A Multi-Strategy Approach to Increase ESOL Student Performance on the High-Stakes Virginia End-of-Course Biology Standards of Learning (SOL) Assessment

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Introduction

In Virginia, the Standards of Learning (SOL) Tests have completely changed the way in which teachers teach high school students Biology. In order to earn a high school diploma, Virginia students must now pass a certain number of these end-of-course tests, as well as earn the required number of credit hours in various subject classes. Students who do not meet these minimum criteria will not graduate. Schools (principals and teachers) are also held accountable for the number of students who pass or fail these state assessments as individual schools must meet State accreditation standards.

The Virginia Department of Education has provided Biology teachers with an SOL Teacher Resource Guide that outlines the standards, and contains a skeletal version of the essential understanding, knowledge and skills that students must master in order to pass the Biology SOL test. Unfortunately, the curriculum is too extensive and overwhelming for students to learn in one school year. Another problem that arises is the level of English proficiency necessary to be able to read and understand the multiple-choice questions on the test.

Herein lies my challenge. These graduation barrier tests have impacted all students, but most especially the future of students with limited English proficiency (LEP). As a Biology teacher of mainly students who are in the English for Speakers of Other Languages (ESOL) program, I feel great pressure to prepare my students to pass this barrier test. At the end of the previous two years, the pass rates for my students had been 43.5% (1998/1999 school year) and 45.7% (1999/2000 school year). I had to ensure that my LEP students had a chance to pass the Biology SOL test and thereby closer to eligibility for a high school diploma.

After much reflection, I realized that there was going to be no quick fix. I would not be able to change just one aspect of teaching or learning in my classroom in order to meet the new standards requirements. The stakes were too high. In fact, the more I reflected on my teaching, and the more I thought about the well below grade level English proficiency of my students, I knew that I had to completely revamp my biology program, in order to prepare my students for one of the most difficult academic tests they had ever encountered. I received support from an article I read in which the authors emphasized the importance of educators changing their approach to teaching in order to improve student learning. If the educator uses a process that doesn’t work, then they must change what they are doing (Whiting, Van Burgh & Render, 1994).
Even after coming to peace with my decision, the task ahead of me still seemed formidable. How and where do I begin? First, I had to be flexible. I also had to maintain high standards and hold myself accountable for what my students were learning. I was willing to try anything if it would help my students achieve these high goals.

During the 2000/2001 school year, I began to try out a variety of techniques in my classroom and at the end of the school year my passing rates jumped to 83.7%. Yet, to be honest, I knew I had tried a wide variety of techniques, yet I had done so in a haphazard fashion. I would try a technique for one quarter and then not the next. I did not keep data on what I was doing nor did I talk to my students about what I was doing. My multi-strategy approach to learning included the following:

- Analysis of the Biology Standards of Learning in the Teacher Resource Guide
- Modified Mastery Learning Techniques
- Teaching Specific Test-Taking, Study and Organizational Skills
- Use of a computerized Test-Bank
- Providing Appropriate Practice Tests
- Use of Bilingual Dictionaries
- Teaching Biology Terminology using Latin and Greek Root Words
- Collaboration with ESOL teachers

Yet in order to understand which of the techniques were really making an impact on my students' test scores, I realized that I needed to reflect on every aspect of my teaching and do so in a more systematic manner. That was a core purpose of my LTMIP action research project for the 2001/2002 school year.

The Course Context

**J.E.B. Stuart High School Profile**

Fairfax County Public Schools, located in Fairfax County, Virginia is the 12th largest school system in the nation. Stuart High School, with a population of 1,460 students, is one of the smallest high schools in Fairfax County. At the same time it is the most culturally and ethnically diverse school in the county. Approximately fifty percent of students were born outside of the United States in one of more than 82 countries worldwide. Sixty percent of the students speak a language other than English as their primary language. There are more than 30 different languages spoken by our students and their families. More than fifty percent of our students receive free or reduced-cost breakfast and lunch.

**Biology with Adaptive Strategies Student Profile**

All but five of the fifty-eight students enrolled in the Biology with Adaptive Strategies classes were born in one of 22 countries other than the United States. These students have lived in the United States anywhere from 8 months to 7 years, with the majority having lived here in the 2-3 year range.
Thirteen different languages (not including English) are spoken by 97% of all students, Spanish being the predominant language. Of the five students born in the U.S., two are African American native English speakers. Of the three remaining students, one speaks Arabic at home, while the other two speak Spanish.

Three percent of these Biology students have exited the ESOL program while seven percent have never participated in an ESOL program. Eighty-three percent of these Biology students are intermediate ESOL students who have developed some oral English proficiency and are gaining additional experience in reading and writing. To enter this intermediate level, students must have a minimum 3rd/4th grade reading level.

Seven percent are advanced ESOL students who have considerable proficiency in speaking and understanding English, but are in the process of refining their English reading and writing skills. To enter this advanced level, students must have a minimum 5th grade reading level.

The majority of students surveyed claimed to be able to read and write their first language very well (76%), a minority (21%) claimed to be able to read and write their first language a little, while only 2 students (3%) did not know how to read or write their first language. When queried about their parent(s)/guardian’s level of English proficiency, students claimed the following: did not speak any English (12%), spoke only a little English (53%), spoke English at the same proficiency level as the student (14%), and spoke better English than the student (21%). As a measure of socio-economic status, 74% of students received free or reduced-cost breakfast and lunch.

Materials


- **Eduware: Wizard Test Maker** (Biology). Computerized test bank providing New York State Regents Biology exam questions. 1 (888) EDUWARE  
• Bilingual Dictionaries in the following languages: Spanish, Dari, Vietnamese, Twi, Portuguese, French, Urdu, Somali, Amharic, Arabic and Chinese.

Research, Methodology and Results

Due to the multi-strategy approach used with my students, I divided this action research report into sections according to the different strategies utilized in the classroom.

I. Biology Standards of Learning: Teacher Resource Guide and the SOL Test

The Research: Almost every state has developed new standards of achievement for all grade levels and adopted a form of a statewide standardized test (Robertson, 2000). In Virginia, biology teachers are provided with a Biology Teacher Resource Guide that outlines the essential knowledge, understanding and skills that students must learn in order to pass the Biology standardized SOL test.

Sheppard and Dougherty conducted a study in which they determined that teachers felt pressured from the district and the media to improve their students’ test scores. In response to this pressure, teachers began “teaching to the test,” which meant narrowing the focus of instruction to rote memorization of material that might appear on the test. Content that would not appear on the test was not taught. On the other hand, a positive outcome of standardized testing was that teachers spent more time instructing their students on basic skills and test preparation activities throughout the year, hoping it would have a direct impact on improving test scores (Patten, 2000).

The President’s Advisory Commission on Educational Excellence for Hispanic Americans supports standards-based school improvements but they caution that students bear the consequences of academic failure or success. The effects of such high-stakes tests that affect graduation from high school can undermine the future of any student, but most significantly the future of LEP students (Robertson, 2000). Research by Viadero indicates that too much emphasis on test scores also affects students’ enthusiasm for learning. The reward of a high test score becomes more important than the learning, reducing enthusiasm (Patten, 2000).

The Method: My challenge: how can I teach all the essential knowledge to my LEP students, uphold high standards of performance, and cover the curriculum while not letting students’ enthusiasm drop? I decided the best way to start was to analyze the previous years released Biology SOL tests as well as the standards based curriculum in the teacher resource guide. It had taken me a year to become familiar with the standards and to understand which standards I could teach well in the time that I had with my students. After analyzing the released test items, I realized, that, while many of the test items were part of the essential knowledge mentioned in the teachers resource guide, there were quite
a few questions that did not fit under any of the curriculum standards. This told me that even though the test was supposed to assess only information in the teacher’s resource guide, it was not a good match to the standards. But in looking over the details of individual student performance on the assessment from the previous year, I noticed that students did not have to answer all the questions correctly in order to pass the test; rather, they had to correctly answer a majority of the questions. Only scaled scores used in determining pass/fail status were released making it very difficult to pinpoint exactly how many of the 50 questions students had to correctly answer in order to pass the test. I determined a rough estimate of at least 28 or 29 questions answered correctly to correlate to a passing score.

After looking at the Biology SOL, I realized that this guide was overwhelming to teachers because it included more content knowledge and skills than can possibly be taught well to the average student in a single school year, let alone to a student with limited English proficiency. This is when I reminded myself that my students come first. I had to do what I knew would be best for my students. I dissected the curriculum according to standards and benchmarks that I thought would be accessible to my students, and those standards students would have great difficulty comprehending due to their language skills and often times their lack of the necessary prior knowledge.

The standards (or parts of standards) that I included in my curriculum for the year were the ones that were clearly written and provided sufficient details (vocabulary, concepts, descriptions, scientists and experiments) under the essential knowledge and skills section. Also, the standards had to be ones that could be taught and learned well within a reasonable time frame during the school year. The following is a list of the topics under each standard that I chose to and not to teach. For the sections I decided not to teach, I have included the rationale for my decision.

**Standard BIO 1**

- **Taught:** the scientific method and its importance in the history of scientific discoveries
- **Did not teach:** determining the range, mean and values for data, use of graphic calculator/computer spreadsheet, communicating using presentation software – many of my students are also below grade level in math skills and therefore would have difficulty understanding this information and it would take too much time to teach the basic skills necessary to actually use this technology. Also, it is not possible to test these skills on a multiple-choice test.

**Standard BIO 2**

- **Taught:** Microscopes and the evolution of the DNA model, theory of natural selection
- **Did not teach:** Hypothesis and experiments that led to formation of first organic molecules, germ theory and explanations for disease, changes in health practices that emphasize sanitation, safe handing of food and
water, aseptic techniques, vaccinations, chemicals and processes to destroy microorganisms – requires detailed knowledge of microorganisms and how they cause disease, and does not tell which specific scientists and experiments to teach.

**Standard BIO 3**
- **Taught**: Biochemistry (importance of water to living things, osmosis, pH scale, organic and inorganic compounds related to life), photosynthesis and respiration.
- **Did not teach**: Not applicable here.

**Standard BIO 4**
- **Taught**: Cell theory, structure and function of prokaryotic and eukaryotic cells/cell parts, structure and function of the cell membrane, transport of materials through cells.
- **Did not teach**: Not applicable here.

**Standard BIO 5**
- **Taught**: Basic comparison between monerans, protists, fungi, plants and animals, homeostasis, sexual and asexual reproduction, viruses and lytic cycle.
- **Did not teach**: details in comparing structures, metabolic activities, behavioral responses to the environment of the 5 kingdoms, human anatomy, body systems and life functions – too much information to be covered in a short amount of time, too general and no specific information provided in terms of which terms: organs, glands, diseases, etc. that specifically needed to be taught.

**Standard BIO 6**
- **Taught**: Comparison of mitosis and meiosis, cell specialization, Mendelian genetics (monohybrid & dihybrid crosses), structure of DNA and RNA molecule, basics of protein synthesis
- **Did not teach**: Details of genetic recombination and mutations, details of protein synthesis (transcription and translation) and DNA replication, genetic engineering techniques, the Human Genome Project and related practical and ethical questions, cloning – requires detailed knowledge of DNA and proteins, very complicated steps that students have difficulty understanding and remembering in sequence.

**Standard BIO 7**
- **Taught**: Classification/taxonomy, levels of classification, binomial nomenclature, dichotomous keys, cladograms/phylogenetic trees, evidence of evolution from the fossil record, similarities in embryonic
stages, homologous/analogous structures, and similarities in amino acid and nucleotides sequences.

- **Did not teach**: Observation and identification of local flora and fauna using field guides and dichotomous keys – requires out of class investigations or field trips which are not always possible due to monetary and field trip restrictions, does not list the flora and fauna that are to be identified.

**Standard BIO 8**

- **Taught**: History of life using the fossil record, relative and absolute age of fossils, Darwin and natural selection, effect of mutations and adaptations on a population, emergence of new species.
- **Did not teach**: Not applicable here.

**Standard BIO 9**

- **Taught**: Ecology, biotic and abiotic factors, interactions within and among species, populations, communities and ecosystems, population ecology, nutrient (carbon, oxygen, water) cycles, flow of energy through the ecosystem, ecological succession, effects of natural events and human influences on ecosystems.
- **Did not teach**: nitrogen cycle – too complicated and requires differentiation of terms that are very similar e.g. nitrogen, nitrates, nitrites, ammonia, and ammonium.

**The Results and Conclusion**: I opted to make sure that students knew well the information I taught them. I didn't want to cover too many topics for the sole purpose of “covering” the curriculum, and risk having students gain only a rudimentary understanding of it all. I knew I would have better success with covering fewer topics in greater depth, so that students would really understand the content and be able to answer at least the minimum number of SOL questions correctly. I believe I accomplished this task and that my students learned as much of the curriculum as they could have been expected to learn in one school year given their limited English proficiency.

**II. Modified Mastery Learning**

**The Research**: Mastery Learning is not a new idea. It was first formulated in the 1960’s by Benjamin S. Bloom, while he was investigating ways individualized instruction could be used to improve student learning in group-based classrooms. Mastery learning involves a process that includes initial instruction by the teacher, a formative evaluation administered to students, corrective or enrichment activities, and then a second formative evaluation. This theory holds that all students can learn the same information well if they are provided with the necessary time and appropriate learning conditions, while working at a more individualized pace (Guskey & Passaro, 1992).

The material to be learned must first be divided into concise instructional units, similar to the way textbooks are organized. The teacher then instructs the
students on the content of each unit. A formative evaluation or quiz is administered to the students in order to provide feedback to both students and the teacher on what was learned well and what was not. Using the results of the formative evaluation, special corrective activities are then offered to the students who did not “master” the content and who need additional time and practice to learn it. For those students who learned the material well, enrichment activities are planned to provide further opportunities to apply the knowledge they have gained (Guskey, Passaro & Wheeler, 1995).

The corrective activities provide students with an opportunity to not only find the correct answers, but also to identify why the answers are correct or incorrect. Students also gain practice and increase their ability to solve problems in the future (Guskey & Passaro, 1992). This can be a means of individualizing instruction by using the activities to approach the information in a way different from when it was initially presented. Corrective activities can be worked on with individual or group help from the teacher, with peers in pairs or teams, or even by students independently (Guskey, Passaro & Wheeler, 1995). From their research, Whiting, Van Burgh and Render (1994) encouragingly found that students exposed to mastery learning techniques became better learners as they became more aware of their learning styles, and expected to learn. Students learn throughout the process and remediate unlearned material even though they may not have to retake a test. These researchers were also convinced that “mastery learning can make an excellent teacher outstanding, and certainly any teacher more effective” (Whiting, Van burgh & Render, 1994).

A review of mastery learning cautions that this process should always be used for an extended period of time in order to see its effectiveness. It is also recommended that both standardized and teacher-made tests be used (Slavin, 1990).

**The Method:** After becoming familiar with the above studies, I decided to use a modified version of mastery learning that would most benefit my students. It was also important to decide on a format that would be both manageable for me in terms of creating assessments and corrective strategies, and also fit in the time constraints of class time and after-school help hours.

I briefed students on the modified mastery learning approach that I would be using in class throughout the year and provided them with a handout that explained the process in detail. Students were to take the handout home and explain the procedure to their parents/guardians and get their parents signature on the form. I knew from past experiences that most of the students would not actually explain this procedure to their parents, but that they would get the requested signature all the same. The reason I did this was mostly to get the students to realize that this was an important part of the learning process that they would become accustomed to in my classroom. I also understood that many parents would not be able to read and understand the directions as they were described in English.

I emphasized that this technique would help students learn and remember Biology content and vocabulary longer, better preparing them for the SOL test.
that they would take at the end of the school year. I explained that many of the quizzes the students would be taking would cover 2 topics: a new concept recently covered in class would comprise approximately 75% of the questions and a review concept that had been previously learned in either the current unit or a different unit altogether would be represented by 25% of the questions. Both topics (including notebook page numbers) were disclosed to students in advance so that they were clearly aware of what to study while preparing for the quiz. This information was always posted in the same place on the board under the homework assignment section. Students were also made aware of the grading procedure that was to be used. Examples were performed on the board using fictional students and grades to help the modified mastery learning procedure become more concrete in the students’ minds. This procedure included the following two scenarios.

1. Only students who answered all the review topic questions correctly would earn a numerical grade on the quiz, no matter how many of the current content questions were correctly answered. These students would need no further remediation.

   **Example 1:** Student X took a 10-question quiz. She correctly answered 4 out of the 7 questions on the current topic but answered all 3 of the review questions correctly. This student earned a grade of 7/10 or a 70%. This student did not have to make an appointment for remediation.

2. Any student who did not answer all the review topic questions correctly would automatically earn a letter grade of “F” on the quiz no matter how many of the current content questions were correctly answered. Students would then have a chance to remediate their grade. These students would have to make arrangements with the teacher for help with remediation. Students scheduled appointments with the teacher for after school help on a day of their choosing within one week of the graded quiz being returned to students. The school provided late buses on 3 out of the 5 school days each week making it feasible for students to stay for this after school remediation. Students had the opportunity to stay at least 4 of the 5 days, if they walked home or made other arrangements with their parents. The possible remediation time available was anywhere from 75 to 120 minutes, depending on the day of the week. At the time of remediation, students would have to not only provide the correct answers to all quiz questions for which they chose the wrong answers, they also had to explain why that answer was wrong and why the correct answer was right. Students could work individually or in pairs during this corrective procedure and explain their thought processes in writing. They could use their notes as necessary to help with explaining their answer. To ensure that students had really mastered the information, the teacher would read student responses for accuracy or ask for an oral explanation before the student left the classroom. If students were not able to furnish the correct explanation, they were to remediate again with the help of a peer or the teacher until it was determined that
remediation had been successful. At this point, the student’s quiz grade was changed from the “F” to the original numerical grade that the student earned. No extra credit points were allotted for participating in remediation. After each remediation session, students were informed if they had or had not achieved a mastery level of understanding.

**Example 2:** Student Y took a 10-question quiz. He correctly answered all of the 7 questions on the current topic and correctly answered 2 of the 3 review questions correctly. Initially a grade of “F” or a 0% was recorded for this student. This student would have to make an appointment for after school remediation. Once the student proved that they now understood the content that they had previously not mastered, his grade was changed to a 9/10 or a 90%.

**Example 3:** Student Z took a 10-question quiz. She correctly answered 6 of the 7 questions on the current topic and correctly answered 2 of the review questions. Initially, a temporary grade of “F” was recorded for this student. This student was supposed to make an appointment for remediation, but did not do so. Since the student did not take advantage of remediation, the grade of “F” was permanently recorded as a 0%. The student could have earned a grade of 8/10 or 80% if they had followed through with the remediation process.

Students were also informed that all unit tests would be cumulative, 50% of the questions would be from the current unit of study and the other 50% would include questions from all the previous units of study. Test scores were reported in percentages as well as a Pass (75% and above) or Fail (74% or below) similar to the way SOL scores are reported. This was used to give both the teacher and each student an idea of how they would perform on the SOL test. Remediation after unit tests was done during regular class time. It either took the form of a whole-group discussion with the teacher leading the discussion, or students were assigned to homogeneous groups of 2-3 students based on their quiz grades. This allowed students who needed a large amount of remediation the time they needed and those students who did not need much remediation had time to complete a related enrichment activity. Students who needed no further remediation were asked to act as peer helpers in the classroom, helping groups of students who were still struggling.

**The Results and Conclusion:** Once the details of the modified mastery learning process were explained to students, I answered any questions that students had, to ensure that they understood the procedure. At this point, the majority of the students were not enthusiastic about the process and did not like or “buy into” the program. They made comments such as “it’s just not fair” and that none of their “other teachers” were making them do this.

The first few times the mastery learning process was used with the quizzes, the teacher had to remind students each class period to make
appointments for remediation. On average, there were 3-4 students who did not follow through with remediation for quizzes. The one-week remediation rule was also made flexible to encourage students to participate. After the first semester, students did not have to be reminded and all students went through the remediation process.

Student responses on the survey at the end of the school year indicate that 81% of students believed that the mastery learning techniques used in the classroom were very important or important to the amount of Biology content and vocabulary they learned and remembered throughout the year. None of the students believed that the mastery learning techniques were not important to their learning in Biology. This data is even more amazing since almost 38% of students admitted that they either never or almost never studied for quizzes, and 29% said they never or almost never studied for tests. Only 21% of students studied for more than 40 minutes for a test, 31% studied for 21-40 minutes and 43% studied 20 minutes or less.

My students made the following comments on an anonymous survey regarding the mastery learning techniques used in class:

- “I hated to come after school, but it [the method] always helped me to understand…”
- “I didn’t like [it] but it help a lot you understand more about it.”
- “I didn’t like it at the beginning, but later I realized that I was learning a lot.”
- “It helped a lot. I think that if we didn’t have those “tests on everything” I would only study for the new information but it helped me to go back, review and learn even more.”
- “This one[mastery learning] was a good method to do because it helped us review topics that we forgot, and it helped us to pass the SOL Exam.”
- “[It was] important was [to] come after school to correct our quizzes and understand why we get answer wrong.”
- “I didn’t like it that much but it helped me a lot on learning stuffs. It also help me pass the SOL exam.”
- “I think that the SOL was hard but we were prepared for that.”

Considering these comments were made by mostly high school freshmen and sophomores, who have not yet reached the level of intrinsic motivation that most adults function with, I think it was a success. I will use this modified mastery learning technique again next year. I feel this method of learning really helped my students learn and remember more Biology content longer than in previous years. Mastery learning made my students and me focus on the learning objectives, which made it easier for me to determine what to teach and to let my students know what they were expected to learn.
III. Bilingual Dictionaries

**The Research:** Many educators and researchers discourage students from using dictionaries because they believe that guessing a word’s meaning is a better method, and that dictionaries should be used only as a last resort. Their rationale is that looking up words frequently in a dictionary interferes with short-term memory and disrupts the comprehension process. Well, this advice appears to be based more on conjecture than on empirical evidence. In a study conducted with college level students, Knight found that students who used a bilingual dictionary were able to identify the meaning of more words in context than students who did not use a dictionary. The students who used a dictionary could remember the meaning of more words immediately after reading, and also two weeks later. Their overall reading comprehension scores were also higher than the group that did not use a dictionary. Overall, it would seem that dictionary usage does not necessarily disrupt the short-term memory, but rather enhances comprehension (Knight, 1994).

For ESL students, a dictionary can be a valuable tool when it provides the meaning of an unknown word presented in context. Use of a bilingual dictionary is becoming more and more necessary as the number of students whose native language is not English finding their way to content-based, general education classrooms increases. Studies have found that in order to be successful, students must develop adept dictionary skills. But using a dictionary has pitfalls as well. Students very often have difficulty understanding dictionary definitions. They also get confused with the inflectional endings of words (example: executing, disabled, nightmarish, periodically) and do not realize that the closest definition can be found in the stem. Dictionary work is laborious, but necessary for language learners. For a small minority of students, the activity can be frustrating because the dictionary does not provide them with adequate definitions. To teach students how to use dictionaries properly, teachers must provide opportunities for dictionary practice in the class (Gonzalez, 1999).

**The Method:** The Virginia SOL test allows for certain standard and nonstandard accommodations to be made for LEP students, but only if these accommodations are used in the classroom throughout the year. Use of a bilingual dictionary is one of the available standard accommodations. Students were encouraged to bring bilingual dictionaries to class for use during classroom activities, quizzes, and tests. But only a handful of students actually did so. At first, when students asked for the meaning of certain words that were unfamiliar to them, I refused to tell them hoping that that would force them to bring in a dictionary to class. Unfortunately, this had an adverse effect on their quiz scores because student I knew understood the content necessary to correctly answer questions, were answering the questions incorrectly. After going over the test questions with students, it became clear to me that it was the language used in the questions and answer choices that was confusing students.

At this point I made a decision to explain any non-biology English terms that my students were not familiar with, whether or not they had a dictionary.
For the sake of learning, it was the right thing to do. An informal survey of my classes revealed that many students did not own dictionaries, or had small pocket dictionaries that were not very useful in finding the meanings of words they came across. Students also mentioned that they couldn’t find bilingual dictionaries in their particular language in local or on-line bookstores, or that they couldn’t afford to purchase them.

This led me to survey the different languages that my students were able to read and write in order to determine which bilingual dictionaries needed to be purchased for them. Dictionaries were purchased in 12 different languages including: Spanish (Peru, Bolivia, Costa Rica, El Salvador, Ecuador, Honduras); Dari (Afghanistan); Kurdish (Iraq); Vietnamese (Vietnam); Twi (Ghana); Portuguese (Angola, Portugal, Brazil); French (Morocco); Urdu (Pakistan); Somali (Somalia); Amharic (Ethiopia); Arabic (Sudan, Kuwait, Egypt); and Chinese (China). Dictionaries in the different languages were not equivalent in the number and types of words defined because of their respective editors and publishing companies. One student from Sierra Leone spoke Kriole but was not able to read or write the language thus rendering a bilingual dictionary useless to the student.

Once these dictionaries were made available to students, they were strongly encouraged to use them during quizzes and tests. The teacher was still available to help students with finding words in their dictionaries, and providing meanings of words that were not found in the dictionary. Whole class discussions were held on how to properly use dictionaries, but individual instruction was most beneficial to students due to the nature of the different languages and different dictionaries being used. Instruction took place whenever a student looked up a word in their dictionary or when the student requested the teacher for the meanings of certain words. As the year progressed, the role of the teacher decreased, and the role of the dictionaries in determining the meanings of words increased. This was done to prepare students for the SOL exam, during which students are not allowed to ask the teacher for the meaning of words, but only rely on their dictionaries for help.

**The Results and Conclusion:** Students found using the dictionary tedious but still helpful. There were some students who found using their dictionary frustrating because they were not able to successfully find the definitions of some words. This was either due to the limited number of words in their dictionary, or because the students were not familiar with the vocabulary in their native language used in the definition. There were some students who just didn’t want to use the dictionary at all because they felt they didn’t need it, or found it bothersome to use.

Some typical words that LEP students looked up in their dictionaries included: distinguished, determining, link, sheds, subunits, raw and locomotion. All of the above words were found in the students’ dictionaries except for subunits which is more a technical term related to the field of science. Overall, students were successful in finding the term, understanding the meaning in context, and felt the dictionary helped them better understand the question.
Of the 55 LEP students surveyed, 84% used their bilingual dictionaries on the SOL test. Of these students, 98% thought that using the bilingual dictionary not only helped them better understand the questions on the SOL test, but also helped them to correctly answer those questions. An overwhelming majority of these students (96%) also believed that they had a better chance of passing the SOL test because they used their bilingual dictionaries.

How many words and what type of words did the students look up while taking the SOL test? Keeping track of the exact number was not feasible due to the high-stakes nature of the test and because standardized testing protocol had to be followed. In order to maintain test security, the content of the test cannot be discussed with anyone, making it impossible to determine the type of words students looked up. After the test, students were surveyed to determine how many words they remembered looking up while taking the test. The results show that 42% of students claim to have looked up between 1 and 5 words, 40% claimed to have looked up between 6 to 10 words, 13% claimed to have looked up 11 to 15 words, while 4% claimed to have looked up more than 15 words in their bilingual dictionaries.

The majority of students who used their dictionaries thought it was worth the time and effort it took to search for words. My students made the following comments on an anonymous survey regarding their use of bilingual dictionaries:

- "When I used the dictionary, I was able to find the words that I didn’t know."
- "The dictionary helped me, but I was not able to find all the words I was looking for."
- "I am not able to found the word on the dictionary. It’s too small. I look for 5 but I only found 1."
- "I was able to find almost all of the words but in some case was impossible to find them."
- "Because we have to pass the SOL, so I wanted to be sure that I understand every and each question."
- "I think that I use the dictionary more for the SOL because I was not sure about many words, because they were harder."
- "I used dictionary on the SOL test because most of the words are hard; some words I don’t know. On the regular Biology class tests the vocabulary words are easier."
- "Sometimes I looked in the dictionary I didn’t understand what was the definition for a certain word."
- "Dictionaries were very helpful for the SOL exam because it helped me understand better the questions."
- "I used the dictionary on the SOL … but it takes time to find a word."
IV. Biology Terminology: Latin & Greek Root Words

The Research: It has been suggested that almost 75% of English words are of either a Latin or Greek derivation. The terminology used in science has a higher percentage of such terms than other areas of study. In 1977, Masciantonio emphasized that a student who knows the meaning of the Latin word *aqua* (water) would have no difficulty with understanding the following English words: aquarium, aqueduct, aquatic, Aquarius, and aqueous. Students taking preparatory classes for the Scholastic Aptitude Test (SAT) know that learning Latin root words correlates to higher verbal scores. Learning Latin can have a positive effect on vocabulary and other English language skills (Holmes and Keffer, 1995).

J. H. Wandersee, in 1985, stated that “there are more new words introduced in a beginning biology course than in the first-year study of a foreign language.” For students to master the subject matter, they must learn the terminology. A successful approach to teaching new vocabulary involves teaching root words rather than using vocabulary lists as is traditionally used. By stressing the importance of learning vocabulary in this way, students discover that this method is less time-consuming, and is also applicable to other disciplines. It is an easier approach and causes less frustration for students when they encounter new terms (Kessler, 1999).

The Method: I agree with Wandersee’s statement regarding the number of biological terms. My students are always overwhelmed by the number of vocabulary terms they have to learn in order to “speak biology.” I used to give my students a list of vocabulary terms to define before beginning a unit, but I no longer do that. I realized that it was not an effective way of studying because students used the glossary in the text to just copy the definition. LEP students could not understand the term or the definition after completion of the assignment, which made it a waste of time.

I therefore decided to teach the biology content first, and the vocabulary second. This way the terms were not learned in isolation but in context. When I typed up the notes for my students, I used the terms as a part of the explanation of the concept being learned. For example, when teaching the function of a “microscope”, the word was broken down into 2 parts: *micro* = small and *scope* = to see. Therefore, students learned that a microscope was an instrument used to see objects that are small. Every time a term that had a direct Latin or Greek derivative came up in the lesson, I would take the time to teach students how to break-down the word into its components, before explaining what it meant. All this was written into the notes so students would always have it as part of their notebook and could refer to it when studying. Students were also provided with a list of prefixes and suffixes that would be covered throughout the year.
The Results and Conclusion: This was a very successful way of teaching vocabulary in Biology. It was effective because students were able to remember the meanings of words months later. When asked for the meaning of the word homeostasis, many students would say, “same-state, keeping it the same” – which is exactly what I wanted them to know. Students were also able to transfer this knowledge to their other classes. After students learned the meaning of the prefixes mono and poly after studying about monomers (one subunit) and polymers (many subunits) in the biochemistry unit, they mentioned that they were able to figure out the meaning of the words monotheistic and polytheistic in World History class.

Teaching root words made the learning of vocabulary less frustrating for students. They were able to see the relationships between the parts of a word and this helped the words become more concrete to them. Being taught prefixes and suffixes was thought to be very helpful to 84% of students in studying vocabulary. They were able to explain the meaning and remember more difficult biological terminology than I had been able to get students to do in the past.

My students made the following comments on an anonymous survey regarding the lessons on root words:

- “It helped me not only for biology class but for the everyday English. It helped me in my English class too.”
- “Prefixes and suffixes helped us to know what the words were talking about.”
- “I had to go over, and over it again [for it] to stay in my head.”

V. Student-Created Study Guides

The Research: Graphic organizers help students link new information to their existing knowledge, which contributes to student learning. They aid in moving pertinent information into long-term memory (Dye, 2000). A graphic organizer is a visual representation of knowledge that the learner can benefit from. Teachers should always model creating such organizers before requiring students to do so (Egan, 1999). Graphic organizers are mostly used as a technique for facilitating comprehension of content area texts, and may be used as a teaching or learning strategy. It is critical that students receive training in the use, purpose, and construction of graphic organizers. Research has shown that secondary level students can improve scores on vocabulary and comprehension by using student-created graphic organizers. Students were also able to retrieve information quickly and accurately from memory (Dunston, 1992).

The Method: I noticed early on in the year that students did not know how to study for quizzes and tests. An informal survey suggested that most students just read over the notes and worksheets that the teacher provided, but did nothing to facilitate the transfer of content to memory. I decided to teach students to create study guides to help them study—a way to manipulate the
content they had to learn. To encourage participation in this process, I offered students extra credit points. I began by providing a study guide that I had created, but in a fill-in-the-blank format for students to complete while studying. I then transitioned to modeling graphic organizers as a review technique on an overhead transparency before scheduled quizzes. I tried using different techniques: outlines, webs, charts, lists, diagrams, etc. I got the content for the organizer by soliciting information from students until all the necessary knowledge was included. Next, students created their own study guides, and with permission from students, I shared some of their examples with the class. This allowed students to see the variety of study guides that could be created, and that there was no right or wrong way to do one.

The Results and Conclusion: Many students began using study guides as a study tool, and some students were able to raise their quiz scores because they had developed a deeper understanding of the content. Not all students used the method and those who did, did not use it all the time; but quite a few students began to see the benefits of studying this way. An added benefit was that students who would not usually study, started creating study guides only for the extra credit points; but since they were manipulating the content while creating the graphic organizer, they inadvertently were learning the information and began increasing their quiz scores as well!

VI. Test-Taking Skills

The Research: Data from a wide variety of sources support the idea that test preparation programs do indeed increase standardized test scores. Test-taking skills can include the following components: following directions; reading questions carefully; knowing when to guess; understanding the vocabulary of the test; using time effectively; taking practice tests; relaxation strategies; responding to various types of items; using separate answer sheets; and understanding the overall importance of the test (Brown, 1999). Using several techniques before and during a test can be used to make sure that test scores reflect what students really know (Boyd, 1988).

The Method: Most of my students were not familiar with test-taking strategies, making it very important for me to teach them specific skills and to give them an opportunity to practice these skills throughout the year before they took the SOL test. Modeling the proper strategies was the most effective way for me to do this.

At the beginning of the year, during a class discussion about the Biology SOL test, I realized that many of my students did not really understand why they had to take the test. They thought it was unfair that they not only had to earn a science credit by passing the class, but that they also had to pass the SOL test in order to graduate. They had been told that they had to take the SOL tests, but no one had told them why. I knew that if I expected my students to take the SOL
tests seriously, I had to let them know why they were being required to take them. I explained that the SOL tests are a statewide mandate and that every student enrolled in a Virginia public school Biology class would take the same test. Students accepted that tests were a way to evaluate schools and their performance in order to make sure that students were receiving a quality education. It was also a way to measure if students meet the academic competencies needed to graduate. I also let them know that many other states require students to take similar tests. This reduced the feeling of unfairness and anxiety among students, as they realized they were not the only students taking the test.

Throughout the year, I reminded students that the only way to prepare for the SOL exam was to learn the biology content and vocabulary as we went through the curriculum. Students were reassured that I would help them constantly review content so that they would be prepared at the end. They were further cautioned that leaving the studying for the end of the year and being able to pass the exam was unrealistic and probably not possible.

Since the Biology SOL test, and every quiz and test students had to take in my class was in a multiple-choice format, the directions were never complicated. Students knew to pick just one answer, but they didn’t all realize that there could be more than one correct answer and therefore they would have to pick the best one. We discussed the importance of answering every question, as there was no penalty for guessing. We also talked about physically eliminating some of the choices (by crossing them out) before making an educated guess. I modeled my thought processes out loud every time we went over a review worksheet, a quiz, or test so that students could internalize the process. I also used overhead transparencies of the questions to show students how to underline/highlight the important parts of the question while reading, so that the essential items would stand out.

While taking unit tests, students were required to mark the answers on a separate answer sheet in preparation for the SOL test. I knew that students would be able to write on the actual SOL test booklet, so I made each student a copy of every quiz or unit test so that they could write directly on it to practice underlining and eliminating answers. Students were never provided the answer sheet until they had attempted every item on the test itself. This was how I taught students to read through the entire test; circling answers they were sure of. Students put an identifying mark beside questions they couldn’t answer or were unsure of, skipped those, and then moved on with the rest of the items. Marking the questions they were having trouble with helped them find those items faster when they returned to them. The importance of rechecking answers was emphasized. Students could focus on answering all items before worrying about transferring their answers onto the answer sheet. Before accepting a completed quiz or test from a student, I would ask them if they had checked to make sure all questions had been answered, and bubbled-in correctly.

Time management was never really an issue because all of the assessments students took in class were untimed just like the SOL test. If class time was not enough, students were given the opportunity to complete the
assessment after school or at lunch. This encouraged students to take the necessary time to properly answer questions.

**The Results and Conclusion:** Data from the survey shows that 71% of students found going over the correct answers to review worksheets, quizzes and tests always helpful, while 24% thought it was almost always helpful in learning how to answer questions correctly. This is obviously seen as a good way to reinforce both content and skills for answering multiple choice questions. Most students (71%) used the technique of eliminating incorrect answer choices before choosing the best one, but only 46% underlined/highlighted important words or phrases while reading the questions. Students commented on an anonymous survey regarding the value of learning test-taking skills:

- “I think that the method of highlighting words on tests and quizzes helped me a lot to see the key words of what the questions were asking. It helped me a lot!”
- “I practice a lot and I learn and remember all the skills because in practice test these were some of mistake [I made and ]why I get some questions wrong.”
- “It help me a lot to get better score in my test or quiz.”
- “I did answer every single question very carefully.”

The most beneficial result of teaching students test-taking skills is that they became better test-takers, gained self-confidence in themselves as learners, and were better prepared to take tests.

**VII. Practice Tests and Multiple-Choice Test Questions**

**The Research:** Administering and scoring practice tests prior to taking a criterion-referenced standardized test can relieve a lot of test anxiety and better prepare students for the actual test. It familiarizes students with directions, completing answer sheets, and provides a “dry run” through the test. This is a good time to review and define basic concepts that will appear on the tests. It also provides a stress-free environment to practice test procedures and test-taking skills (Brown, 1999).

Good assessment also yields good information about the results of instruction. In fact it is a necessary component of good instruction (Brookhart, 1999). Multiple choice items can be used to measure both simple and complex objectives; can provide highly structured and clear tasks, and can measure a broad sample of achievement. But they also have some limitations. Good questions are difficult and time consuming to construct (Hansen and Dexter, 1997). Research indicates that science teachers with a higher degree of sophistication in measurement build higher quality classroom tests than those with less knowledge of measurement issues (Richichi, 1996).
**The Method:** Well-constructed, multiple-choice questions were also used on all in class assessments and practice tests. These questions were chosen mostly from the Wizard Test Maker software, but some were from the textbook test bank. Some questions had to be created by the teacher for certain topics that were not available in the software’s test bank.

In the five-week period prior to taking the Biology 2002 SOL exam, students were assigned one practice test per week. Students were to stay after school, on a day of their choosing, to complete the test. The five tests were equivalent in content and level of difficulty. They could work individually or in pairs to answer the questions. Their bilingual dictionaries were made available to define words unfamiliar to them. They were also allowed to ask the teacher for help in answering questions. These 5 tests were shorter in length (42 questions) compared to the actual SOL test (60 questions). The 5 practice tests contained approximately 50% content and 50% inference and skill (analyzing graphs, charts, diagrams, etc.) type questions. The completed answer sheets were scored on a weekly basis.

The Spring 2000 and 2001 released Biology SOL tests (50 questions each) were also completed in class and answer sheets were scored. Students worked on these tests individually, and received no help from the teacher or peers. Appropriate test accommodations were provided to keep testing procedures as close to the actual test situation. Scores from these tests were used to predict scores on the 2002 test.

**The Results and Conclusion:** For many of my LEP students, placement in my Biology class was one of their first experiences in a semi-mainstreamed core-subject class. They had never experienced multiple-choice questions that required a deep understanding of the English language. Students were in shock the first time they were presented with a quiz made up of test bank questions. They didn’t know how to handle the level of language difficulty, nor the higher order thinking skills required. I realized that they would require a lot of help throughout the year on assessments. Their 3rd/4th grade reading level was putting them at a serious disadvantage even if they knew the content.

I continued to keep the assessment standards high, but provided a lot of support. I began by underlining important terms in the questions to help students learn how to sort through the reading. I anticipated non-science vocabulary that might prove difficult and wrote the meaning above the words in the questions. I would write in hints next to diagrams to help them process the information. As students began to take ownership of these skills, I reduced the level of support. I always offered to read questions verbatim to students because they often misread words making it even more difficult to understand the question.

Scores from the five practice tests (Table 1) showed a gradual improvement in scores. This can be attributed to the students becoming more familiar with the nuances of answering questions they had never seen before.
Table 1: Average Scores Earned by Students on the Practice Tests

<table>
<thead>
<tr>
<th>Student Average</th>
<th>Practice Test #1</th>
<th>Practice Test #2</th>
<th>Practice Test #3</th>
<th>Practice Test #4</th>
<th>Practice Test #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Score out of 42 points</td>
<td>34.16</td>
<td>34.43</td>
<td>36.28</td>
<td>36.91</td>
<td>37.18</td>
</tr>
<tr>
<td>Score out of 100%</td>
<td>81.30</td>
<td>81.90</td>
<td>86.40</td>
<td>87.80</td>
<td>88.50</td>
</tr>
</tbody>
</table>

Students made the following comments on an anonymous survey regarding the practice tests they completed:

- “I think that the tests were good for us to see how the SOL could be and make us prepared.”
- “I think [to] have similar practice help to get self confidential [self-confidence] and don’t be scare to the SOL 2002 because we practice and got the best preparation we could.”
- “The SOL was much more easy than the practices SOL.”
- “The practice tests helped us a lot to eliminate answer and by our knowledge try to work the right answer.”
- “It helped me to recognize lots of words that I didn’t know before.”

VIII. Collaboration: Content And ESOL Teachers

**The Research:** Students who are classified as LEP need to be provided with ESOL support after they have been mainstreamed. They need help in reading to learn, by analyzing and synthesizing the reading from content areas texts. Collaboration between ESOL teachers and content area teachers is essential to overcoming potential problems these students may encounter. Collective responsibility is necessary for the development of LEP students’ language, reading, and learning skills. Collaboration may take the form of coordination of curriculum and instruction (each teacher builds upon, supports, and reinforces the efforts of the other), collaborative creation of resources (sharing time, expertise, and responsibility for creating resources) or even consultation and training (get advice on specific students, problems, materials, etc.). However, collaboration among professionals sometimes leads to feelings of resentment over what may be seen as an intrusion into their own professional worlds. Collaboration also requires more time and effort than some may have, or be willing to give (Kang, 1994).

Support for collaboration begins with the administration at district and local school levels. Resistance can be reduced through an atmosphere of mutual trust, acceptance, and confidence. Interpersonal contact and communication is indispensable. ESOL and content teachers should be considered equals within their areas of expertise. Students and teachers all benefit when teachers work
together to enrich the language experiences of ESOL students (van Loenen and Haley, 1994).

**The Method:** Due to the large number of LEP students enrolled at Stuart, there has been administrative support for collaboration between ESOL and content teachers at both the district and school level. ESOL students at the B1 level are (usually) enrolled in World History and Geography I and Biology; their first reading intensive core-content area classes. They are concurrently enrolled in two ESOL classes. One class focuses on literature and grammar, while the second on reading in the content areas. There are two ESOL teachers that supported my students' content reading needs, as well as helped them with reading comprehension strategies, content area writing, vocabulary reinforcement, and concept development. The ESOL teachers were kept abreast via e-mail, common planning periods, and after school meetings of what chapters, concepts, vocabulary, etc. were being covered in Biology in a given week so that they could provide support to the ESOL students.

The ESOL teachers were also provided a list of Latin and Greek root words to help with learning vocabulary. One teacher even had ESOL students create flash-cards to aid in Biology vocabulary study. Both ESOL teachers, while teaching students how to do a research project, were given a list of biologists (included in the SOL) to research.

**The Results and Conclusion:** Collaboration between the ESOL teachers and myself was of great benefit to our students. The ESOL teachers provided the necessary language support that was not possible for me to provide. They were also able to coach students in the skills of reading a content area textbook. Using Biology concepts as a subject to read, write and discuss in class, ESOL students were getting additional reinforcement for what they were learning in Biology, making them not only better Biology students, but more confident learners across the curriculum.

**Reflections**

Statewide data from the Virginia 2000 and 2001 spring Biology SOL tests (Table 2) show the LEP students pass rate of 46% and 57% respectively, compared to the non-LEP scores of 80% and 82% respectively. The large discrepancy between the scores of LEP students and non-LEP students could eventually affect the graduation rate of LEP students. In 2001, Fairfax County’s (Table 3) LEP students scored a pass rate of 64.2% compared to the non-LEP students pass rate of 89.7%, both of which were above the state average. Surprisingly, the LEP students at Stuart High School scored a pass rate that was 22% higher than the state average, and 14.8% higher than Fairfax County’s average.
Table 2: Comparison of 2000 and 2001 Statewide LEP and Non-LEP Pass Rates

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</thead>
<tbody>
<tr>
<td>Statewide Passing Rates</td>
<td>80%</td>
<td>46%</td>
<td>82%</td>
<td>57%</td>
</tr>
</tbody>
</table>

Table 3: Comparison of 2001 Scores across the State of Virginia, Fairfax County Public Schools, and J.E.B. Stuart High School

<table>
<thead>
<tr>
<th>Biology SOL Test 2001</th>
<th>Non-LEP Pass Rate 2001</th>
<th>LEP Pass Rate 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>State of Virginia</td>
<td>--</td>
<td>82%</td>
</tr>
<tr>
<td>Fairfax County Public Schools</td>
<td>--</td>
<td>89.7%</td>
</tr>
<tr>
<td>J.E.B. Stuart High School</td>
<td>--</td>
<td>86.3%</td>
</tr>
</tbody>
</table>

The strategies I used were sometimes very time-consuming for both my students and for me. I feel we all worked very hard throughout the year and that my students learned a lot of good Biology. Many of my students also gained insights into how they learn and how they can become better learners. However, the final success of the cumulative effect of this multi-strategy approach is evident in the 87.5% pass rate earned by my students on the Spring 2002 Virginia Biology End-of-Course SOL Assessment. I maintained (and even slightly improved) the pass rate of my students from the previous year. All the qualitative and quantitative data collected give me confidence that the time and effort invested in this approach to learning directly resulted in this outstanding performance by my LEP students on the 2002 Biology SOL test. I will continue to use this multi-strategy approach during the next school in preparation for the 2003 Biology SOL exam.
References


