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Methods of Science Vocabulary Instruction with a Focus on the Inclusive Classroom

Brian Gallagher
St. John Fisher College

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Thesis

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Dedication

To my family, for all of the support they have given me throughout my entire academic career. Thanks to Mr. Costello, my 7th grade social studies teacher, for putting the joy of learning into my life as well as inspiring me to pursue a teaching career. A special thanks to my wife Anne, as she has loved and supported me throughout this graduate work.
This research would not have been possible without the support of my research partner, colleague, and friend Tamara. Without her constant support and gentle reminders of deadlines, I may have never have finished this work. I would also like to thank Dr. Diane Barrett for her support and inspiration throughout this capstone experience.
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Methods of Science Vocabulary Instruction with a Focus on the Inclusive Classroom

English teaches us humanity, math teaches us logic, but science teaches us reason. It is the purview of science to make judgments and inferences of the universe, and everything contained therein, based on observations. When a completely new observation is made, or a new inference made on an old observation, a new word is usually created to describe that observation or judgment thereof. These new words and experiences build on each other to form a second language that must be learned in order to understand the concepts of science.

Science teachers have an enormous job of teaching the students of today how to reason, the language to describe that reasoning, and the language of the scientists that came before them. That job must be done today in every science classroom, including the classrooms that are general education and special education mixed. The language portion of this instruction contains numerous multisyllabic words for the students to learn.

This is a challenge in and of itself, but coupled with an inclusive classroom setting and the task can seem almost impossible. The students in these classrooms range from gifted to learning disabled. This environment poses some unique problems for the instructor as the information must be presented in such a manner that the learning disabled students can understand and internalize it, but it also must be engaging enough that the students that are gifted will not lose interest in it.
This study looked for those strategies that can work for both ends of the spectrum of student learning. Using the Japanese Lesson Study model, lessons were reviewed and modified so that the methods that received the best results were isolated. Those lessons were then used to study which of the methods worked the best to achieve a high level of student success learning new scientific vocabulary.

Success was measured by classroom assessments that occur in the course of teaching. The level of success was dependant on the level of usage of the new vocabulary with respect to Bloom's Taxonomy with simple identification being the lowest level of success and true evaluation with discrimination between ideas indicating the highest level of success.
Science Vocabulary

Literature Review

Carnine and Carnine (2004) wrote that “the vocabulary load in a week’s science lesson is greater than a unit in foreign language” (p. 210). Teaching the multisyllabic words that are many in the secondary science curriculum can be a daunting task, especially when most of the words are what Harmon and Hendrick (2005) call “low-frequency words;” (p. 263) meaning that they are not used very often or at all in common speech. Combine that task with the inclusive classroom that is the least restrictive environment as required by the No Child Left Behind legislation and you have a task that is more then daunting, it can seem impossible.

Most teacher support the inclusion model on principle, but feel that they simply do not have the time or resources to be successful in it (Kirch, Bargerhuff, Turner, & Wheatly, 2005). These learning disabled students are then placed, many times, in general education classrooms with teachers that are trained heavily to teach to the general education students and not to students that have a spectrum of special needs. Many of the learning disabled students have difficulty processing new words (Alexakos, 2001) as well as many other disabilities, more often then not, “the challenges of the students become the challenges of the teachers” (Carnine & Carnine, 2004, p. 216). It is that challenge that often has the teachers at a loss as they try to teach for understanding and not rote memorization. It is those demands that exceed those with either inquiry or direct instruction alone (Pasley, Weiss, Shimbek, & Smith, 2004).
There exists, however, more than a few strategies that can be used to help the students learn the language of science that is necessary and required in order to understand science concepts and successfully perform and communicate laboratory experiments. Even with the growing emphasis on hands-on/brains-on inquiry science teaching the textbook still stands at the center of science instruction. Munk, Bruckert, Call, Stoehrmann, and Radandt (1998) wrote that any strategy must include the textbook as it is a mainstay of both general and inclusive content education. Miller (1998) uses picture books in that “the artwork is integral to the experience of the book” (p. 376) to help the student with lower reading levels still grasp difficult concepts.

It was said that, “Literacy instruction is currently given preference over science and social studies learning, receiving the lion’s share of the instructional time in elementary schools” (Gregg & Sekeres, 2006, p. 56). This is true in secondary schools as well as there is often a Math and English Language Arts specialist, but the science or social studies specialist is conspicuously missing. Science instructors teaching vocabulary also feel that they see very little return on their investment (Harmon & Hendrick, 2005). This leaves many teachers with the feeling that task they have is theirs and theirs alone.

The research that exists currently was focused on general literacy and on making meaning as well as the state of textbooks in the secondary science curriculum. The strategies that are being used help the students construct the meaning for
themselves. This is a dangerous area for science content learning if we are allow students to make their own meaning without giving them the tools to describe the meaning, we are setting them up for failure. Young reminds us, “Without a clear understanding of the language of science content, students will certainly experience difficulty and a lack of interest with their science content area material” (p. 12). If we lose the students’ interest, then it does not matter what strategy we use, it will not work.

There is evidence to support that inquiry instruction aids in a student retaining the information. Schmidt, Gillen, Zollo, and Stone (2002) note that, “students often continue to talk about the experience days later” (p. 534). The area that these studies seem to lack is a concrete way to measure successful vocabulary understanding. Unfortunately, talking about the experience and evidence that they understood the science concepts and could use the correct vocabulary to describe the phenomena they witnessed are not the same things. It is this area that is of most interest to this study. The review will focus on and be organized by methodology, including population, process and data collection, as well as results and discussions.

The review of the methodology will allow for the analysis of the techniques used. By looking at the techniques of others the study can focus on the gaps that exist and not duplicate any work that has already been done. This also serves as a point or origin for the study in general.
Inclusion and Literacy

Student populations are as diverse as ever. “Today’s student population is diverse not only in terms of gender, race, and ethnicity but also in terms of academic ability, skill level, and general attitude toward school” (Wehmann & Hounshell, 1998, p. 29). Students are a product of globalization and they are exposed to more and more media every second. The segregation in American schools of the urban populations being all African Americans and the suburban populations being all European Americans is coming to an end. This diversity has not reached our teachers as most teachers are of European decent (Schmidt et al. 2002). So to coming to an end is an era where most students in school have a positive attitude toward learning. As a result most studies were of varying grades of diverse students.

Most of the studies focused on student with learning disabilities. Not surprising, the students with learning disabilities also had the lowest reading levels. Carnine & Carnine (2004) write, “In some schools, it is common to have significant numbers of classes in which 75-80% of the students cannot successfully read textbooks” (p. 204). 75-80% reading below a level that they can even comprehend the material seems to be impossible, but it is the reality that most of the teachers face everyday. Teachers find themselves often in a position in a general education classroom of having the majority of the students unable to read the textbook. The research suggests, and correctly so, that most students, learning disabled or not, are
reading below grade level and unable to process the material presented to them, let alone able to process new words as well.

A subset of the learning disabled population, those with Attention Deficit Hyperactivity Disorder or ADHD, has been the target of research in the area of literacy. Inattention, hyperactivity, and impulsivity make this group of student ill-equipped to learn in a traditional environment an environment where textbooks are the tools to learn concepts and vocabulary. "Data demonstrated that children with ADHD performed significantly below their nondisabled peers on letter formation, alignment, and neatness. Spelling is also a problem" (Reid & Lienemann, 2006, p. 54). These students have problems with the most basic level of written communication. Their literacy skills are lacking on almost all levels and they consistently score lower than their peers by as much as one-half standard deviation. (Reid & Lienemann, 2006) It is because of this that this portion of the learning disabled population has been given special attention.

If "fluent reading and reading comprehension of the materials needed for textbook comprehension" (Carnine & Carnine, 2004, p. 204) does not fully exist in general education populations, then what of the learning disabled population? Unfortunately, Williams and Hounshell (1998) tell us, "Activities that nondisabled students take for granted, like listening, note-taking, answering questions in call, reading aloud, and performing in front of a group, are ones that LD students labor over with expectations of failure" (p. 29). This is the population that is most focused
on in the literature and rightly so as they are not only as disadvantaged as their
general education cohorts, but also at a unique disadvantage for closing the learning
gap that exists.

That gap can become obvious in various assessment models as well. One
study by Reid and Lienemann (2006) used a Story Construction Test form the Test of
Written Language-3. A baseline score was taken for each participant and then those
baselines were compared to more data points taken later on in the study. In the end
this data collection method seems to have the most structure of any of the studies
reviewed. This is most likely because it was focused on a very narrow population and
had very clear outcomes that would determine success.

This may well have been why the majority of the research used data collected
in the normal course of classroom assessment and not formalized/standardized testing
techniques. Williams and Hounshell (1998) sum up their collection with this, "When
assessing LD students, teachers should make assignments clear and grade using a
qualitative scoring rubric" (p. 31). This is mostly consistent with the studies as most
do not discuss, in specific, data collection methods. The methods used in the vast
majority of studies were a classroom technique with built-in assessment. It was that
assessment that was used to collect data.

The participants in these studies are from all grade levels but special attention
seemed to have paid to early elementary and middle levels. Gregg and Sekeres
(2006) focused their study on a third grade, inner city classroom where the young
subjects learned "words that everyone typically knows" (p. 53). At first glance this 

does not seem to link to any content area, but the elementary grades is where the 

foundation of language and communication begins. Reid and Lienemann’s (2006) 

participants were in grades 2 through 5 and most had an IEP (individual education 

plan) which included some form or written language goal. Once again this study was 

focused on how to increase the general literacy skills of the students, which will 

translate to success later in their academic careers.

A final common thread for the studies is income level. Many of the 

participants were of low-income. Harmon and Hendrick (2005) describe their 

participants as, “low-income children in the intermediate grades” (p. 265). Schmidt et 

al. (2002) comments on the participants setting where 36% receive free lunch. These 

populations tend to have a higher percentage of students that do not read to grade 

level and are therefore an excellent place for not only pure research but for action 

research where the study can make an impact on student’s education now.

Constructivism/Summary Methods

For meaning to be constructed words and concepts must be hung onto 

preexisting thoughts and ideas. Harmon and Hendrick (2005) make this clear, 

“instruction must relate newly acquired words to other words and concepts” (p. 266). 

There is no independent knowledge or meaning not attributed to an experience 

(constructed) by the learner and this is at the heart of the constructivist educational
theory. Young (2005) tells us that the approach must include contextualized word meanings and establish connection with vocabulary words and words that the students already know. A strive has been made to connect meaning to students’ cultural heritage by exploring the origins of science, discussing solutions used in all parts of the world, highlighting the achievements of diverse scientists, and presenting diverse scientific applications; and in that way relating science to their lives (Salend 1998).

Honnert and Bozan (2005, p. 19) stated, “Summarizing is considered one of the most beneficial skills that students can develop to comprehend science material.” It is this skill that they highlighted in their study on summary frames. The students were presented the material, looked for pictures, read together, took notes on the material with attention to links to the student’s lives, and were finally given summary frames. This sounds very traditional and in fact it is, but Harmon and Hendrick (2000) pointed out that, “direct instruction servers and important role in school-age children’s vocabulary acquisition” (p. 254). This traditional style often has a place right next to a more constructivist approach as no single technique seemed to be the magic bullet to dramatically increase the literacy rates and vocabulary retention of the learning disabled population.

The results from the studies that used inquiry methods and a constructivist approach are largely the same. Schmidt et al. (2002) summarizes the results of their study in these words, “First, the children maintained a sustained focus or concentration during lessons. Second, interactions with their classmates became more
positive. Third, they demonstrated clear oral and written understanding of major concepts’’ (p. 540). This was true of most of the inquiry studies. Galles (2005) wrote, “Student retention of vocabulary increased dramatically” (p. 12). This vocabulary increase was a result of the students interacting with their environment and making their own meaning, so it is no doubt that these methods were successful.

**Preteaching**

Preteaching of vocabulary is a method that exposed the students to the words in a manor in which they will get some social interactions with the words thereby facilitating improved decoding and comprehension (Munk et al., 1998). Verbal construction was used as well, as passages were read aloud and the students used their experiences with some targeted vocabulary to construct meaning and are asked to identify the words they were learning (Gregg & Sekeres, 2006). In these cases the teacher had written the texts to ensure that the second reading was close enough to the previous experience that the students could make meaning out of the concepts. Williams and Hounshell (1998) would agree with the teaching and reteaching as they stated, “When introducing new vocabulary words, repetition is important. Teachers should think of science as a second language” (p. 31). The research suggests that it is the students with disabilities that benefit the most from this method of learning.

“...activities-oriented approach that reduces a reliance on textbooks, lectures ... seeks
to promote learning by providing students with experiences that allow them to discover and experiment with science” (Salend 1998, p. 68).

Games

Marturano’s study said, “Games are a great way to help students make meaningful connections between abstract science concepts and vocabulary” (2004, p. 38). Marturano is making my next point for me in that quotation, that learning for students in the modern classroom has to be an experience that is very different from the traditional classroom. The population that benefits the most from learning with games is those students with learning disabilities. In Marturano’s (2004) study 3 games were used to reinforce lessons in the classroom: secrets where the object is to connect words in a correct order to tell a secret; connections where the object is to make relationships between concepts; and pair of opposites where the object is to put opposite words together to enhance comprehension. (Marturano, 2004) The most notable aspects of all of these games is that they are all aiming for more then simple identification of the vocabulary and that they are non-adversarial. They allow for fun, deep learning, without the need for conflict.

There were some studies that used role-play as a method to teach concepts and thereby teach vocabulary. Although not strictly a game per say, but a play technique is involved is engaged the students in learning. Zigo (2001) wrote, “Another narrative strategy in which the students seemed fully “abled” was a collaborative
development and elaboration of stories through role-playing" (p. 66). Zigo's study focused on using narrative theory to help struggling readers. The study went on to explain that it was also an effective way to have students comprehend both the textual and curricular content. Role-playing in this way also helped the students gain perspective of culture and circumstance that otherwise may not have been gleamed from a purely textbook based lesson. Appelget et al. (2002) agreed with this historical role-playing as the study describes using a court room setting to recreate trials based on evolutionists verse creationists. When it was time to deliberation to occur the teacher wrote these on the board: evolution, natural selection, agents of natural selection, adaptation. The students had to include these words in their statements.

Harmon and Hendrick (2005) would seem to support this technique as they write, "Discussion and direct student involvement also appear to be important components in science vocabulary instruction" (p. 273). Role-playing activities satisfy both the need to be involved so that the learning experience is more easily remembered and the goal of having the students gain need perspective of science concepts.
Technology

Technology is changing rapidly and its educational uses are changing too.

Ten years ago Fitzgerald (1996) told us,

"Newer approaches of educational technology, however, use the computer as a tool to construct knowledge, for writing and multimedia construction, and to situate problem solving. Students are increasingly using videodiscs, CDs, telecommunications, and multimedia authoring programs as learning tools.

The challenge of technology integration faces all teachers regardless of setting or student ability level." (p. 123)

Ten years later and most of the technology she spoke of have become ubiquitous. Teachers and students alike own and use these technologies on a daily basis. Taking these everyday technologies into the classroom, however, takes time. The conservative institution of education with the historic funding problems and shear lack of any corporate competition makes the adoption rate of technology in schools always lag behind society at large and is further complicated by inadequate preservice and inservice training (Tinker, 2001).

This is not to say that existing classroom technology cannot be used effectively today. Williams and Hounshell (1998) confirm this as they state, "technology is advantageous, and it is a good idea to use computers as often as possible" (p. 30). This use of everyday technology, and computer technology in
specific, will help the students gain an understanding of the concepts we are trying to convey to them by using a medium that they are familiar with, enjoy, and are engaged by through the use of voice recognition, computer graphics and latent semantic analysis (Tinker 2001).

Computers are not the only form of technology used in these studies as Williams and Hounshell (1998) go on to write about the learning disabled students, "All students seem to be mesmerized by television, and LD students are particularly receptive to television and videos because they appeal to a number of senses" (p. 30). This use of technology can present vocabulary and concepts in a medium that students are more than casual users of and in a manner that is suited to their learning styles. Tinker (2001) stated, "I expect the greatest technology advances for special learners will come from applications that require little or no special adaptation" (p. 31). If the current studies are any indication, he is correct, most if not all, of the technologies used were existing technologies that required little or no modification to be productive. Gregg and Sekeres (2006) did just that with the use of video, DVD, and web field trips.

Technology as a data collection tool can be cleverly abstracted from the students. Tinker (2001) wrote about an educational toy that taught math facts, from simple addition and subtraction to fractions. This toy also had a port that you could connect to your computer to download progress. It would also make suggestions on the timing of purchasing other educational toys in the line to keep up with the
student’s progress. This method was simple, innocuous, and productive in collection and delivery of the required information. Moreover the collection in no way interfered with the student’s performance, an important consideration when dealing with learning disabled population.

In reviewing of the technology research, two major themes develop: learning disabled students benefited from the use of technology in all forms, from the television to the computer with internet access; learning disabled students could become quickly overwhelmed with the technology and not benefit at all from the technology if it was not gradually introduced to them. Williams and Hounshell (1998) stated, “A project that requires a student to search the internet for a topic, look up library sources on the computer, use a word processor to write a paper, and use visual aids to present the topic to the class would be overwhelming to an LD student” (p. 31). They suggest that the information of how to use the technology has to be just as scaffolded to the students as the content they are expected to learn, but when that scaffolding is in place the students understanding of the concepts improve.

Traditional

These technology strategies are often dovetailed to existing traditional literacy practices which make them a powerful tool for the learning disabled to understand content material. A simple assignment journal will help keep the learning disabled on task and can mark of accomplishments. (Williams & Hounshell, 1998) This is a
great way to get the students to use an old technique in a new way. More than one of the studies used mnemonics, a memory technique that uses key words, to help the students remember vocabulary lists. For learning disabled student, mnemonics offer a security that can minimize test anxiety (Williams & Hounshell). Munk et al. (1998) used a keyword based mnemonic that linked the memory keyword to a definition, in this way the student had more than a list of names to recall but meaning of those names as well.

Traditional interdisciplinary approaches also appear in the literature as many of the studies are focused not only on vocabulary but writing and general literacy. In Galles (2005) study students are working with both an English and science teacher that have joined forces to teach vocabulary and writing skill cross curriculum. Students hear the vocabulary and skills in both classes and in two different contexts. Allowing the students to see that skills are not isolated into 8 distinct boxes throughout the day brings their skills into sharper focus.

Graphics and Graphic Organizers

Visuals are becoming increasingly important especially in the inclusive classroom as learning disabled students benefit from them. Miller (1998) takes this a step further with the use of picture books and writes, “Generally, in a theme to genre unit the whole class reads a particular book to establish the common themes and issues for the unit” (p. 378). It is the selection of books that is unique as it is
vocabulary rich picture books that are used in this study to add to the student’s enjoyment of the words learned (Miller, 1998).

Schmidt et al. (2002) took a different approach by allowing the students to create the recording devices of the observations. They were given black pages, studied and drew their own representations of the observations, were encouraged to explore books and other materials to discover more information on the observations, choose their own topics of research, and generated their own questions. This inquiry based free form allowed the students to really reach out from the traditional rote classroom environment. The class then took their questions and did a classroom KWLQ; K for “What I Know,” W for “What I want to Know,” L for “What I learned,” and Q for “More Questions to be answered.” Schmidt et al. (2002) in this manner the students constructed their own learning from research that they wanted to do, engagement levels increased as a result.

Munk et al. (1998) stated, “Graphics are particularly useful when the student is required to learn the names of parts of a larger system, organ, process, or organism” (p. 75). Graphics and requirements can be customized to the student as well providing differentiation for an inclusive classroom. These graphics in this study were not unlike Carnine & Carnine’s (2004) use of notebooks. Their process used notebooks that were setup to include everything from notes to pictures and concept maps. They became living science journals helping the students organize and connect concepts together.
Summary

Students need a variety of experiences that provide meaningful practice of vocabulary to gain an understanding of science concepts (Harmon, Hedrick, & Fox, 2000). Harmon, Hedrick, and Fox (2000) stated, "Supporting content literacy in general and vocabulary development in particular is the responsibility of all teacher, and effective vocabulary practices are embedded in sound conceptual teaching (p. 270). The studies reviewed share this view in the broad sense. They all strived to find a way that literacy in general, and vocabulary in specific, was taught to the students in a manner in which they could truly understand it."
Methodology

Kenkyujugyo is the Japanese word for the study or research lessons. In our context, and language, we phrase it as lesson study. Anyway you phrase it; it is a group process of studying one's methods of teaching to maximize student performance. Though the use of lesson study the goal of the research was to improve student retention and raise their cognitive awareness of scientific vocabulary as well as to have a positive effect on the students' overall engagement in regard to science education.

Population

The research participants were high school, inner-city science students. The school is a bi-lingual school with the population 50% African American, 32% Hispanic, 15% European American and 3% Asian American. The students in the study were split almost 50/50 African American/Hispanic, with less then 5% European and Asian American. The majority of reading levels at this school and classroom was below grade level with only approximately 25% testing at grade level. Many of the students struggled with multi-syllabic and low frequency scientific vocabulary. These students had a difficult time doing simply more than identifying the word and reciting a memorized definition. This was evident when the students were asked for simple comparison while integrating their key scientific vocabulary.
Method/Process

According to Fernandez and Yoshida (2004) lesson study follows a set of steps:

1. Collaboratively planning the study lesson
2. Seeing the study lesson in action
3. Discussing the study lesson
4. Revising the lesson
5. Teaching the new version of the lesson
6. Sharing reflections about the new version of the lesson (p. 7)

For our lesson studies we followed Doug Llewellyn’s observation protocol as provided for us as St. John Fisher College. Assessments were inline with typical classroom activities; this afforded us the ease of implementation as well as getting realistic classroom data.

These lessons focused on vocabulary strategies concentrating on reading and writing strategies. We started by asking students to create vocabulary cards that include their key term, the definition of the term and a picture to represent the term and its definition. Based on their comprehension and retention of the vocabulary, we then modified the lessons to include teacher found or created images of vocabulary words, class discussions of vocabulary, paraphrasing definitions, graphic organizers, and comparison activities.
Success Measured

Assessments measured success at the conclusion of each lesson. Vocabulary usage was categorized according to Bloom's Taxonomy, with success increasing in respect to Bloom's competence levels. The level of success is dependant on the level of usage of the new vocabulary with simple identification being the lowest level of success and true evaluation with discrimination between ideas indicating the highest level of success. Improvement was noted when the students progressed from one competency level to another as well as increased test scores.
Results

The formative and summative assessments taken in the normal course of teaching showed an overall improvement in the student's grades. Weekly vocabulary instruction techniques increased the student's confidence as well as their own lexicon. This increased confidence and vocabulary knowledge translated to higher test scores and overall achievement. The lesson study method helped to focus in on the parts of the lessons that need improvement and thereby perfected the techniques that were needed by the students in this classroom setting.

Research Results

A simple Friar Model with the deletion of the not examples was used as a starting point for our lesson study. Students were asked to write their term and definition and draw a picture to illustrate the term/definition. The terms were always taken from the science unit that was currently being taught as well as some common testing words. The goals of this lesson were multifaceted.

The primary focus of the lesson at its inception was to get students into a routine for vocabulary instruction/development. The lesson's first priority was to have the students in the frame of mind for vocabulary instruction at the same time every week, and with the expectation of a grade at the end of the lesson.

The ancillary foci were to move students out of vocabulary identification and into comprehension as well as to give the students opportunity to experience vocabulary instruction independent from their science lessons.
The first iteration was a success. The students now know that Wednesday is *Word Wednesday* and they are ready for the list of words to begin the activity is to be associated to that list. The routine was such a success that the classroom practically ran itself on successive lessons. The students were aware of their expectations and completed the tasks weekly. Vocabulary recognition increased during this period and the students began to use the vocabulary in their classroom discussions as well.

The failing in the lesson at this point was determined to be the method of generation of the pictures in the student's work. In the previous lessons the students were asked to draw a picture that represented the definition, but they were simply reproducing images directly from the text and as such, no real processing was occurring. The modification in this lesson made in the lesson study process was the addition of a mini-lesson filled with images. This was added to stimulate discussion of the vocabulary words as well as to expose the students to more than one image. The additional images were shown to the students of select vocabulary words as their engagement to the routine vocabulary lesson.

The primary focus of this modification was to broaden visuals so students would stop replicating images from their textbooks. They were expected to start integrating these other images and creating original works from their imagination to truly show processing and internalizing of the vocabulary words and their meanings.

The ancillary foci of this lesson were to initiate class discussions about their vocabulary words and to increase engagement and motivation surrounding science vocabulary. The images were selected with the intent to inspire classroom discussion even if the selected topic was not of immediate interest to the students. This extension
challenged the students and was tailored to the development of genuine excitement for science and the building of intrinsic motivation.

This iteration was not as successful as the first. It resulted in several students producing original images, while most reverted to the more familiar form of the exercise and made direct reproduction of the images in the textbook. As for the discussion session, students asked some questions but true discussion was difficult. It was more of a forum for students to have their questions answered by the teacher then a continual movement of ideas and questions driven by the responses of the students. As a result, the students took this time to probe for information on the selected topic and not to generate new ideas on said topic.

The failing in this lesson was the fear of failure. The students did not want to risk being wrong during a classroom discussion and they felt that there was not enough time to complete all of the images and not copy them from the text. The modification was made to have the students work on only one vocabulary term in groups and created a poster. This would allow them focus on only one term thereby relieving the pressure on time constrains and to have their discussion in a smaller forum as to alleviate the risk of embarrassment since they were allowed to form their own groups.

The primary foci of this modification were to prevent tracing of images from the textbook and to increase visual and kinesthetic aspects of drawings. This was accomplished by increasing the size of the paper from standard to poster as well as allowing students to use markers to create colorful images. Students were required to fill their paper completely and were repeatedly encouraged to produce original images.
The ancillary foci of this lesson were for the students to build interpersonal skills, teambuilding and an all for one grading system. This was achieved by allowing the students to choose their own groups to work with. Students collaborated within their groups to complete this task and contributed portions based on their academic abilities. Assessment was given as a whole based on the completion of the assignment.

The third iteration was a success. Groups completed their assignments whereby they produced images that exceeded teacher expectation. The images produced were not only high quality but were also imaginative and demonstrated a clear understanding of the vocabulary term. The students worked well together and organized themselves into cooperative learning groups. They each used their individual strengths to have a high level of personal and group success. An additional benefit of these groupings was discussion that surrounding the vocabulary term and science in general. The next modification of the lesson was to push the students to take it to the next level.

The primary focus of this iteration was for students to make a greater connection with vocabulary terms. The posters were changed to use Young’s Definition Map. This map included three guiding questions: What it (the term) is, what it is like and an example. We also asked students to draw an illustration of their vocabulary. This extension included a comparison as well as the requirement to put the definition in their own words.

The fourth iteration was not as successful as the previous lessons. The work that the students produced was for the most part not at a higher level than previous work. They did not work as well in their groups as they did not feel as if they could meet the task easily and resisted the change that was presented to them. Some of the groups
reverted to their first assignment and did not complete the new activity. In short, they again feared being wrong. The student groups were unwilling to present a new idea to the class as a whole so the modification was made to remove the element of fear. Students created new posters and exchanged with other groups for presentation. The posters that were created had to be detailed enough so that the presenters could accurately explain the information on the poster after only five minutes of study.

The primary focus of this iteration was to remove the fear element in the classroom. The students felt as if they could not be wrong if they were presenting another group's information. Limited discussion time did not allow for students to feel the pressure of a long presentation or discussion of their work.

The ancillary foci were to make the students responsible for their own learning. Student groups had to study the posters before they presented and had to take direction from another group about the information on the poster. Additionally, the posters had to be detailed enough so that they could be understood and presented by a group other than the one creating it. The students were teaching each other the terms resulting in student centered learning.

The final iteration was a success. The work produced was the next level work we were looking for. The comparisons that were made were good and showed true understanding of the material. The presentations were basic, but did meet the requirements. They were in line with what would be expected of students in their first few times presenting.
Discussion and Conclusion

The literature stated students' achievements in subject areas would improve in regular and special education students when their exposure to vocabulary was expanded beyond normal lessons into a variety of activities for students to internalize their vocabulary (Appelget, Matthews, Hildreth & Daniels, 2002; Fang, 2006; Williams & Hounshell, 1998). Successive iterations of the lessons through the study moved farther away from a traditional model and gave the students unique activities in which to learn their vocabulary. As a direct result, students' scores increased and their mastery of the vocabulary was evident in their use of the terms in classroom discussions.

The first lesson's goal was mainly to establish routine and allow the students to be exposed to this method of vocabulary instruction. The literature had a focus on activating prior knowledge and through that allowing the students to experience and begin to enter the vocabulary into their lexicon before the subject matter was taught (Alexakos; Gregg & Skeres; Harmon, Hedrick, & Wood, 2005). The use of pictures was also supported along with the encouragement to use many different media forms.

The modification of this lesson wanted to have the students broaden visuals so students would stop copying pictures from their textbooks and start using other pictures and their imagination and initiate class discussions about and using their vocabulary words. This change was met with fear on the part of the students. The students were reluctant to speak as they were fearful of giving incorrect information. Some of the
students went back to copying images from the book as a safety measure to alleviate some of that fear.

A future modification for the definition portion of the lesson we would take away the textbooks and have students find definitions in their notes only or on the internet. The discussion/conclusion section of the lesson modification we discussed formalizing the discussion with small groups to take the large classroom environment out of the equation.

The addition of small group posters allowed for the development of interpersonal skills during the lesson. The group work really made the students think about the roles they each played as they were told they would be given a singular grade on the project. This worked out to be just as beneficial as Alexakos; Gregg & Skeres; Harmon, Hedrick, & Wood (2005) predicted it would be. Not only were the students incapable of simply copying the material, (and the images were amazing) but they organized themselves into roles in their groups as well as had meaningful discussions on the topics.

The modifications for the fourth iteration of this ongoing lesson study added a presentation to the posters along with writing the definitions in their own terms. This idea of Young’s (2005) definition map came from the literature where the students were given guiding questions and asked to answer them in their own terms as well as present on those ideas. The fear being wrong caused many of the students to revert back to copying from the book. These students are not used to being asked to take risks and many were defiant to the point of reverting to their old assignment and not completing their activity.
Once again we were tasked with the job of removing fear from an activity that seemed mostly harmless. The decision was made to make the students responsible for their own learning. They still had to create posters, and they still had to present them, only the posters that were created were for other groups to present. This seemed to remove the fear element in the room as work presented was not their own and they could therefore not be held responsible for it being incorrect. Williams & Hounshell (1998) agreed that a safe environment must be established in order for learning to occur. For these students, it became clear that a safe environment for these students included as low risk level as possible. This modification achieved that.

The definition of success was dependant on the level of usage of the new vocabulary with simple identification being the lowest level of success and true evaluation with discrimination between ideas indicating the highest level of success as well as the increase in test scores. The true results of this study were just that, the students’ scores have increased. The average gain was over 10% with some students gaining as much as 25%. The literature was an excellent starting point for strategies to allow the students in this study to truly learn their science vocabulary.

Science teaches us reason. These students had begun to form the tools to teach themselves the language of science as well as to make judgments and inferences of the universe, and everything contained therein, based on observations.
References


