Title: "Instructional Strategies Drive Student Achievement: Methods to Improve Student Understanding of Topics in Earth Science"

Co-Authors: Carolyn H Wilson, Ed.D; Matthew Stephen Weston, M. Ed.

Publication Date: December, 2010

Abstract:

The purpose of this research is to share strategies and techniques used by highly qualified educators and experts in the field of education and instruction. Differentiated instruction is one of the most common terms used in education. It is also the key to teaching students with multiple or a wide range of disabilities. Quality classroom instruction impacts student achievement; however, when working with students with disabilities it is often a specific type of quality instruction that makes the difference, and that method most likely does not work for another student with the same disability in the same class. The inclusion classroom with collaborating teachers is a common learning environment in most educational institutions. The inclusion classroom is where students with a wide range of abilities are all taught the same materials in classes together (Idol, 2006). The students can range from high academic abilities to students with multiple disabilities. Collaborative teaching programs can be implemented in a variety of forms. Consulting teacher model is an indirect form where the special education teacher would serve as a consultant for the general education teacher. Cooperative teaching model is where the special education and general education teacher work together, co-teaching in the same classroom. The last is the supportive resource program where students would regularly attend a resource program while receiving the majority of their education elsewhere (Idol, 2006). This wide range of abilities in one room can create a unique set of challenges for the collaborating teachers. One of the challenges that receive the most attention has to do with the interactions between the collaborating teachers.

Introduction

It is safe to say that quality instruction is the hallmark of a quality teacher. When a highly qualified teacher provides high quality instruction, student achievement is driven to new heights. What happens when the lesson that is taught does not match the learning style of a specific student? In the best situation, highly qualified teachers take note of the student who hovers outside the realm of understanding. The teacher then switches the format in the same lesson and tries again. This practice is called differentiated instruction.

Differentiated instruction involves providing students with different avenues to acquire content, to process, construct or make sense of ideas. It also involves developing teaching materials so that all students within a classroom can learn effectively, regardless of differences in ability. Simply put, it is instruction with the student placed at the center of both the teaching and learning ("Differentiated Instruction", 2010). Also, the learning environment is tailored to the individual student's needs (National Association for Gifted Children [NAGC], 2010). This is the key concept behind working with students with disabilities.

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Collaborative teaching programs can be implemented in a variety of forms. Consulting teacher model is an indirect form where the special education teacher would serve as a consultant for the general education teacher. Cooperative teaching model is where the special education and general education teacher work together, co-teaching in the same classroom. The last is the supportive resource program where students would regularly attend a resource program while receiving the majority of their education elsewhere (Idol, 2006). While all of these models may exist in some form in a school, it is the cooperative model that receives the most attention.

The passage of The Individuals with Disabilities Education Improvement Act (IDEIA), combined with the passage of No Child Left Behind (NCLB) have provided the momentum for school districts to examine and redefine the roles of both the special and general education teachers (Carpenter & Dyal, 2007). In order for these teachers to meet the challenges of educating such a wide range of student abilities, both the special and general education teachers must learn to adapt. They have to learn to work together and develop strategies to meet the needs of not just most students, but all students (Rekkas, 1997). As an aid to schools implementing inclusive programs, the government developed Curriculum 2000, which formulated three core principles of inclusion; 1) setting suitable learning challenges, 2) responding to pupils' diverse needs and overcoming potential barriers to learning, and 3) assessment for individuals and groups of children (Hodkinson, 2006).

As with any government policies or guidelines, there is often interpretation that has to be done before it becomes practice. Often when beginning something new there are misconceptions and concerns. Inclusive classrooms are no different. Many general educators are not receptive to the idea, due to major concerns about the behaviors of students with disabilities (Crawley, Hayden, Cade, & Baker-Kroczynski, 2002). This is often due to their minimal training and experience with students with disabilities. In Earth Science specifically, the topics are non-tangible and often difficult to make interactive or hands-on. This encourages many teachers to resort to lecture-based instruction, which tends to exclude students with disabilities (Lewis, 2008). Special educators often are concerned about their ability to provide accurate instruction in their assigned content area (Cawley et al., 2002). Often as a result of their concerns, collaborating teachers will be unclear regarding their roles in the shared classroom. Numerous school professional development resources are used trying to give each teacher a defined role.

I believe this is counterproductive. Teachers in a co-taught classroom must be willing to work under a different set of assumptions. They must redesign the curriculum and work together to develop a new and imaginative system for educating their shared students (Wood, 1998). The true strength of a collaborative team is in their ability to combine individual talents to achieve positive results for all of their students (Wood, 1998). The path to collaboration begins when teachers of different disciplines can work together and foster positive student performance (Cawley et al., 2002).

Once the collaborative teachers are focused on instructional methods and not just their working relationship, they can begin working toward the goal of educating all learners. Many times teams will allow the students to demonstrate a wide array of tasks at various skill levels. Other activities will vary based on the level of the individual student working on the task (Byra & Jenkins, 2000). The implementation of instructional methods can take on different avenues of focus. Some collaborative teams use cooperative group learning, which allows students of various levels to pull from each other in a collaborative work environment. Drawing from the idea that different students will better understand different topics, this method can help improve group members' levels of understanding. This model tends to be productive for both students with and without disabilities (Rekkas, 1997). Another method is concept mapping, in which events, objects or topics are linked with a similar label (Okoye, Momoh, Aigbomian, & Okecha, 2008). When this method is used in science, relatively independent topics become connected, arranged in a manner that creates a hierarchical order and allows for the student to learn materials through meaningful and logical methods (Okoye et al, 2008). Differentiation also occurs in an inclusive class through reading and language development. Many of the students who are struggling in the class or who have a disability may need assistance in this area. Poor skills in word identification, reading comprehension, and vocabulary often diminish a student's ability to learn new materials (Schmidt, Rozendal, & Greenman, 2002). Topics in science are no exception. Using the specific science vocabulary and reading for information activities will familiarize students with terms and encourage confidence when reading.

Teaching in an inclusion setting has its own unique challenges. Challenges include co-teacher compatibility, understanding the diversity of the student population, and determining which different instructional strategies or methods will work for those students. It is important to have co-teachers who are willing to place students at the center of instruction and lessons, and to adapt to the ever-changing needs of their students. Once that is achieved, differentiated instructional strategies will become commonplace and all students will have an opportunity to be placed at the center of their learning.

Methodology

The ultimate question posed by the researcher is, "will quality differentiated instruction result in guaranteed improvements in the topics of Earth Science on benchmark testing?" The researcher categorized the topics of Earth Science: Scientific Investigation, Space "Universe", Space "Solar System", Maps, Atmosphere and Weather, and finally Oceanography.

The methods for gathering data were through student participation in both pre and post testing as well as district designed benchmark testing. Each of the pre and post tests were composed of 15 questions assembled from various Virginia Standard's of Learning (VA-SOL) released tests. The benchmark tests were created by a school official using a web-based achievement test generator by Interactive Achievement (IA). The benchmark test generator is designed to create tests that would simulate taking a VA-SOL. Both the pre and post tests, as well as the benchmark, were given during class. The pre test was always administered before any of the topic information had been taught. Its purpose was to assess each student's pre-existing knowledge of the topic. The post test was always administered after the final wrap-up of a topic. Its purpose was to show the level of knowledge gained through instructional strategies.

The test questions were the same for both the pre and post tests. The 15 questions were not rearranged, and all were multiple choices, addressing only the specific SOL topic. The tests were administered and scored by the researcher to insure test validity. The students that were being assessed were only aware of the fact that the tests were to track and gauge information learned. The tests were not used for grading purposes, but the students were aware of the importance of doing their best on each assessment.

The benchmark, however, was developed by an unknown school official and the questions on the assessment were unknown to the students, teacher, and researcher, prior to the test. Test questions were based on the VA-SOL's. The teacher's pacing guide allowed the test designer to focus on the topics covered in the class. The test was administered by the researcher. It was scored by IA and results were acquired from their online reporting center. The reporting center divided the questions based on their VA-SOL strand. This feature allowed the researcher to gather testing results based on the VA-SOL correlation and to assimilate it into the data charts gathered.

Every student enrolled in the researcher's inclusion classes was initially included in the test group. Students were removed from the test group only if they were absent when a pre or post test was administered. Other students were removed from the test group if absenteeism from instruction impacted their learning of topics being studied.

Subjects

The school system from which the research was acquired is located in central Virginia. The school system is located in an urban setting. The school division consists of three elementary schools, one middle school and one high school. The study took place at the high school, which is venturing through its first year of a new 4X4 block schedule. This block schedule format means that the students will take only four classes during first semester then four new classes during second semester. This schedule allows each student to potentially earn eight credits in one school year.

As of November 12, 2010 at 8:20 am, the student enrollment was 1161 students. The school's demographic breakdown at that time was as follows: 55% African American, 42.12% White, 1.12% Asian, 0.86% American Indian, 0.09% Native Hawaiian, and 0.81% other. The focus of the study is primarily 9th graders enrolled in Earth Science. To get a historical understanding of student enrollment and achievement in the target subject area, the 2009-2010 school report card is used for reference, as found on the Virginia Department of Education's website. In the 2009-2010 school year, the total school enrollment was 1,148 students. The individual grade level breakdown of students was as follows: 353 students in 9th grade, 288 students in 10th grade, 272 students in the 11th grade, 230 students in the 12th grade, and 5 students that were classified as post-graduates.

The school report card did not provide the specific number of students taking the Earth Science class. It did, however, provide pass/fail percentages and demographic area breakdowns. Last year, the students participating in the Earth Science SOL performed as follows: All students: 74% passed and 26% failed; Female students: 70% passed and 30% failed; Male students: 79% passed and 21% failed; Black students: 66% passed and 34% failed; White students: 91% passed and 9% failed; Hispanic students: 64% passed and 35% failed; Students with disabilities: 42% passed and 58% failed; Economically Disadvantaged: 67% passed and 33% failed.

With the background information gathered from the school report card, two classes were selected to be a representative test group. Both classes would be co-taught inclusion classes. The original test group consisted of 45 students. At the end of the testing process, the usable testing group consisted of 37 students. During the process, eight students were eliminated from the test group due to missing pre or post tests, absenteeism, or other incidents that would render their testing data unusable. The resulting group consisted of the following: 57% female students, 43% male students, 70% African American, 24% White, 6% Hispanic, and 38% were students with disabilities.

The classroom is arranged to support the instructional needs of the topic being addressed. Sometimes the students are working in pairs, or are arranged in rows or group clusters. Block scheduling allows for approximately 80 minutes per class and instructional changes are based on the needs of each subject area. Instructional methods used in the classroom are a mixture of reading strategies that use Interactive Cornell Notes, four square vocabulary and word walls. Other strategies such as concept sorts, cooperative learning and foldable creative activities are used as practice and reinforcement. The following results give insight into the effectiveness of these instructional methods.

Results

Figure 1. *Student Scores on Topic of Scientific Investigation*

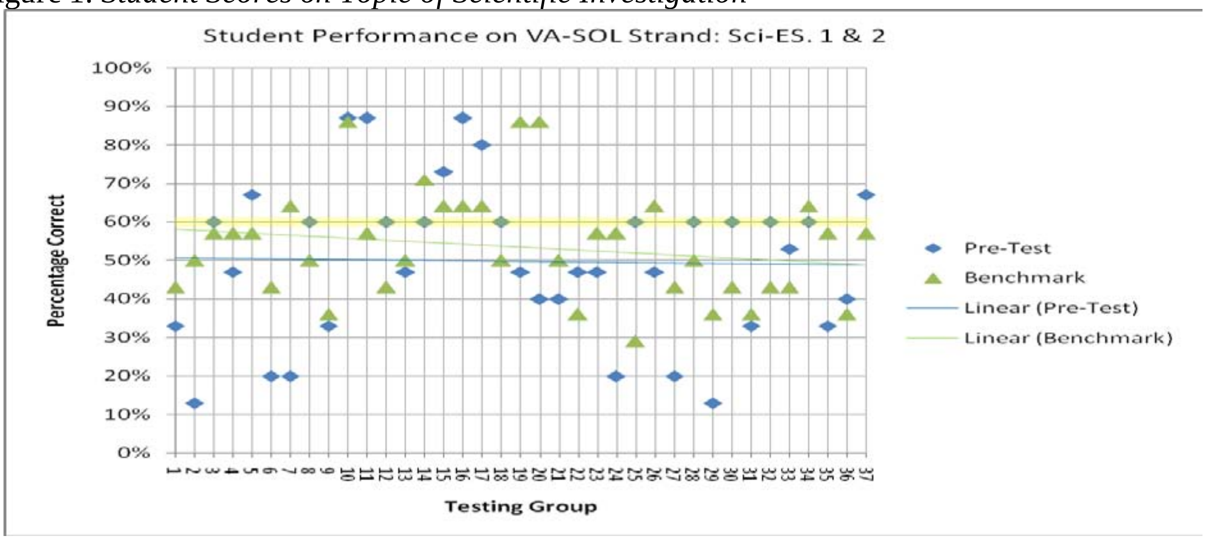

Figure 1 illustrates the individual student percentage score on the pre-test and the benchmark assessments as compared to the state target of 60%, which is the equivalent of passing the VA-SOL. Also included in the chart are linear trend lines for both tests. The contents of this chart allow for easy comparison of pre-existing knowledge and performance on the benchmark assessment.

Figure 2. *Class Average Scores on Topic of Scientific Investigation*

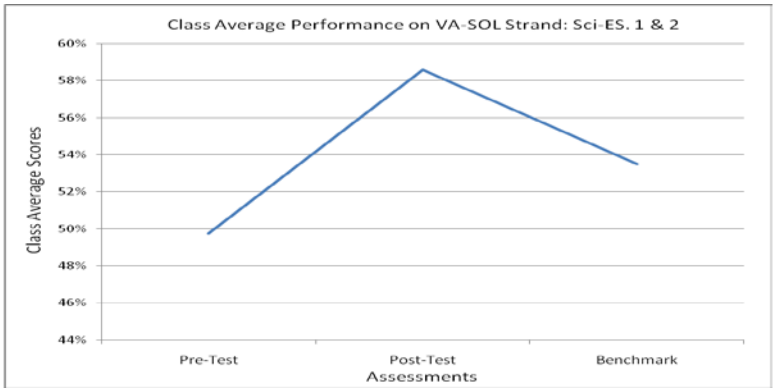

Figure 2 illustrates the test group average on the pre-test, post-test and benchmark assessment. The chart displays a simple flow of the group's learning and retention. The pre-test displays the group's pre-existing knowledge and the post-test shows the level of gains as a result of the instructional strategies. The chart ends with the benchmark assessment which illustrates retention of knowledge over time.

Figure 3. *Student Scores on Topic of Space "Universe"*

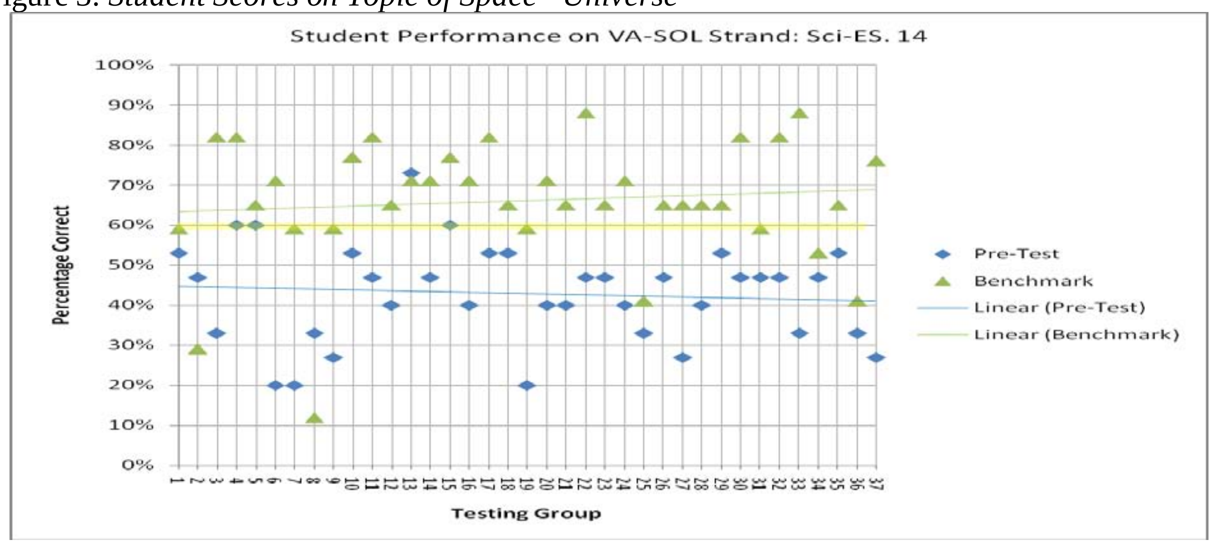

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Figure 4. *Class Average Scores on Topic of Space "Universe"*

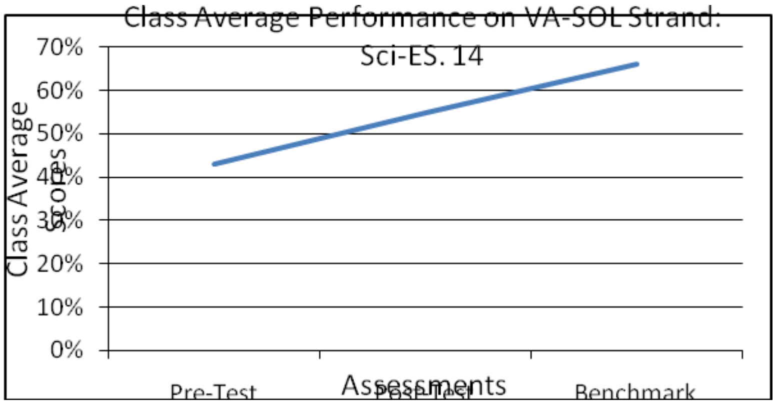

Figure 4 illustrates the test group average on the pre-test, post-test and benchmark assessment. The chart displays a simple flow of the group's learning and retention. The pre-test displays the groups pre-existing knowledge and the post-test shows the level of gains as a result of the instructional strategies. The chart ends with the benchmark assessment which illustrates retention of knowledge over time.

Figure 5. *Student Scores on Topic of Space "Solar System"*

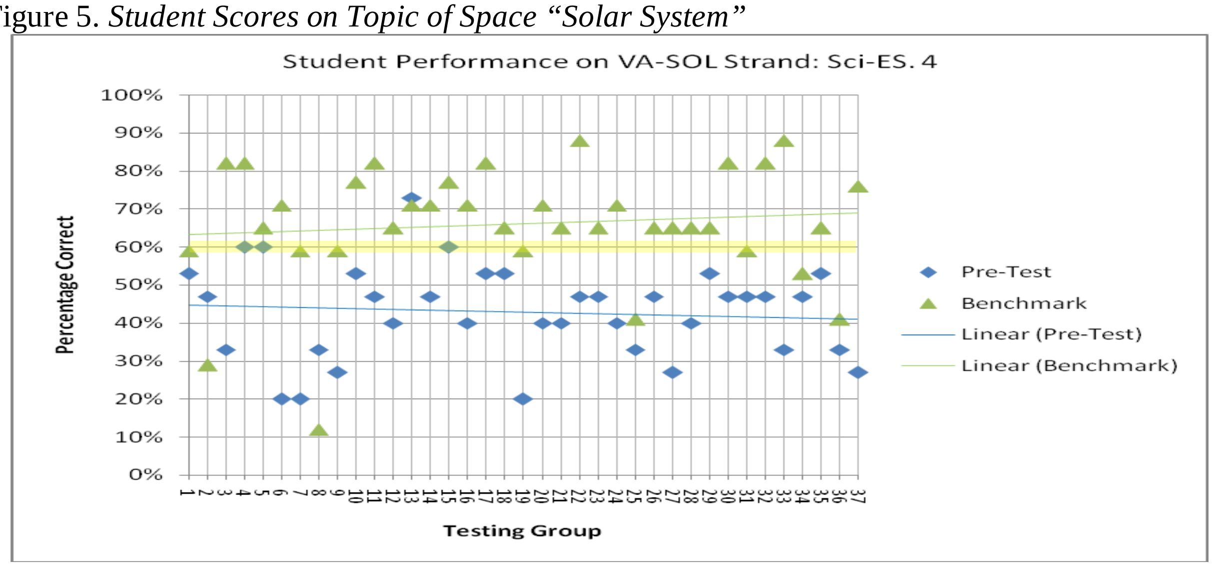

Figure 5 illustrates the individual student percentage score on the pre-test and the benchmark assessments as compared to the state target of 60%, which is the equivalent of passing the VA-SOL. Also included in the chart are linear trend lines for both tests. The contents of this chart allow for easy comparison of pre-existing knowledge and performance on the benchmark assessment.

Figure 6. *Class Average Scores on Topic of Space "Solar System"*

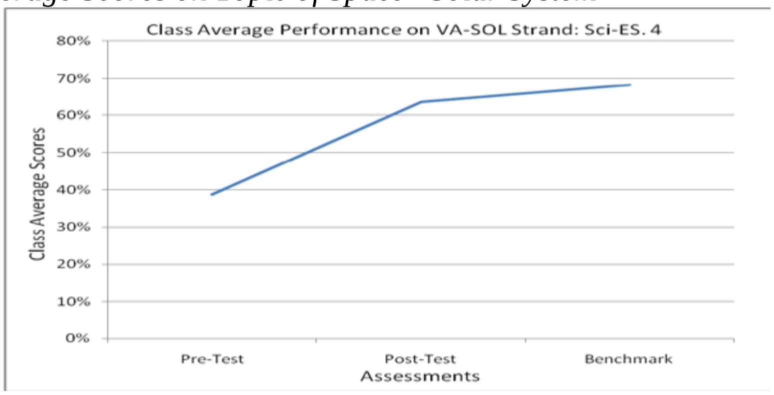

Figure 6 illustrates the test group average on the pre-test, post-test and benchmark assessment. The chart displays a simple flow of the group's learning and retention. The pre-test displays the group's pre-existing knowledge and the post-test shows the level of gains as a result of the instructional strategies. The chart ends with the benchmark assessment which illustrates retention of knowledge over time.

Figure 7. *Student Scores on Topic of Maps*

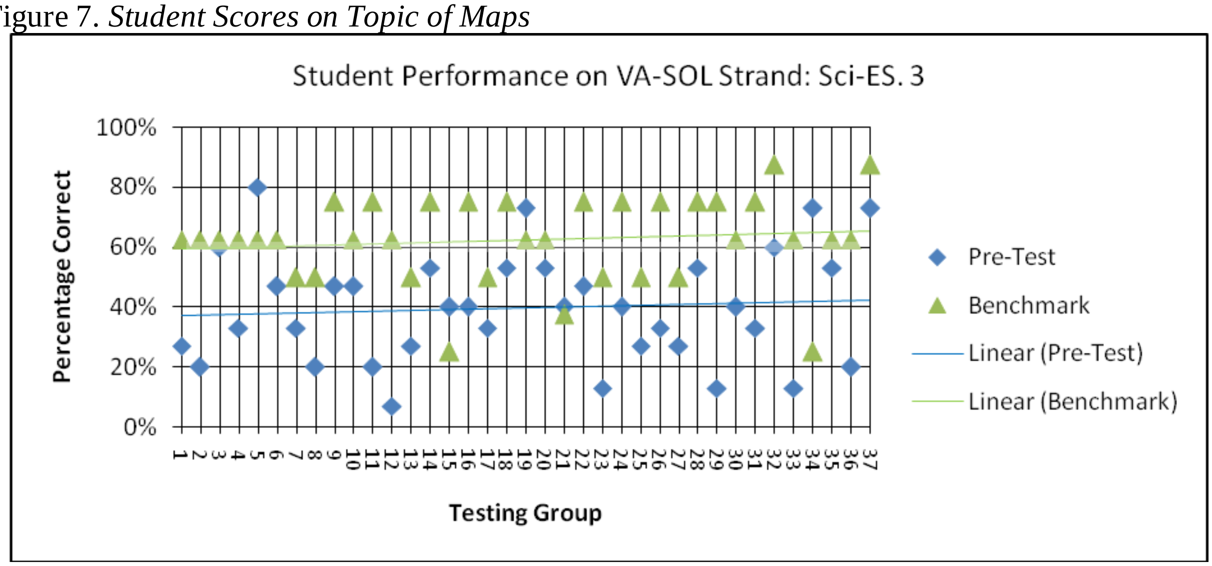

Figure 7 illustrates the individual student percentage score on the pre-test and the benchmark assessments as compared to the state target of 60%, which is the equivalent of passing the VA-SOL. Also included in the chart are linear trend lines for both tests. The contents of this chart allow for easy comparison of pre-existing knowledge and performance on the benchmark assessment.

Figure 8. *Class Average Scores on Topic of Maps*

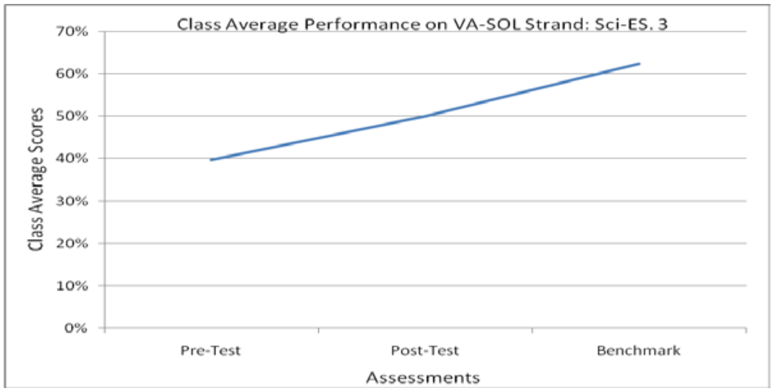

Figure 8 illustrates the test group average on the pre-test, post-test and benchmark assessment. The chart displays a simple flow of the group's learning and retention. The pre-test displays the group's pre-existing knowledge and the post-test shows the level of gains as a result of the instructional strategies. The chart ends with the benchmark assessment which illustrates retention of knowledge over time.

Figure 9. *Student Scores on Topic of Weather & Atmosphere*

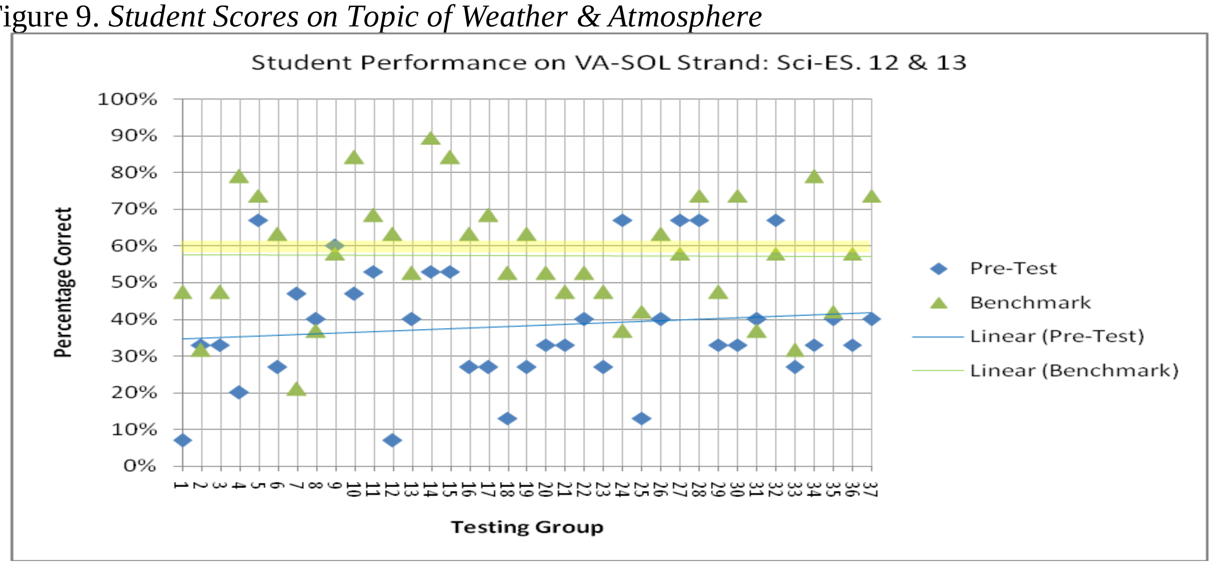

Figure 9 illustrates the individual student percentage score on the pre-test and the benchmark assessments as compared to the state target of 60%, which is the equivalent of passing the VA-SOL. Also included in the chart are linear trend lines for both tests. The contents of this chart allow for easy comparison of pre-existing knowledge and performance on the benchmark assessment.

Figure 10. *Class Average Scores on Topic of Weather & Atmosphere*

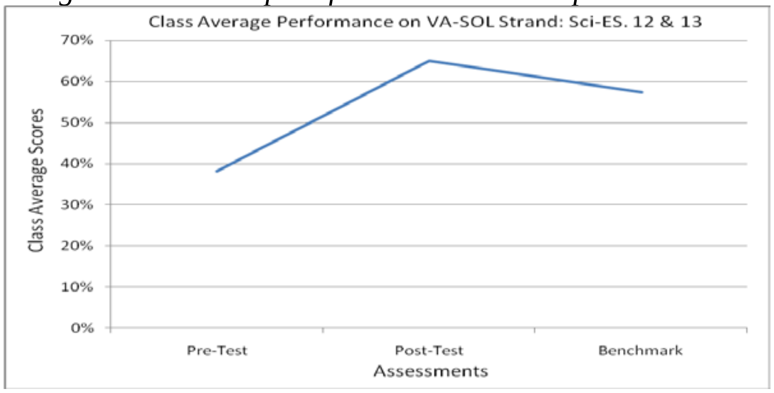

Figure 10 illustrates the test group average on the pre-test, post-test and benchmark assessment. The chart displays a simple flow of the group's learning and retention. The pre-test displays the groups pre-existing knowledge and the post-test shows the level of gains as a result of the instructional strategies. The chart ends with the benchmark assessment which illustrates retention of knowledge over time.

Figure 11. *Student Scores on Topic of Oceanography*

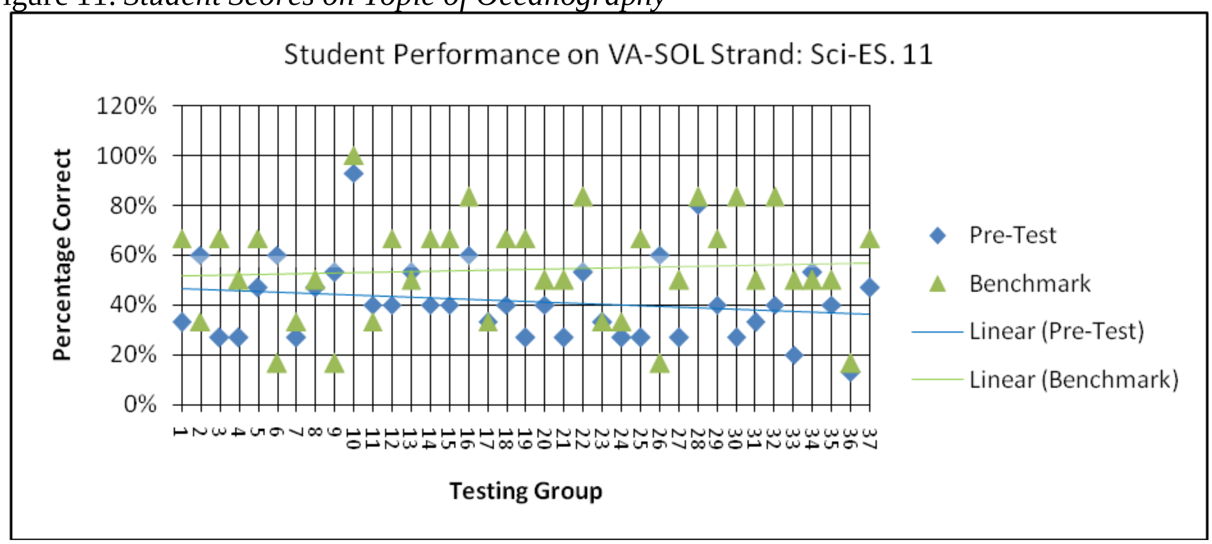

Figure 11 illustrates the individual student percentage score on the pre-test and the benchmark assessments as compared to the state target of 60%, which is the equivalent of passing the VA-SOL. Also included in the chart are linear trend lines for both tests. The contents of this chart allow for easy comparison of pre-existing knowledge and performance on the benchmark assessment.

Figure 12. *Class Average Scores on Topic of Oceanography*

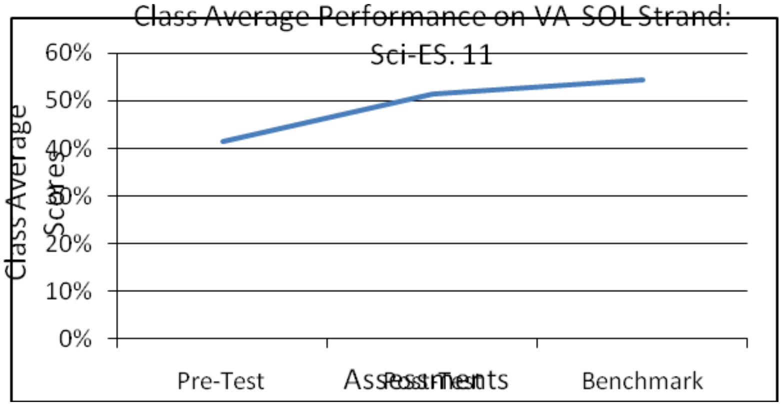

Figure 12 illustrates the test group average on the pre-test, post-test and benchmark assessment. The chart displays a simple flow of the group's learning and retention. The pre-test displays the group's pre-existing knowledge and the post-test shows the level of gains as a result of the instructional strategies. The chart ends with the benchmark assessment which illustrates retention of knowledge over time.

Conclusions

As a result of the strategies implemented, it is clear that the students were able to learn and retain the information taught. The testing data of the entire group showed consistent improvement of varying levels across all topic areas. At times, some students showed greater knowledge on the pre-test than on the benchmark test. These results could be attributed to student confusion over a specific topic after instruction, misunderstanding the question(s) on the benchmark test, or the lack of student effort while taking the benchmark test.

Areas such as scientific investigation, which require reasoning and interpretive skills, proved to be more difficult for students than areas that only require memorized facts or processes. While it is not conclusive that these same students would score differently without the use of different strategies by the teacher, it is certain that the students were able to access the information and display knowledge learned on a multiple choice format test. It is also unclear which, if any, single strategy or combination of strategies was most helpful to student learning. If further testing is administered, tracking students' reflections on different methods of instruction might provide further insight. However, it is the researcher's opinion that the results would probably display a wide range of preferences from the students.

Recommendations

It is recommended that it is in the students' best interest to deliver and review materials in as many different methods as possible. This will allow all students to access the information primarily in their preferred method and other methods as well. It is also the researcher's opinion that while some methods can change the directions for implementation, others need to be consistent to allow the student to master the method and to know what to expect when the practice is put in place. Listed below are recommended instructional methods with the directions and their expected goal.

- Interactive Cornell Notes: This assignment could accompany any reading, whether teacher-created or from a textbook. Students would be expected to read each passage and write a predetermined number of questions and answers. Students should include illustrations when appropriate. The goal is for the students to learn the material as they improve their reading skills. For subjects such as science, that are very vocabulary-specific, it is important that the students become comfortable when reading for information.
- 4 Square Vocabulary: It is vital that the students are capable of reading the word in front of them and then having various mental references to help with information recall. Four square vocabularies are a vocabulary block that is designed to have students write down more than just a definition. Depending on the word, components such as facts, pictures, examples, symbols, and informational questions can be used to build more reference points for that topic.
- Word Walls: This is a simple practice that is often used at the elementary level but rarely at the secondary level. Words that the students have studied are placed around the room, allowing students to scan their surroundings and read words they have learned, helping to keep word references fresh in their minds.
- Concept Sorts: Often used to allow students practice with topic information, students are given a flow chart and a selection of words. The students then use acquired knowledge to sort the words into a flow chart in a way that would display the information correctly.
- Foldables: Even with older students, created illustrations can become a tangible method for learning a given topic. In science, where much of the topics are not easily represented or reproduced in classroom explorations, the drawing, coloring and labeling of concepts can bridge the gap between the abstract and tangible.
- Cooperative Learning: This method can be used in a variety of situations. Whether students are working together on a worksheet, laboratory experiments, or even flash card review, when they work together on an activity a different type of learning takes place. Peer learning, while risky if not managed properly, can boost the learning of even the lowest of students.

It is also recommended by the researcher that most instruction be as diverse as possible in using instructional strategies. When presenting information to a diverse student group, not every method will work for every student. By addressing the overall needs of the class, and developing basic learning skills, students will be able to access information on their own terms and with greater retention. Using these best practices will result in higher student performance on benchmark assessments.

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