Effectiveness of Direct Instruction of Science Vocabulary in the Science Classroom

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Effectiveness of Direct Instruction of Science Vocabulary

in the Science Classroom

Approved for the Faculty

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ABSTRACT

In order to determine if direct instruction was an effective method to increase student understanding of science terms, science vocabulary was taught and pre- and post-tests were administered. The study found that direct instruction of science vocabulary was effective.

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CHAPTER 1

Introduction

Background for the Project

No Child Left Behind was a law passed in 2002. No Child Left Behind strove to close the achievement gap between historically disadvantaged students and their higher achieving peers by using proven educational methods, and holding schools accountable for the results. States were allowed to develop individual accountability programs (United States Department of Education, 2009). As one part of the accountability program, Washington chose to administer a year-end exam, the Washington Assessment of Student Learning (WASL). The Washington Assessment of Student Learning measured student progress in reading, writing, mathematics, and later, science. Historically, students in Washington had not scored very well on the science portion of the WASL. Since the 2006 school year, the average scores for the fifth, eighth, and tenth grades had been well below the 60^{th} percentile, and in the tenth grade, the average score had not even reached the 50^{th} percentile. Students attending school in the author's school district had similar results (Office of the Superintendant of Public Instruction, 2009). Science students in Washington needed a better foundation in science skills and content if scores on the WASL were going to rise.

Science content had a large number of vocabulary words that were new to students. Science had been compared to world language classes with respect to the number of new words that were introduced to students each year. Vocabulary knowledge was extremely important to reading, according to the National Institute for Literacy (2007). The Institute identified characteristics of good readers that helped students succeed academically. Students with good reading skills had a wide range of oral and print vocabulary. The vocabulary range of good readers came from repeated exposure to words through both reading and speaking. By contrast, struggling readers had problems with word identification, lacking the skill to decode vocabulary, especially multisyllabic words. Allen (1999) maintained that exposure to content-area vocabulary seemed to be key to understanding the subject matter at hand. Without a firm understanding of the language of science, students had difficulty understanding the content. Baker, Simmons and Kameenui were quoted by Janet Allen (1999) that "vocabulary acquisition is crucial to academic development. Not only do students need a rich body of work knowledge to succeed in basic skill areas, they also need a specialized vocabulary to learn content-area material" (p. 11).

The National Institute for Literacy (2007) classified vocabulary into two categories, print and oral, indicating that print vocabulary was more difficult to obtain. Print vocabulary comprehension required students to quickly, accurately and automatically recognize the written word, and that the skill was further

complicated by the complex and obscure nature of print vocabulary, especially when compared to the conversational vocabulary with which students were more familiar. One debate regarding vocabulary instruction in the science classroom was if direct instruction or indirect instruction (understanding vocabulary through context) was more effective. Direct instruction of vocabulary was a tool used to ensure student understanding and promote greater student achievement in science.

Statement of the Problem

The issue to be studied was whether or not direct instruction of science vocabulary in the science classroom was more effective in promoting student understanding of science concepts than no direct instruction of science vocabulary.

Purpose of the Project

The purpose of this project was to analyze the effectiveness of direct instruction of science vocabulary in the science classroom. The project determined whether or not direct instruction of science vocabulary was valuable to Washington science students.

Delimitations

The study, direct instruction of science vocabulary in the science classroom, was conducted during the first and second semesters of the 2009-2010 school year in a large high school in a semi-urban area in Washington state. The high school was one of three in the district. As of October, 2008, 1,727 students were

enrolled in the high school. The ethnicity demographics were as follows: 0.5% American Indian/Alaskan Native, 2.6% Asian, 0.2% Pacific Islander, 2.8% Asian/Pacific Islander, 3.2% Black, 13.5% Hispanic, and 79.5% White. As of May 2009, 18.3% of students at the high school qualified for free and reduced lunch. Students qualifying for Special Education were 8.6% of the population. Transitional bilingual students made up 2.2% of the population, while students in the migrant program comprised 2.8% of the student population. The high school had 79 teachers. Of these teachers, 94.6% were teaching classes for which the teachers were highly qualified. Of the teachers at this high school, 59.5% had at least a master's degree, and had an average of 16.4 years of experience (OSPI, 2009).

The study of direct instruction in the science classroom was conducted in three Integrated Science 3 and 4 classes, consisting of a total of 71 students. The curriculum for the Integrated Science 3 and 4 classes included three quarters of Physics and one quarter of Earth Science. The students ranged in age from 15-18 years old. Of the students enrolled in the class, 70 students were taking the class for the first time, while 1 was repeating the class. The students self-reported the following ethnicities: 1.4% American Indian/Alaskan Native, 4.2% Asian, 0.0% Pacific Islander, 0.0% Asian/Pacific Islander, 4.2% Black, 23.9% Hispanic, 64.7% White. Languages spoken in the sample classes were English, Spanish, Russian, and Cambodian. The classes had the support of three paraeducators

whose role was to give additional support and management skills to the Special Education students enrolled in the class. Two of the paraeducators were one-on-one with students who qualified for additional special education services.

Assumptions

There were a large number of new vocabulary words introduced in the Integrated Science 3 and 4 class. Knowing the words made the content easier to understand, and students performed better on class work. Students who were taught the vocabulary words deliberately by the teacher had greater understanding of the material. The author assumed that paraeducators in the class were trained to effectively support and assist Special Education students and English Language Learners. The author assumed that each student was treated fairly and equally. Appropriate accommodations were made for Special Education students, as indicated by each student's Individualized Education Plan.

Research Question

Is direct instruction of science vocabulary an effective strategy to increase student understanding of science concepts?

Significance of the Project

The findings of this project had great impact on the author's classroom and school. Vocabulary instruction was important for students to understand science content. If findings for the project were positive, the author planned to increase the time spent on effective vocabulary instruction strategies in science classes.

The author also planned to advocate for direct instruction of vocabulary in all science classes in the high school.

Procedure

The author conducted research to determine a number of activities and strategies for teaching vocabulary in the science classroom. The research included a literature review and discussions with experts, including the literacy coach at the high school and the Mathematics and Science Curriculum Adviser. During each chapter, different vocabulary instruction was taught. At the end of the chapter, students were surveyed to determine if that strategy helped the students learn and understand the science material. At the end of the research, the author compiled results to determine whether direct instruction of vocabulary was effective in improving student learning of science concepts.

Definition of Terms

direct instruction. Direct instruction included explicitly teaching the meaning of the new term or phrase.

vocabulary. Vocabulary included key terms and phrases that pertained to science content.

Acronyms

OSPI. Office of Superintendent of Public Instruction.

WASL. Washington Assessment of Student Learning

CHAPTER 2

Review of Selected Literature

Introduction

The literature covered three distinct areas: identifying important vocabulary in the science classroom, promoting student understanding of science concepts through the use of direct instruction of vocabulary, and identifying the best practices for vocabulary instruction in the science classroom.

Identification of Vocabulary

Depth of understanding of a topic was encapsulated by the terms related to the topic students knew (Marzano & Pickering, 2005). Marzano and Pickering (2005) and Allen (1999) indicated that, when identifying vocabulary terms relevant to the concept, teachers must determine what words were at one of three level of importance: critical, useful but not critical, and interesting but not very useful. Vocabulary knowledge occurred on differing levels, and instruction depended on what degree students were able to access the given word.

Marzano, Pickering and Pollock (2001) outlined a strategy for choosing vocabulary terms. The researcher recommended choosing a small number, less than 10, of key terms and topics that related to the topic. The words or phrases did not have to be directly taken from the text, but could be words or phrases that helped students understand the concepts being discussed. Many of the words chosen fell into one of the categories of academic vocabulary as identified by the

National Instutute for Literacy. The first category was high-frequency words, such as bus and eraser, occurring throughout the school day and across disciplines. The second category was of non-specialized academic words occurring across content areas, such as focus and examine. The words in the second category were essential for student academic success, but may not appear on vocabulary lists identified by textbook publishers. The third category of academic vocabulary included specialized content area words unique to specific disciplines, such as ecosystem and foreshadow (National Institute for Literacy, 2007). Understanding of words in all three academic vocabulary categories was essential for student success, and teachers needed to be aware of words crucial to success that did not appear in the textbook.

Janet Allen (1999) suggested choosing terms that related to a study of the concept, rather than single, unrelated terms. Allen used a list of ten points to consider when identifying vocabulary terms. The points included identifying words important to understanding the text, identifying prior knowledge students had about the concept, determining if the word was encountered frequently or if the word had multiple meanings, deciding the significance of the concept and the degree of preteaching needed, determining words that could be identified through context, grouping related words, and choosing strategies to integrate the concepts into the multiple experiences of the students while making repeated exposure fun and enjoyable.

Importance of Direct Instruction

The National Institute for Literacy (2007) postulated the major goal of vocabulary instruction was to facilitate the ability of students to comprehend text. Marzano and Pickering (2005) agreed that vocabulary instruction dramatically increased student understanding of concepts. However, indirect instruction of vocabulary terms was an ineffective means to understanding. Allen cited Baumann and Kameenui that "parroting back definitions and synonyms does not improve student understanding of text that use the word" (1999, p.8). Allen (1999) expanded the idea that teaching vocabulary meaning from context clues was an ineffective means for inferring the meanings of specific words. Students were more likely to learn specific vocabulary when the definition was combined with context clues. Allen concluded that relying on contextual analysis as a means to transfer and generalize the meanings of words was limited at best.

Marzano et al. (2001) tied together the relationships between vocabulary and intelligence, ability to comprehend new information, and income level. Marzano et al. maintained that direct instruction of vocabulary was highly recommended. Marzano et al. cited Stahl and Fairbanks and the research suggested that direct instruction of general vocabulary increased student comprehension of new material by 12 percentile points, and that achievement increased by 33 percentile points if the new words being taught directly related to content being studied. The National Institute for Literacy (2007) suggested a

model of direct explicit and systematic instruction for teaching vocabulary. The model included steps to explain word meanings and model usage, guide students to practice, and provide time for students to practice independently.

Best Practices

Marzano et al. (2001) suggested a five-step approach to teaching vocabulary that introduced students to new words and phrases multiple times. The first step presented students with a short explanation or description of the new word or phrase. Next, the teacher presented students with a nonlinguistic representation of the new term or phrase. The third step was that students produced their own explanation or description of the new word or phrase. The fourth step was that students created a new nonlinguistic representation of the new word or phrase. The final step was ongoing, and required the teacher to periodically ask students to review the accuracy of the students' own explanations and representations. While learning vocabulary words, students had to have encounterd each word in context more than once, and that direct instruction, using the new words, enhanced the learning of the new words (Marzano et al., 2001). Marzano et al. (2001) also suggested that associating images with new words produced higher achievement gains than nonimagery-based instructional methods.

Another strategy that represented vocabulary words in a nonlinguistic manner was called Draw Me (Marzano & Pickering, 2005). Students were assigned to a team, and each team chose an artist. The artist selected a card with

the vocabulary word, and then proceeded to represent the vocabulary word with a drawing. The other students in the group identified the vocabulary word. The first student to identify the vocabulary word correctly became the new artist.

Another strategy to use nonimagery-based methods was called Vocabulary Charades (Marzano & Pickering, 2005). The teacher took a few minutes periodically throughout the day to review one vocabulary word at a time. Students were given time to think, and then stood and devised a way to represent the vocabulary word with bodies. The teacher would repeat the activity several times throughout each day, with different words or practicing the same words again, if students seemed to have trouble with the representation. When students seemed to be comfortable with this part of the activity, the teacher divided the students into groups. One student from each group was chosen to stand in front of the group and the student selected a card with one of the vocabulary words. The student used the body to show a representation of the word to the other students. The students tried to identify the vocabulary word based on the charade. The first student to correctly identify the word became the next student to stand in front of the group. While verbal and visual experiences were all positive strategies for student retention, visual was the most effective.

Allen (1999) recommended repetition of the words in a meaningful context. Wordstorming was an activity that used repetition and couched the words within the experiences of the students. Students were asked to write down

all the words related to the given concept or theme that the students could think of. When the students could think of no more, the teacher prompted more ideas with specific directions and questions, including listing more words with the same root as the target word. Students were then instructed to group the words on the list and devise a label for each group. At this point, the teacher listed more words and asked students to put the new words into the groups.

A similar strategy from Allen (1999) was called List-Group-Label. Students worked alone to list as many words as possible related to the major concept of the text. Students then worked in teams to group the listed words based on a common attribute or characteristic. Once the words were grouped, students work in the teams to decide on a label for each group of words.

Another strategy cited by Allen (1999) from Blachowicz presented students with a list of words that would appear in the material. The teacher talked briefly about the concept, then the teacher divided students into groups. The groups selected words from the list students expected to find in reading selections about the concept.

Research suggested that students able to connect the vocabulary word to prior experiences showed better retention. Allen (1999) proposed three strategies that would focus student learning on connecting the words to their experiences. The ABCx2 strategy gave students a template with the concept at the top, connected to three columns. In column A, students analyzed the concepts, and

then applied the concept to previous knowledge or experiences. In the B column, students brainstormed other words or concepts that may be connected to the given concept, then used those brainstormed words to bridge to the other concepts in student experience. The C column asked students to compare the given concept to other experiences or concepts, and then students contrasted the given concept to other experience or concepts.

The Analysis Map began with the teacher giving the students the concept or word to be studied. Students defined or renamed the concept, using their prior experiences. Students contrasted the concept with prior experiences, and then compared the concept to prior experiences. Finally, students gave examples to support the comparisons.

The Context-Content-Experience strategy began with the context of the word. The sentence or paragraph that included the word was listed at the top of the paper. Below the context, students wrote the target vocabulary word. The students then identified the actual definition and a possible definition derived from the context. Comparing the two definitions, students arrived at a common definition. Students gave specialized examples of the word, and finally recorded a personal experience illustrating the word or concept.

Repetition was key to retention of vocabulary and success with academic content. Marzano and Pickering (2005) suggested several vocabulary games to make repetition fun and enjoyable. The Free Association game was a quick and

unstructured review of the vocabulary words. The teacher said a vocabulary word, and students called out words associated with the target word. After a short amount of time, the teacher told students to stop, and the last student to call out a word had to explain the association of that word to the target word.

Solving Analogy Problems set up a series of comparisons for students. The analogies followed an A is to B as C is to D formula. Teachers set up most of an analogy for students, leaving item D blank. Students competed to complete the analogy. To increase understanding even more, teachers left both items C and D blank, forcing students to first identify the connection between A and B, and then identify two relationships among the vocabulary words that exemplified the given connection.

Another team game was called What is the Question? Teachers created a game board matrix, with point values down one side and subjects or concepts across the top. Within the matrix, the teacher listed words or pictures related to the subjects and covered the words or pictures. Students, working in teams, selected a subject and a point value. The teacher uncovered the word or pictures, and students created a question that showed understanding of the target concept. The teacher decided if the question accurately showed understanding of the concept and awarded the team points.

To play the Talk A Mile A Minute game, students were divided into groups, and each group was given a stack of cards. On each card was listed the

target vocabulary word and a short list of related words. One student was chosen from each group, and that student selected a card from the stack. The student described the target vocabulary word to other students in the group without using the target word or any of the words on the list. Other students in the group tried to identify the target vocabulary word based on what the selected student was saying.

Summary

Identifying target vocabulary words was the most important role in vocabulary instruction. The teacher needed to be aware of important words that may not be identified by the textbook as well as content-specific words. Direct instruction with effective repetition was the most effective manner of teaching vocabulary. Researchers have identified many effective ways to teach and review vocabulary to be fun and effective for student success.

CHAPTER 3

Methodology and Treatment of Data

Introduction

The author administered pre-test and post-tests of identified vocabulary terms during each chapter to students enrolled in the Integrated Science class taught by the author. The author compared pre-test and post-test scores to determine if direct instruction of vocabulary improved post-test scores.

Methodology

The study of direct instruction of science vocabulary was structured as a qualitative study, as identified by Gays, Mills, and Airasian (2006). The author collected data on pre- and post-tests and compared the scores to determine if direct instruction of vocabulary, using research-based strategies, increased student understanding of science concepts. The pre- and post-tests were created by the author and were relevant to the content taught in the author's classroom. The research was "conducted in a real-world setting in order to have relevance to real-world settings" (p. 400). The findings positively answered a research question posed by the author.

Participants

The study, direct instruction of science vocabulary in the science classroom, was conducted during the first and second semesters of the 2009-2010 school year

in a large high school in a semi-urban area in Washington state. The high school was one of three in the district. As of October, 2008, 1,727 students were enrolled in the high school. The ethnicity demographics were as follows: 0.5% American Indian/Alaskan Native, 2.6% Asian, 0.2% Pacific Islander, 2.8% Asian/Pacific Islander, 3.2% Black, 13.5% Hispanic, and 79.5% White. As of May 2009, 18.3% of students at the high school qualified for free and reduced lunch. Students qualifying for Special Education were 8.6% of the population. Transitional bilingual students made up 2.2% of the population, while students in the migrant program comprised 2.8% of the student population. The high school had 79 teachers. Of these teachers, 94.6% were teaching classes for which the teachers were highly qualified. Of the teachers at this high school, 59.5% had at least a master's degree, and had an average of 16.4 years of experience (OSPI, 2009).

The study of direct instruction in the science classroom was conducted in three Integrated Science 3 and 4 classes, consisting of a total of 71 students. The curriculum for the Integrated Science 3 and 4 classes included three quarters of Physics and one quarter of Earth Science. The students ranged in age from 15-18 years old. Of the students enrolled in the class, 70 students were taking the class for the first time, while 1 was repeating the class. The students self-reported the following ethnicities: 1.4% American Indian/Alaskan Native, 4.2% Asian, 0.0%

Pacific Islander, 0.0% Asian/Pacific Islander, 4.2% Black, 23.9% Hispanic, 64.7% White. Languages spoken in the sample classes were English, Spanish, Russian, and Cambodian. The classes had the support of three paraeducators whose role was to give additional support and management skills to the Special Education students enrolled in the class. Two of the paraeducators were one-on-one with students who qualified for additional special education services.

Instruments

Before the beginning of each chapter, the author administered a brief matching quiz identifying target vocabulary words. The author chose a short list, from four to twelve words, for each chapter. The words chosen were taken from the key terms list at the end of each chapter. The author determined the words from the list that aligned with the state Grade Level Expectations. The same matching quiz was administered again in conjunction with the chapter test to compare scores. The author chose several of the activities outlined in Chapter 2 to review the direct instruction of the identified vocabulary terms of each chapter. During the teaching of the chapter material, students participated in at least one of the selected activities.

Design

The author used a qualitative design for the study. The author administered pre-tests and scored the test. The scores were averaged into an average

percentage for that chapter, combining all students from all classes. The author then gave direct instruction on vocabulary concepts, followed by a post-test identical to the pre-test. The post-tests were also scored and averaged into an average percentage for that chapter, combining all students from all classes. The percentages for the pre-tests and post-tests were compared.

Procedure

The author began by identifying the chapters to be studied during the Integrated Science course, using the textbook for the class, *Conceptual Physics*, by Paul Hewitt. In each chapter, the author identified vocabulary words critical to understanding of the science concept. The number of vocabulary words chosen to study ranged from four words to twelve words. Prior to instruction of each chapter, a short pre-test was administered, requiring students to match the concept or word with a definition or explanation. During instruction of each chapter, the author explicitly taught the meanings of the words, and selected up to two vocabulary review strategies to use to review the vocabulary words and concepts. At the end of the instruction, a post-test was administered. The post-test was identical to the pre-test. The author calculated the average score for the classes by calculating percentages, and compared the scores on the pre-test to the scores on the post-test. The first two chapters did not receive the direct instruction of science vocabulary. For the first two chapters, the author administered the pre-

test and post-tests, but did not use any of the direct instruction of vocabulary strategies. The data from the first two chapters were compared to data from chapters including direct vocabulary instruction to further illustrate effectiveness of direct instruction of science vocabulary.

Treatment of the Data

The scores from pre-tests and post-tests from each chapter were calculated as percentages, and the percentages for all students in all classes were combined into a pre-test average and a post-test average. The pre-test and post-test percentages were compared to determine if direct instruction of science vocabulary was effective at increasing the post-test scores.

Summary

The qualitative research looked at the results of direct instruction of science vocabulary in an Integrated Science class on a post-test, and compared those results to the pre-test. Two chapters with no direct instruction provided further comparison that the direct instruction of science vocabulary was a key factor in improving student scores.

CHAPTER 4

Analysis of the Data

Introduction

The issue studied was whether or not direct instruction of science vocabulary in the science classroom was more effective in promoting student understanding of science concepts than no direct instruction of science vocabulary.

Description of the Environment

The study took place over first and second semesters in three Integrated Science classes at a large high school. The classes were taught physics and Earth science by the author. The classes totaled 71 students, and were primarily White, with 13% of the population Hispanic. Three paraeducators provided support for Special Education students enrolled in the classes.

Research Question

Is direct instruction of science vocabulary an effective strategy to increase student understanding of science concepts?

Results of the Study

After comparing the pre-test and post-test scores, direct instruction of science vocabulary was effective at increasing student understanding of science concepts. After direct instruction of vocabulary, student scores increased an average of 34.2%. After no direct instruction of vocabulary, student scores increased only 20.4%. The difference between direct instruction of vocabulary and no direct instruction of vocabulary was 13.8%. The research question was answered positively. Direct instruction of science vocabulary increased student understanding of science concepts.

Table 1: Chapters with no direct instruction of science vocabulary

	Pre-test score	Post-test score
Chapter 1	59.0%	73.4%
Chapter 2	29.6%	55.9%

Table 2: Chapters with direct instruction of science vocabulary

	Pre-test score	Post-test score
Chapter 3	28.5%	62.5%
Chapter 4	26.7%	66.2%
Chapter 5	65.7%	86.7%
Chapter 6	58.9%	84.2%
Chapter 8	30.4%	79.9%
Chapter 12	35.2%	60.1%
Chapter 25	26.2%	71.6%

Findings

Direct instruction of vocabulary in the science classroom increased student learning of science concepts. Simple vocabulary instruction activities increased student learning of science concepts. The research question was answered positively. Direct instruction of science vocabulary increased student understanding of science concepts.

Discussion

The study of direct instruction of science vocabulary compared favorably with expectations. Marzano showed that the depth of student understanding was encapsulated by terms related to the concept students knew (2005). Students with

a greater understanding of science vocabulary had a better understanding of the concepts related to the vocabulary. The National Institute for Literacy agreed that a major goal of vocabulary instruction was to facilitate the ability of students to comprehend texts (2007). Direct instruction of vocabulary, using strategies based in research, improved student understanding of science concepts.

Summary

The issue studied was whether direct instruction of science vocabulary was more effective than no direct instruction at increasing student understanding of science concepts. The study was conducted in three Integrated Science classes taught by the author. Data showed that direct instruction of science vocabulary did increase student understanding of science concepts. The research question was answered.

CHAPTER 5

Summary, Conclusions and Recommendations

Introduction

The purpose of the study was to identify if direct instruction of science vocabulary was more effective than no direct instruction at increasing student learning of science concepts.

Summary

Research showed that vocabulary instruction was important for student understanding of concepts. The author conducted a qualitative study using pre-tests and post-tests to measure if research-based vocabulary instruction strategies were effective in increasing student learning of science concepts. The author found that direct instruction of science vocabulary was effective in increasing student learning of science concepts.

Conclusions

Research suggested that learning vocabulary was essential for student learning of content area concepts. Understanding the concepts depended on understanding the terms used to talk about the concepts. Using research-based vocabulary instruction strategies identified for use in the content areas, the author found that direct instruction of vocabulary increased student understanding of science concepts by an average of 13.8%, according to pre- and post-test data.

Recommendations

The author recommends that science teachers use research-based vocabulary instruction strategies in science classrooms. The author plans to continue using the vocabulary strategies in future Integrated Science classes. The literacy coach was helpful in identifying many research-based vocabulary strategies, and the author would recommend that every school continue to fund a literacy coach position, and to use that literacy coach to instruct science teachers in vocabulary instruction strategies. The author also recommends further research into the type of vocabulary strategy that would be most effective in the science classroom.

REFERENCES

Allen, J. (1999). *Words, words, words: Teaching vocabulary in grades 4-12.* York, ME: Stenhouse.

Gay, L. R., Mills, G. E., & Airasian, P. (2006). *Educational research: Competencies for analysis and applications* (8th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.

Hewitt, P. G. (1997). *Conceptual physics* (3rd ed.). Menlo Park, CA: Addison-Wesley.

Marzano, R. J., & Pickering, D. J. (2005). *Building academic vocabulary: Teacher's manual.* Alexandria, VA: Association for Supervision and Curriculum Development.

Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001). *Classroom instruction that works: Research-based strategies for increasing student achievement.* Alexandria, VA: Association for Supervision and Curriculum Development.

National Institute for Literacy. (2007). *What content-area teachers should know about adolescent literacy.* Jessup, MD: United States Department of Education.

Office of Superintendent of Public Instruction. (2009). *School report card.* Retrieved from http://reportcard.ospi.k12.wa.us/summary.aspx?year=2008-09

United States Department of Education. (2009). *No child left behind.* Retrieved from http://www2.ed.gov/nclb/overview/intro/edpicks.jhtml?src=ln