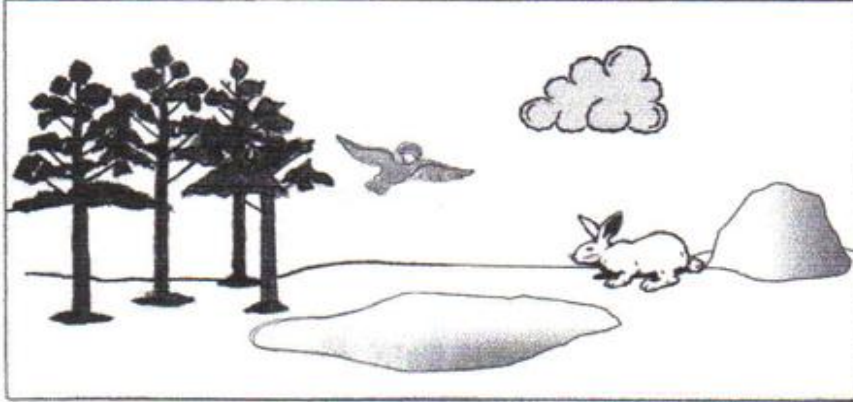
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Appendix A--UTIPS Questions and Objectives for 3rd Grade Science Core, Standard 2

Objective 1: Classify living and nonliving things in an environment.

1) Which are living things in the environment below?



- A. rock, air
- B. cloud, water
- C. sky, soil
- D. trees, bird

2) What two living organisms can you observe in the picture?



- A. water, trees
- B. rocks, grass
- C. sky, water
- D. grass, trees

3) How do you know a tree is alive?

- A. It has a shape.
- B. It has a name.
- C. It grows.
- D. It changes color.

Objective 1: Classify living and nonliving things in an environment. (continued)

4) How could you find out if this object is alive?



- A. Put it in a jar.
- B. Put it in water.
- C. See if it eats.
- D. Look for others.

Objective 2: Describe the interactions between living and nonliving things in a small environment.

5) Which of the following would be the BEST place to read how to create a small-scale environment?

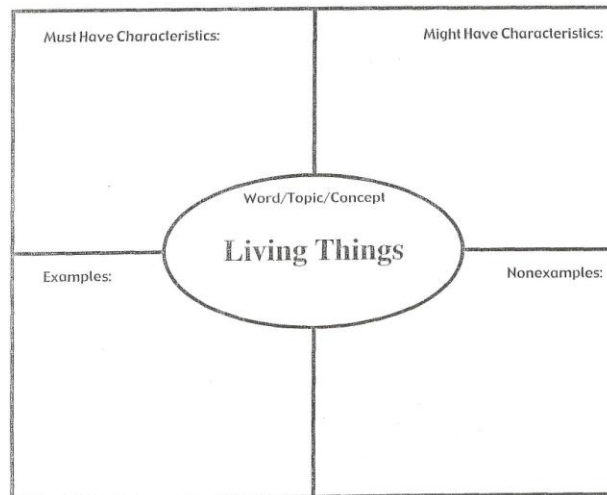
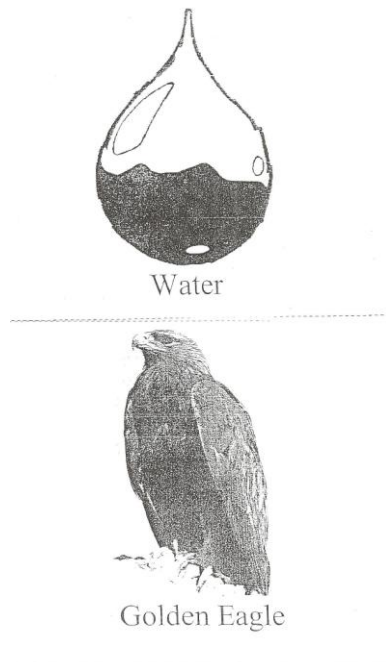
- A. A book called UTAH PLANTS.
- B. An article on living organisms.
- C. A library book called BUILDING AND MAINTAINING AN AQUARIUM.
- D. A T.V. program called "Bill Nye the Science Guy".

6) How will freezing temperatures in the fall change this environment?



- A. The leaves will change color.
- B. The rocks will freeze solid.
- C. The trees on the hill will die.
- D. The fish in the stream will die.

Appendix B: Sample materials from the DSD Core Academy science kit for Standard 2.

**HABATIT In a sack**

- **Sack**
- **Paper**
- **Envelope**

Put in 5 or 8 things from your own habitat into the sack.

Make a list of all of the items in your sack.

Fold the list and put it in the envelope.

Seal the envelope and put your name on the outside of it.

We will trade habitat sacks and see if we can identify each person by the items in their habitat sack.

Remember: a habitat is where a person is ordinary found or lives.

MAKING A VENN DIAGRAM

SCHOLASTIC NEWS SKILLS PAGE

Name: _____

Comparing Pandas

Read the facts below to learn how female and male pandas are the same and how they are different. Then, fill in the Venn diagram.

Female Pandas

- Weigh up to 220 pounds
- Live in the mountains of China
- Eat mostly bamboo
- Spend at least 12 hours a day eating
- Care for cubs
- Roam over small areas of the forest

Male Pandas

- Weigh up to 250 pounds
- Live in the mountains of China
- Eat mostly bamboo
- Spend at least 12 hours a day eating
- Spend no time with cubs
- Roam over large areas of the forest

Female Pandas Both Male Pandas

4 SCHOLASTIC NEWS / SEPTEMBER 4, 2006 / EDITION 2

REPRODUCIBLE SKILLS PAGE

Appendix C: Lesson Plan from Living/Nonliving Science Kit

Objectives to Master:

Objective 1: Given 5 trials, students will correctly identify living organisms for at least 4 of the 5 trials. (USOE 3rd Grade Core, 2:1:a)

Objective 2: Given 5 trials, students will correctly identify nonliving things for at least 4 of the 5 trials. (USOE 3rd Grade Core, 2:1:b)

Vocabulary:

living
nonliving
organism

Materials Needed:

Slideshow #1
Flashcards
Paper
Test Prep Lesson #1

Lesson Plan

State the Objectives.

§1—Model living.

Teacher: Plants and animals are living things.

Teacher: What are living things?

Students: plants and animals.

(Repeat until firm.)

(Advance slideshow with each prompt.)

Teacher: This is a living thing. (picture of a plant)

Teacher: This is a living thing. (picture of an animal)

Teacher: This is not a living thing. (picture of a rock)

§2—Model—nonliving

Teacher: Nonliving things are not living. They are not alive. They are not plants or animals. Are nonliving things alive?

Students: No

Teacher: Right. Things that are NOT plants and animals are nonliving .

What are things that are NOT plants and animals called?

Students: Nonliving

(Repeat until firm.)

(Advance slideshow with each prompt.)

Teacher: This is a nonliving thing. (picture of a rock)

Teacher: This is a nonliving thing. (picture of a wave)

Teacher: This is a living thing. (picture of an animal)

§1 & 2—More Guided Practice—nonliving, living

Teacher: You tell me if these are living or nonliving. Get ready.

(Prompt with each slide) Teacher: Living or nonliving?

Students respond verbally in unison with living or nonliving.

Practice until firm.

§3—*Model organism.*

Teacher: What are plants and animals called?

Students: Living things.

Teacher: Good. Living things are also called organisms.

What is another word for living things?

Students: Organism.

(Repeat until firm.)

Teacher: This is an organism. (picture of a plant)

Teacher: This is an organism. (picture of an animal)

Teacher: This is nonliving. (picture of dirt)

§3—*More guided practice—organism*

(Advance slideshow with each prompt.)

Teacher: Tell me if each thing is an organism or nonliving.

(Prompt with each slide) What is this?

Students respond verbally in unison with organism or nonliving.

Practice until firm.

§1, 2, & 3—*Less guided practice—living, organism, nonliving (if needed)*

Review the vocabulary words and definitions.

Teacher partners students up and gives them a set of flashcards. Students ask each other what each picture is, an organism or nonliving thing. Teacher monitors student progress. Practice until firm.

§1, 2, & 3—*Independent Practice—living, organism, nonliving*

Teacher gives each student a blank white paper folded into fourths. (Model the assignment first.)

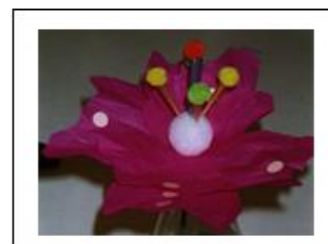
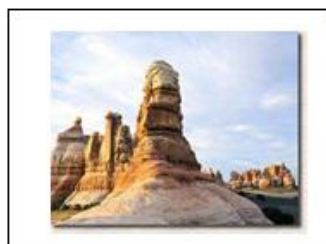
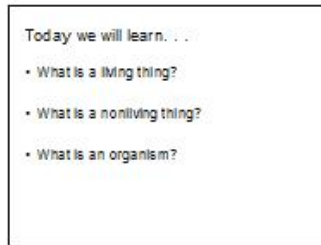
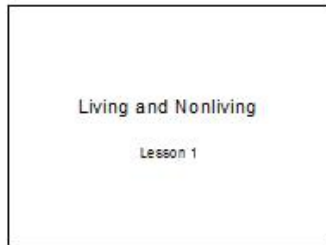
In each box, students are to draw or write the name of 1 organism. On the back side, in each box, students are to draw or write the name of 1 nonliving thing.

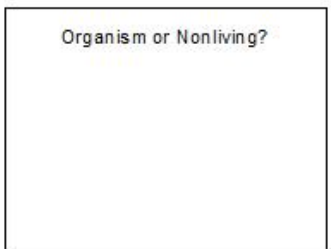
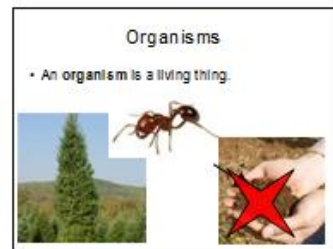
Then, have students share their artwork. Peers should guess the pictures, or guess if they were holding up their living or nonliving side of their paper. Have students turn in the papers at the end.

Test Prep—

Do Test Prep Lesson #1, Questions 1-3 together. If students are independent, have them finish it on their own, then correct them together.

Slideshow #1







Test Prep Lesson #1

Choose the best answer.

Guided Practice

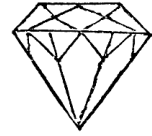
1. What is another word for an **organism**?

- a. dog
- b. living
- c. nonliving

2. Which of these is a **nonliving** thing?

- a. rock
- b. fish
- c. person

3.



- a. organism
- b. science
- c. nonliving

Independent Practice

4. Which of these is nonliving?

- a. deer
- b. sand
- c. flowers

5. Which of these is a nonliving thing?



a.



b.



c.

6. Which of these is an organism?

- a. baby
- b. car
- c. sky

7. What is another word for **living things**?

- a. pizza
- b. my friends
- c. organisms
- d. nonliving

8. What is this?

- a. living
- b. nonliving
- c. organism
- d. electricity

