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# Too Many Words, Too Little Support:
## Vocabulary Instruction in Online Earth Science Courses

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### ABSTRACT

As online coursework become more popular, students with disabilities that need vocabulary support for reading comprehension will be among the increase in cyber school students. Researchers have some evidence that certain types of vocabulary support strategies are more efficacious for students with disabilities. The purpose of this article is determining if what was known about strategies for supporting vocabulary was being applied to online learning coursework. A content analysis of types of vocabulary and types of support strategies was performed on science courses from three online course vendors. The results of this study indicate a need for online course vendors to pay more explicit attention to the types of words supported and the strategies they use to do so and for those who support online learners (teachers, parents) to be more proactive about vocabulary support deficiencies that are likely to be present in the courses.

### KEYWORDS

Analysis of Online Course Content, Online Learning, Reading Difficulties, Students with Disabilities, Tiered Vocabulary, Vocabulary

### EXPLORING THE NATURE OF VOCABULARY SUPPORT IN ONLINE EARTH SCIENCE COURSES FOR SECONDARY STUDENTS WITH READING DISABILITIES

Vocabulary knowledge is vital for school success generally and reading comprehension particularly (Jitendra, Edwards, Sacks, Jacobson, 2011). Students with disabilities that directly or indirectly effect their success in reading skill development need vocabulary support both to learn content (Harmon, Hedrick, & Wood, 2005) and develop disciplinary literacy skills (Pullen, Tuckwiller, Konold, Maynard, & Coyne, 2010). In traditional classroom environments, there is evidence that vocabulary support is not taking place for all students (Greenwood, 2002, 2009, 2010), especially in subjects with highly technical vocabularies like science (Kossack, 2007). In fact 40 percent of students (regardless of disability status) cannot comprehend science text at grade level, which makes vocabulary support in this subject for students who struggle academically vital (Hock & Deshler, 2003). In order for vocabulary support to be helpful, however, decisions must be made by curriculum designers and/or teachers to determine which words should receive special attention.

As online coursework becomes an increasingly attractive learning mode in secondary contexts, it begs the question of whether online course content identifies vocabulary and then provides proper support. This process of selecting and then supporting is especially important for populations of

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students who struggle in school, particularly in secondary school since subject matter expertise becomes more prominent in both teaching and learning (Cess-Newsome, 2002). Traditionally, online courses were considered more appropriate for students who are independent as learners (Barbour & Reeves, 2009). Increasingly, those who are not considered to be independent learners, such as students with disabilities are starting to choose to engage in online coursework. This coursework is often considered regular coursework as well as credit recovery (Mackey, 2008).

This study had two purposes. The first was to determine what type of vocabulary were identified by curriculum developers of secondary earth science online courses as needing support. The second purpose was to classify that support against what is known about vocabulary support for students with disabilities. In order to attend to these purposes, a directed content analysis of supported words from earth science courses in three different online learning environments was performed.

## FRAMING VOCABULARY SUPPORT FOR SCIENCE CONTENT

Corson (1984) proposed the concept of a lexical bar. This bar is essentially a threshold between common words in English that are usually learned through oral communication during childhood and the academic written language in English learning educational settings. This bar, Corson observed, is easily crossed by some students, but for others, it is a daunting task. For almost all students, crossing the lexical bar requires instruction that explores the lexical nature of academic written language, which includes vocabulary instruction. The purpose of this section is to describe what it takes to cross the lexical bar in terms of science vocabulary, explore the ways in which words that help students reach the lexical bar are identified for instruction, and summarize research on vocabulary support strategies for students with disabilities—a group that has particular trouble crossing the lexical bar.

### The Nature of Science Vocabulary

Fang (2005) summarized key linguistic features of academic text. Those features are abstraction, information density (Eggins, 1994), nominalization (Christie, 2001), authoritativeness (Schleppegrell, 2001), and technical terms. The first three features have vocabulary components, but these are also bound up in syntactic structures. Technical terms are easier to isolate from their surrounding grammatical context, although they are still tied to the pragmatic context. A technical term is any word that has a discipline-specific meaning (Wignell, Martin, & Eggins, 1993). In addition, technical terms usually have meanings derived from Greek and Latin roots (microorganism, phenotype), but there are also words with non-vernacular uses. These words not only have meaning in science, but they also have meanings outside of science text (Fang, 2006). Table 1 provides some examples of words with both common and esoteric science meanings. Fang argued that higher numbers of technical or non-vernacular words or phrases in text makes the text more difficult to understand.

The words in Table 1 make visible some of the issues with technical terms in science. First of all, the distance between the common term and the technical one is often great. In the example of cleavage the general meaning is to cut or separate, but the common meaning is a particularly distracting one for adolescents trying to learn science. The common meanings of the word mass ("taking communication during mass" or "buried in a mass grave") are also esoteric and in some circumstances, students might not know that term and so the word mass might be less familiar to some students than others.

Technical terms are also difficult because they often rely on each other for comprehension. In the example above, the word matter is used to help define mass. These words have shared features or conceptualizations, but are not synonyms. Matter is the "stuff"; mass is the quantity of the stuff. The distinction is important for science, but difficult to perceive without substantial exposures to the two terms.

Finally, technical terms are also problematic because of their esoteric nature, but also because many of them are polysemous (i.e., they have multiple meanings). In the case of the word *sheet*, there are many common meanings of the word that are concrete. In science, the word *sheet* is often based

**Table 1. Non-vernacular terms in science and their common meanings**

| Sample Word | Common Meaning of the Term | Technical Meaning of the Term in Science | Sample Scientific Sentence |
|---|---|---|---|
| Cleavage | The space between a woman's breasts | A division of cells or molecules; it also refers the way in which minerals break apart along a plane of weakness | The *cleavage* furrow contains actin, which causes cells to finish dividing. |
| Mass | A religious service in the Catholic church; a large amount | The amount of matter a body contains; it can also form compound words like *mass wasting*, which describes earth material being transported down slope | The *mass* of an object is related to the force required to accelerate it. |
| Matter | To care or to find important | Any substance that occupies space | *Matter* cannot neither be destroyed nor created. |
| Sheet | A broad, thin, rectangular mass of material; a large piece of cloth or bedding; urban slang for "shit" | A movable plane where a physical, biological, or chemical processes occur | In beta *sheets* amino acids are arranged in a zigzag pattern. |
| Solution | The answer to a problem | The answer to a problem, but more commonly: a homogeneous mixture of two or more substances in any state (solid, liquid, gas, plasma) | A saline *solution* is made up of salt and water. |

on the same general concept (a movable plane where physical, biological, or chemical processes occur), but the concept is a highly abstract one. The word *solution* by contrast, has one basic common meaning, and that meaning might be the intended one in a science text. It also might appear in a mathematics class as the answer to a mathematical problem. However, the esoteric meaning of solution in a chemistry class is actually more concrete than the common one.

In summary, there is a number of issues students face when trying to comprehend academic texts. The first is the distance in the definitions that can exist between common and technical terms. The second is the interdependence of the words on each other. The third is the polysemantic features of some words that make precise understandings difficult. For students with disabilities, it is no wonder that learning technical terms can be an aggravating and frustrating process. Their already weak vocabularies and processing difficulties are exacerbated by the definitional distance and the interdependence and if they have inefficient memories (which many students with disabilities do) learning all the different definitions and deciding when to apply which definition could be a harrowing task (Jitendra, Edwards, Sacks, & Jacobson, 2004). These realities underscore the need for vocabulary support in online learning environments, a learning context that is already demanding in terms of its reliance on independence (Barbour & Reeves, 2009).

## Choosing Vocabulary to Teach

While researchers have realized that students with disabilities need support for learning words, only recently has there been an interest in the specific words that students need to learn that will be the most helpful to students, including those with disabilities as they work to comprehend text. Scholars such as Beck, McKeown, & Kucan (2013) and Zwiers (2008) have advocated that teachers engage in word strategic sorting processes to determine which words to teach as part of their curriculum.

Beck, McKeown, and Kucan (2013) advocate for a three-tiered approach where Tier 1 words are regarded as common words that can be learned with little or no instruction and Tier 3 words are terms reserved to specific content areas. Tier 2 words are where most instruction ought to be directed in this model. These words have value in their importance in multiple subjects in multiple years of schooling. They are also words that students are less likely to know without instruction, although a word can be a

Tier 2 word even if the students know it. Since these words have both interdisciplinary and enduring value over time, they need to be taught using effective methods and taught by multiple teachers in multiple subject areas at multiple grade levels. The notion of word tiers does not mandate to teachers which words should be taught; judgment about whether a given Tier 2 word is important to a text at hand and whether the students already know the word should also be considered by the teachers.

Similar to Beck, McKeown, and Kucan's (2013) conception of vocabulary tiers, the Zwiers (2008) model focuses on content words that are critical for disciplinary texts and the connecting and academic high frequency words that give the content words their contextualized meaning. These two types of words are brought together in the metaphor of a wall (Dutro & Moran, 2003). The domain specific words are referred to as bricks. These correspond roughly to Beck, McKeown, and Kucan's (2013) tier 3 words. The connecting words are referred to as *mortar*, which correspond roughly with tier 2 words. Zwiers does not address tier 1 words in his model, presumably because he does not want teachers to focus on those when planning vocabulary instruction. When students understand both the "bricks" (domain specific words) and the "mortar" (general academic words) they can comprehend the wall of text that might initially seem impenetrable and daunting. By advocating for the teaching of both types of words, Zwiers makes visible the entanglement between types of words as meaning is conveyed in text.

## Vocabulary Instructional Support for Students With Disabilities

Vocabulary is important to school success, especially when school success is linked to success with reading comprehension (e.g., Anderson & Nagy, 1991; Cunningham & Stanovich, 1986). According to Jitendra, et. al (2004), students with disabilities are known to have significant problems with vocabulary learning for three reasons. The first reason is that students with disabilities do not engage in independent reading at the same level that students without disabilities do and so their vocabularies are generally weaker (Adams, 1990, Anderson & Nagy, 1991; Baker, Simmons & Kame'enui, 1998; Cunningham & Stanovich, 1986). The second reason is that students with disabilities lack strategies for determining meanings of words from contexts, which means that it is less likely that they would learn new words simply from reading (Pany, Jenkins, & Schreck, 1982). The third reason is that because of the lack of strategic knowledge among students with disabilities, they also lack knowledge about words and word features, which also inhibits their ability to figure out what new words mean and to store those words in their memories in ways that allow efficient retrieval (Bryant, Goodwin, Bryant, & Higgins, 2003).

It is due to these three reasons that students with disabilities are in particular need of vocabulary support for reading. The support strategies that have been documented to be helpful for students with disabilities are (a) keyword (mnemonic) strategy instruction (b) cognitive strategy instruction, (c) activity-based methods, (d) constant time delay (CTD) (e) direct instruction, and (f) computer assisted instruction (CAI) strategies (Jitendra, Edwards, Sacks, & Jacobson, 2004). Definitions of these types of support, as they were described by Jitendra, Edwards, Sacks, and Jacobson appear in Table 2. These strategies have all been tested in general education classrooms and special education classrooms in brick and mortar schools. They have not been tested in online courses. In addition, CAI often relies on some other strategy, such as direct instruction, that has been designed on a computer program. These strategies are usually all considered together to be CAI.

Table 3 outlines these strategies in terms of strength and support. Essentially, most any instructional strategy a teacher uses has the potential to help students with disabilities learn vocabulary, but some are stronger than others. In their review Jitendra and her colleagues (2004) identified only two strategies as being counterproductive to vocabulary learning. These were looking up definitions in the dictionary and using word lists.

While there is no magic number in the research on vocabulary for the quantity of words that should be taught in a given instructional unit to students in general or with reading difficulties, it has been suggested that curriculum makers ought to consider three things about a word before deciding

**Table 2. Definition of types of vocabulary support for students with disabilities**

| Vocabulary Support Type | Definition |
|---|---|
| Keyword/Mnemonic | Vocabulary is learned through associations with sound or imagery links. |
| Cognitive | Vocabulary is learned by applying frameworks for understanding words as semantic networks. |
| Activity | Vocabulary is learned through developmentally appropriate discipline-specific tasks that are highly practical in nature. |
| Constant time delay | Vocabulary is learned when an instructor presents a word and immediately states its definition. The instructor then repeats the word then prompts the student to repeat the definition. Multiple trials of this format occur until error free learning is achieved. |
| Direct instruction | Vocabulary is learned through explicit, systematic presentation of words and meanings. |
| Computer assisted instruction | Engaging in any of the above types of learning, but with a presentational or interactional component on the computer. |

to teach it: (1) importance and utility, (2) instructional potential and (3) whether and how the word builds on students' previous conceptual understandings (Beck, McKeown, & Kucan, 2013). In most cases, this means that vocabulary instruction should focus on developing robust understandings of fewer words rather than superficial understandings of many words.

In summary, determining the words that are suitable for instruction is one that depends on instructor judgment and will vary from teacher to teacher, grade to grade, and year to year. In the meantime, providing instructional support for selected vocabulary has been demonstrated as an effective practice for students with disabilities and most types will meet statistical criteria for effectiveness. The purpose of this study was to determine the nature of the vocabulary support available to students with disabilities in science courses in two widely used online learning environments and one science course from an environment built and maintained by public school teachers in a rural school district in the western United States.

## METHOD

This study employed a directed approach content analysis. In general terms, this type of content analysis is considered highly structured (Hickey & Kipping, 1996). Using existing theory or prior research, researchers identify key concepts or variables as initial coding categories (Potter & Levine-Donnerstein, 1999). Next, operational definitions for each category are determined using the theory. These initial codes and definitions are used as a starting point for conducting the analysis. Sometimes these initial codes are developed based on existing literature may change based on the data collected, but they might also remain the same.

In this study, the initial coding categories used were the first five strategies Jitendra and her colleagues (2004) identified as being successful for students with disabilities. The operational definitions came from studies reviewed in their study as well. The CAI code was not used because all strategies are used in CAI, the content understudy came from online courses.

The main strength of a directed approach to content analysis is that existing theory can be supported and extended. However, one of the main limitations of the directed approach is that researchers approach the data with an informed, but strong bias. Therefore, researchers might be more likely to find evidence that is supportive rather than non-supportive of a theory.

Since the purpose of this study was not to defend vocabulary support strategies, but rather to classify them in an attempt to describe certain features of online courses, the directed approach was an appropriate option. However, it was also important during the coding process to be open to

**Table 3. Vocabulary strategy support for students with disabilities**

| Type of Support Strategy | Description | Strength of Support | Key Empirical Support |
|---|---|---|---|
| Keyword/mnemonic instruction | Uses a keyword or similar sounding word coupled with an image to assist memorization of the new word | Strong effect sizes in initial outcomes and maintenance | Condus, Marshall, & Miller, 1986; Mastropieri, Scruggs, & Fulk, 1990; Mastropieri, Levin, Gaffney & McLoone, 1985; McLoone, Scruggs, Mastropieri, & Zucker, 1986; Veit, Scruggs, Mastropieri, 1986 |
| Cognitive strategy instruction | Provides students patterns and techniques for understanding words in semantic networks | Strong effect sizes and transfer across multiple studies | Anders, Bos, & Filip, 1984; Bos, Allen, & Scanlon, 1989; Bos, Anders, & Filip, 1989; Bos & Anders, 1990; Bos & Anders, 1992 |
| Activity based methods | Features discipline specific activities to interact and engage with vocabulary | Strong when appropriately structured for both short and long-term effects | Gonzalez, et. al.; Mastropieri & Scruggs, 1992; Rutherford & Ahlgren, 1990; Scruggs, Mastropieri, Bakken, & Bingham, 1993 |
| Constant time delay | Applies trials in which an instructor says a word, repeats the definition and then asks the students to do so | No effect sizes calculated; Error free learning that is maintained after 14 weeks, but no large-scale studies have been conducted | Gast, Wolery, Morris, Doyle, & Meyer, 1990; Hua, et. al., 2013; Hudson, Browder, & Wood, 2013; Schuster, Stevens, & Doak, 1990 |
| Direct instruction | Leverages a supposed relationship between vocabulary and reading comprehension by pre-teaching words | Moderate due to limited transfer effects across studies | Pany, Jenkins, & Schreck, 1982; Pany & Jenkins, 1978; Siefert & Esplin, 2012 |
| Computer assisted instruction | Employs keyword, cognitive, or direct instruction in technology-based formats as an alternate way of learning | Overall results were positive, but outcomes were limited; probably because computer assisted instruction relies on another form rather than being a new one | Boettcher, 1983; Herbert & Murdock, 1994; Horton, Lovitt, & Givens, 1988; Johnson, Gersten, & Carnine, 1987; Kennedy, Deshler & Lloyd, 2013; Koury, 1996; |

finding types of vocabulary support that did not fit the existing categories based on Jitendra and her colleagues' (2004) work as well. Two of these were discovered—narrative and metaphor—which are revealed in the findings section and elaborated on in the discussion section.

## Data Sources

The vocabulary words were extracted from earth science courses in two of the most widely used online learning environments and one earth science course from an environment generated by and supported by teachers who were currently teaching in a rural school district. These online learning environments have been given pseudonyms of Acme, LearningCo., and Student Connections. While these online learning environments do not represent every online environment available, their wide availability makes them more likely to be used in general, which includes used by students with disabilities. Words were extracted from 30 earth science course lessons in each online environment. Members of the research team extracted a word if it was denoted in the course as a keyword by (1) its appearance on a word list anywhere in the lesson (2) its demarcation with bolded lettering, italicization, or highlighting, and/or (3) its appearance as an answer to a quiz question in the lesson.

Quizzes and other formal assessments in the lessons were not considered vocabulary support. It is the words extracted from these sample lessons that the coders searched for and catalogued the vocabulary support. These extracted words were visited in their contexts while the types of support were coded.

## Developing Agreement Between the Coders

Two coders conducted the analysis. The coders participated in approximately two hours of collaborative training about where to locate the words for extraction, as well as tiered classification and understanding various strategies for providing vocabulary support. A coding manual was developed consisting of category names, definitions, or rules for assigning codes, and examples (Weber, 1990). Additional fields in the manual were added for taking notes as the coding proceeded. The manual evolved throughout the process of data analysis, and was augmented with interpretive memos. The initial codes were derived from the review of literature on vocabulary support. Since research has identified both technical terms and connective structures that can be divided into tiers, as well as both strong and weak instructional supports, we were interested in all vocabulary support for technical terms in the science courses regardless of classification or efficacy.

In order to ascertain inter-rater reliability, the coders first applied their coding scheme to extracted words from a sample of lessons from that were not included in the final set. A conference followed the coding in order to compare findings and attain agreement. Then extracted words from a set of lessons were coded. Another conference followed. After this second conference, 98 percent agreement had been accomplished. The two coders then proceeded to apply the codes to words extracted from the lessons that were included in the research study. Each researcher coded extracted words from half of the lessons from both of the environments. A total of 974 words were supported in all three environments. Not all of these words were unique. In fact, many overlapped completely letter-for-letter and most overlapped at the word family level. For example, the terms *sample*, *sampled*, *sampling*, and *samples* would all be considered to be in the same word family. There were also many words that shared roots and word parts. Words like *hydroelectric* and *hydrostatic* are examples of words with different meanings but share a common root and have a similar structure.

To increase the trustworthiness of the study, a corpus of 164 words was developed from the database of 974 extracted words. These words were selected to represent all of the word families found across all three environments and the various roots and word parts from the supported words. This list was given to a third researcher with expertise in assigning words to tiers of vocabulary. After the expert assigned the words to Tiers 1, 2, or 3, results were compared with the first two raters. The agreement between the expert and first rater was 94 percent. The agreement between the expert rater and the second researcher was 92 percent. Table 4 contains a sampling of the words and their agreed-upon classifications into tiers.

## Data Analysis

Initial coding started with a theory or relevant research findings. In this case, those findings were related to the vocabulary support strategies in Table 2 (keyword/mnemonic, cognitive strategy, activities, constant time delay, and direct instruction) that demonstrated promise in helping students with disabilities develop vocabulary skills. Then, during data analysis, the researchers immersed themselves in the data and allowed additional themes to emerge. This approach was used to extend the existing empirical basis for vocabulary support for students with disabilities. Data that could not be identified were analyzed later to determine if they represented a new category or subcategory of an existing code. When words were supported using multiple strategies, each strategy was counted. Thus, a supported word was only added to a tier once, no matter how many strategies were used, but each strategy for a word was counted as a unique event.

**Table 4. Examples of tier assignments from raters**

| Tier 1 Words | Tier 2 Words | Tier 3 Words |
|---|---|---|
| Beach | Forecast | Aquifer |
| Cloud | Horizon | Conductivity |
| Color | Hypothesis | Metamorphic |
| Freezing | Manipulation | Epicenter |
| Rain | Texture | Erosion |
| Water | Variable | Watershed |

## Findings

The findings of this coding revealed that there is indeed vocabulary support occurring in the three learning environments. Table 5 reports the distribution of the words that were supported into Beck, McKeown, and Kucan's (2013) tiers.

Although 30 lessons were used from each earth science course, the number of words supported in each of the tiers varies. Figure 1 provides a side-by-side comparison of each of the tiers for each of the courses.

The Acme earth science course supported the most words, by far. The vast majority of these supported words were tier 3 words. LearingCo supported substantially less in all three categories, as did Student Connections.

The next set of Figures (2-4) provides percentages of tiered words in each course.

As the graph shows, 94 percent of the words supported in the Acme earth science course are tier 3 words. Only 5 percent are tier 2. One percent are tier 1.

In the Learning Co earth science course, 87 percent of the supported words are tier 3 words. Four percent are in tier 2. Nine percent are in tier 1, the tier that should have the least supported words in curriculum.

The Student Connections earth science course also supported a majority of tier 3 words, with 73 percent. This course had the greatest percentage if tier 2 words, with 18 percent of words falling into that tier. Nine percent of the words supported came from the first tier.

The next set of Figures (5-7) reports on the types of support in each of the environments. The average number of times a word was supported in all three environments was 1.3. Typically, the words that were supported more than once were defined (direct instruction) and then students performed a task with the words (activity) or were shown the words in relationship to one another on a table or graph (cognitive strategy). The mean score of 1.3 support strategies indicates that most words were supported only once. There were very few words supported twice or with more than two types of support. No words were supported more than three times with more than three types of support.

**Table 5. Tiered distribution in online earth science courses**

| | Tier 1 | Tier 2 | Tier 3 |
|---|---|---|---|
| Acme | 6 | 28 | 582 |
| LearningCo. | 20 | 10 | 208 |
| Student Connections | 11 | 22 | 87 |
| Total | 37 | 60 | 877 |

**Figure 1. Comparison of tiered words in three online earth science courses**

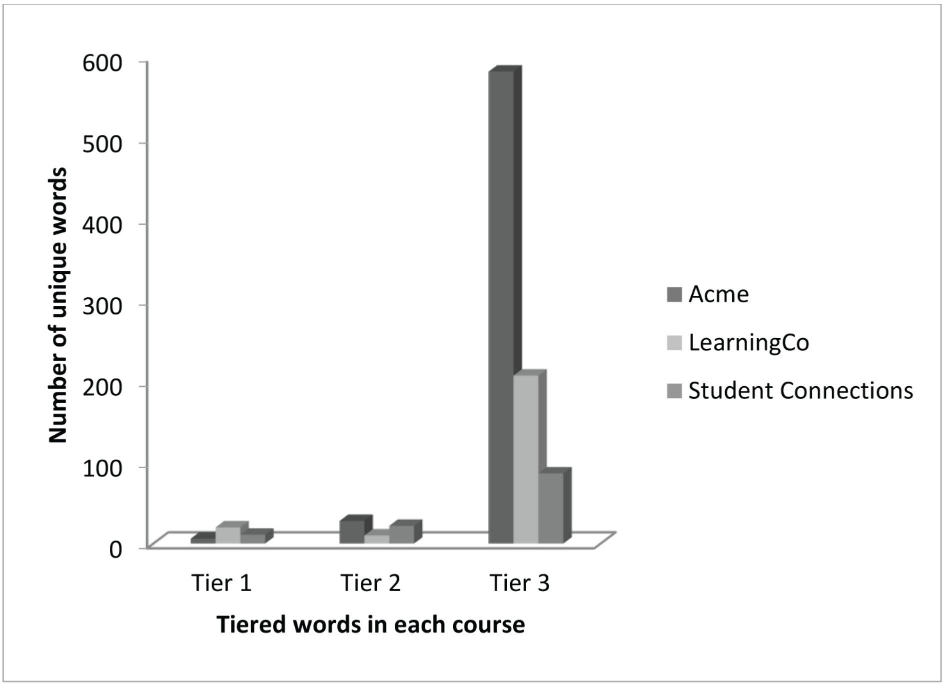
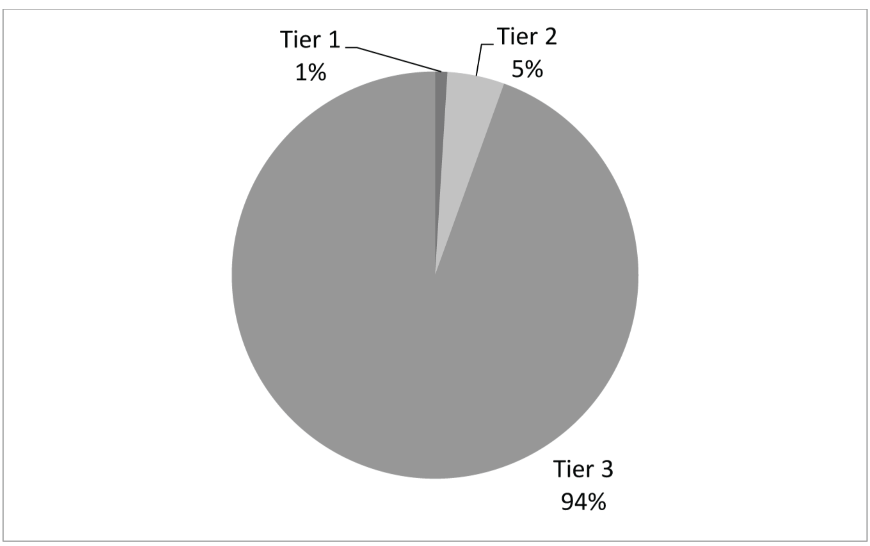



**Figure 2. Acme percentages of tiered words**




The Acme earth science course vocabulary support consists mostly of direct instruction, with 49 percent of the support coming in that form. The next highest category was cognitive support, with 27 percent. The third highest was activity with 24 percent. There was no vocabulary support in keyword or constant time delay form.

Learning Co's earth science course also relied heavily on direct instruction, with 62 percent of support falling into that category. Thirty percent of the support was cognitive. Only 8 percent was driven by activity. As in Acme, keyword and constant time delay strategies were not employed.

**Figure 3. LearningCo. percentages of tiered words**

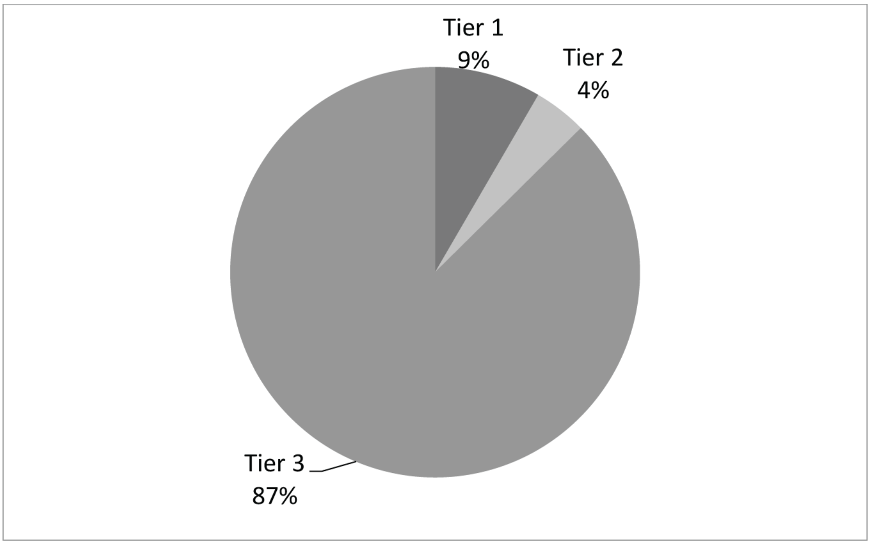
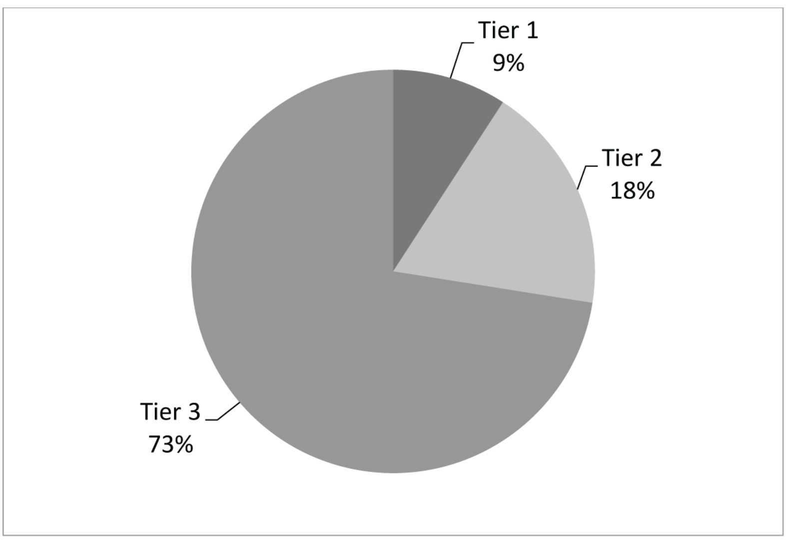



**Figure 4. Students connect percentages of tiered words**




Unlike the other two courses, Student Connections' earth science course had the majority of the support in activities, with 40 percent. Direct instruction was still a major source of support with 30 percent. Only 11 percent of the support was based on cognitive strategies. Student connections' course utilized keyword strategies for 4 percent of the support, constant time delay was not used at all. In addition, there were two new strategies used. One strategy was to tell a story about the word. This was coded as Narrative support. Seven percent of the words were supported in this way. Another strategy used 8 percent of the time was to embed the words into a metaphor and then explore the words and the metaphor together. One example of this happened when the course materials likened the solar system to a running track.

**Figure 5. Acme percentages of vocabulary support**

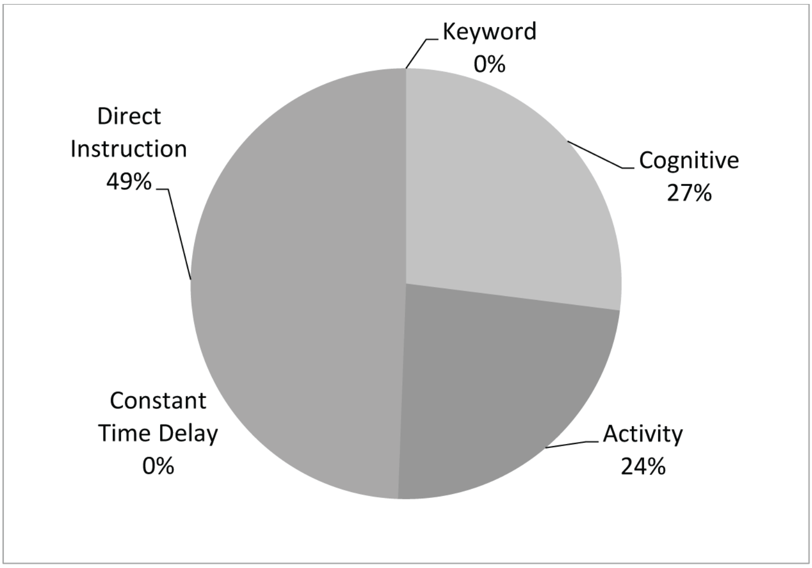
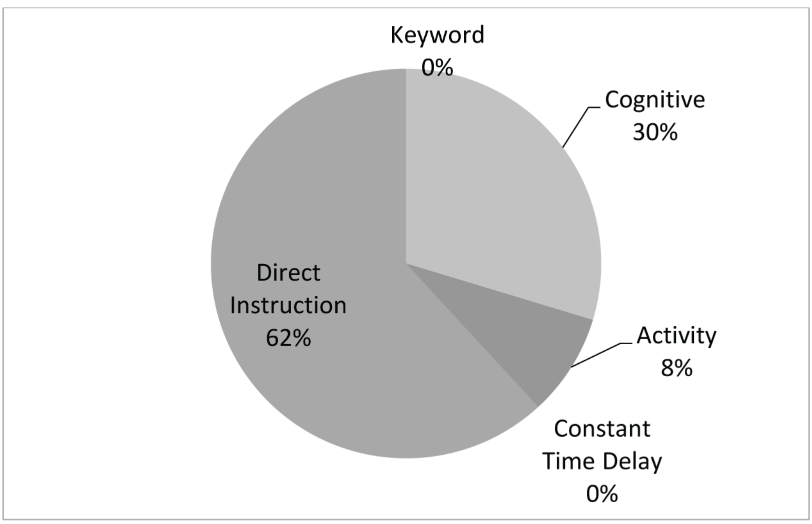


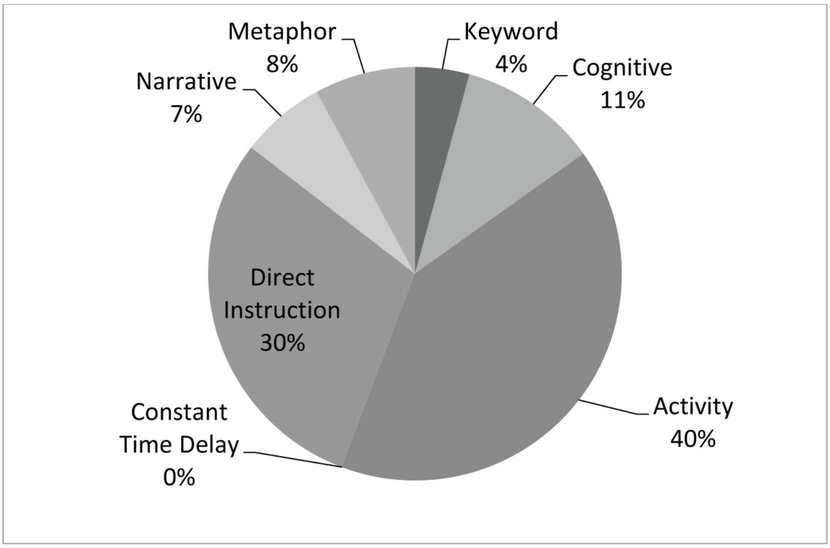

**Figure 6. LearningCo. percentages of vocabulary support**




## DISCUSSION

The findings of this study highlight the abundance of words receiving attention in the online earth science courses. While it could be argued that it is unlikely students will be able to make meaningful use of the sheer number of words that have been selected and supported in these courses, what is additionally troubling is the fact that the number and types of words chosen do not seem to have been strategically selected to facilitate a broad command of academic language based on the notion of tiered vocabulary instruction. Instead, a limited number of words should be chosen that are important to the text, the topic at hand, and generally appear at high frequencies (Beck, McKeown, & Kukan, 2013).

**Figure 7. Student connections percentages of vocabulary support**




Another major finding was that direct instruction was the dominant mode of support, even though it is not the necessarily the most helpful for students with disabilities (Jitendra, Edwards, Sacks, & Jacobson, 2004). Others have noted that direct instruction is helpful for disabilities, but only in concert with repeated exposures across multiple contexts using multiple strategies to help students develop deep word consciousness (Bryant, Goodwin, Bryant, & Higgins, 2003). The average number of times a vocabulary word was supported (1.3 for all environments) demonstrates that this repetition was not occurring and the fact that many of the words are tier 3 words suggests that the words that should have multiple exposures, do not.

Taken together, these findings suggest that students with disabilities who are enrolled in online courses may not have access to the type of vocabulary and the strategies for support that will help them cross the lexical bar (Corson, 1984). Although online instruction has the potential for easy modification of content, the environments in this study did not allow online teachers or learning coaches, who are often parents, to change the number or types of words that receive attention or how those words are supported. Advocates, and other overseers of students, particularly those with reading difficulties, will likely need to provide additional support in sorting the vocabulary words and selecting strategies that move beyond definitions and pictures that facilitate learning. Although the names of the companies supporting these online courses have been changed to pseudonyms, this study derives value from bringing attention to the fact that vocabulary identification and support will need to be vetted by parents and educators looking for online courses for students with disabilities.

## RECOMMENDATIONS FOR ADDITIONAL RESEARCH

Vocabulary support in online course materials offers a fruitful venue for investigation. Some of the new questions that emerge include inquiring into the ways in which the students experience the vocabulary support, determining to degree to which they notice and attempt to use the support, monitoring which words are learned, and how long that learning is retained, and designing and piloting vocabulary instructional materials that can be embedded in online course material (as opposed to supplementary drills) that support students with reading difficulties, but also attend to a broader range of diverse learners. An area of promise for researchers also emerged in the Student Connections earth science course with its use of narrative and metaphor as vocabulary support strategies. New studies into vocabulary instruction might look at whether teachers in face-to-face contexts are also providing support using these strategies and to what extent. Research may also look into whether these strategies are more/less effective than other forms.

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## REFERENCES

Anders, P. L., Bos, C. S., & Filip, D. (1984). The effect of semantic feature analysis on the reading comprehension of learning disabled students. In J.S. Niles, and L.A. Harris (Eds.) *Changing perspectives on reading/language processing and instruction.* (pp. 162-166). Rochester, NY: The National Reading Conference.

Barbour, M. K., & Reeves, T. C. (2009). The reality of virtual schools: A review of the literature. *Computers & Education*, *52*(2), 402–416. doi:10.1016/j.compedu.2008.09.009

Beck, I. L., McKeown, M. G., & Kucan, L. (2013). *Bringing words to life: Robust vocabulary instruction*. New York, NY: Guilford Press.

Boettcher, J. V. (1983). Computer-based instruction: Classroom application and benefits for the learning-disabled student. *Annals of Dyslexia*, *33*(1), 203–219. doi:10.1007/BF02648006

Bos, C. S., Allen, A. A., & Scanlon, D. J. (1989). Vocabulary instruction and comprehension with bilingual learning disabled students. *National Reading Conference Yearbook*, *38,* 173-179.

Bos, C. S., & Anders, P. L. (1990). Effects of interactive vocabulary instruction on the vocabulary learning and reading comprehension in junior high learning disabled students. *Learning Disability Quarterly*, *13*(1), 31–42. doi:10.2307/1510390

Bos, C. S., & Anders, P. L. (1992). Using interactive teaching and learning strategies to promote text comprehension and content learning for students with learning disabilities. *International Journal of Disabilities*, *39*(3), 225–238.

Bos, C. S., Anders, P. L., Filip, D., & Jaffe, L. E. (1989). The effects of an interaction instructional strategy for enhancing reading comprehension and content area learning for students with learning disabilities. *Journal of Learning Disabilities*, *22*(6), 384–390. doi:10.1177/002221948902200611 PMID:2738473

Bryant, D. P., Goodwin, M., Bryant, B. R., & Higgins, K. (2003). Vocabulary instruction for students with learning disabilities: A review of the research. *Learning Disability Quarterly*, *26*(2), 117–128. doi:10.2307/1593594

Cess-Newsome, J. (2002). Secondary teachers' knowledge and beliefs about subject matter and their impact on instruction. In J. Cess-Newsome & N. L. Lederman (Eds.), *Examining pedagogical content knowledge* (pp. 51–94). Dordrecht, The Netherlands: Springer. doi:10.1007/0-306-47217-1_3

Christie, F. (2001). The development of abstraction in adolescence in subject English. In M. Schleppegrell & M. C. Colombi (Eds.), *Developing advanced literacy in first and second language: Meaning with power* (pp. 45–66). Mahwah, NJ: Erlbaum.

Condus, M. M., Marshall, K. J., & Miller, S. R. (1986). Effects of the keyword mnemonic strategy on vocabulary acquisition and maintenance by learning disabled children. *Journal of Learning Disabilities*, *19*(10), 609–613. doi:10.1177/002221948601901006 PMID:3794546

Corson, D. (1984). The Lexical Bar: Lexical change from 12 to 15 years measured by social class, region and ethnicity. *British Educational Research Journal*, *10*(2), 115–133. doi:10.1080/0141192840100201

Dutro, S., & Moran, C. (2003). Rethinking English language instruction: An architectural approach. In G. García (Ed.), *English learners: Reading the highest level of English literacy* (pp. 227–258). Newark, NJ: International Reading Association. doi:10.1598/0872074552.10

Eggins, S. (1994). *An introduction to systemic functional linguistics*. London, England: Pinter.

Fang, Z. (2005). Scientific literacy: A systemic functional linguistics perspective. *Science Education*, *89*(2), 335–347. doi:10.1002/sce.20050

Fang, Z. (2006). The language demands of science reading in middle school. *International Journal of Science Education*, *28*(5), 491–520. doi:10.1080/09500690500339092

Gast, D. L., Wolery, M., Morris, L. L., Doyle, P. M., & Meyer, S. (1990). Teaching sight word reading in a group instructional arrangement using constant time delay. *Exceptionality*, *1*(2), 81–96. doi:10.1080/09362839009524745

Gonzalez, J. E., Pollard-Durodola, S., Simmons, D. C., Taylor, A. B., Davis, M. J., Kim, M., & Simmons, L. (2010). Developing low-income preschoolers' social studies and science vocabulary knowledge through content-focused shared book reading. *Journal of Research on Educational Effectiveness*, *4*(1), 25–52. doi:10.1080/19345747.2010.487927

Greenwood, S. C. (2002). Making words matter: Vocabulary study in the content areas. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *75*(5), 258–263. doi:10.1080/00098650209603951

Greenwood, S. C. (2009). Making academic vocabulary learning effective and efficient: Strategies for teachers of the content areas. *Journal of Content Area Reading*, *8*, 31–54.

Greenwood, S. C. (2010). Content area readers: Helping middle-level students become word aware (and enjoy it!). *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *83*(6), 223–229. doi:10.1080/00098650903505423

Harmon, J. M., Hedrick, W. B., & Wood, K. D. (2005). Research on vocabulary instruction in the content areas: Implications for struggling readers. *Reading & Writing Quarterly*, *21*(3), 261–280. doi:10.1080/10573560590949377

Herbert, B. M., & Murdock, J. Y. (1994). Comparing three computer-aided instruction output modes to teach vocabulary words to students with disabilities. *Learning Disabilities Research & Practice*, *9*(3), 136–141.

Hock, M. F., & Deshler, D. D. (2003). Adolescent literacy: Ensuring that no child is left behind. *Principal Leadership*, *13*(4), 55–61.

Horton, S. V., Lovitt, T. C., & Givens, A. (1988). A computer-based vocabulary program for three categories of students. *British Journal of Educational Technology*, *19*(2), 131–143. doi:10.1111/j.1467-8535.1988.tb00261.x

Hua, Y., Woods-Groves, S., Kaldenberg, E. R., & Scheidecker, B. J. (2013). Effects of vocabulary instruction using constant time delay on expository reading of young adults with intellectual disability. *Focus on Autism and Other Developmental Disabilities*, *28*(2), 89–100. doi:10.1177/1088357613477473

Hudson, M. E., Browder, D. M., & Wood, L. A. (2013). Review of experimental research on academic learning by students with moderate and severe intellectual disability in general education. *Research and Practice for Persons with Severe Disabilities*, *38*(1), 17–29. doi:10.2511/027494813807046926

Jitendra, A. K., Edwards, L. L., Sacks, G., & Jacobson, L. A. (2004). What research says about vocabulary instruction for students with learning disabilities. *Exceptional Children*, *70*(3), 299–322. doi:10.1177/001440290407000303

Johnson, G., Gersten, R., & Carnine, D. (1987). Effects of instructional design variables on vocabulary acquisition of learning disabilities students: A study of computer assisted instruction. *Journal of Learning Disabilities*, *24*(1), 46–71.

Kennedy, M. J., Deshler, D. D., & Lloyd, J. W. (2013). Effects of multimedia vocabulary instruction on adolescents with learning disabilities. *Journal of Learning Disabilities*. PMID:23649222

Kossack, S. (2007). Comparing the effects of high and low learning pathway instructional approaches on vocabulary mastery of middle school at-risk learners. *International Journal of Learning*, *14*(6), 199–206. doi:10.18848/1447-9494/CGP/v14i06/45351

Koury, K. (1996). The impact of preteaching science content vocabulary using integrated media for knowledge acquisition in a collaborative classroom. *Journal of Computing in Childhood Education*, *7*, 179–197.

Mackey, K. (2008). Wichita public schools' learning centers. Creating a new educational model for at-risk students and dropouts: An educational case study. Retrieved July 16, 2013 from http://www.innosightinstitute.org/innosight/wp-content/uploads/2010/03/Wichita.pdf

Mastropieri, M. A., & Scruggs, T. E. (1992). Science for students with disabilities: A review of research. *Review of Educational Research*, *62*(4), 377–411. doi:10.3102/00346543062004377

Mastropieri, M. A., Scruggs, T. E., & Fulk, B. J. M. (1990). Teaching about abstract vocabulary with the keyword method: Effects on recall and comprehension. *Journal of Learning Disabilities*, *23*(2), 92–96. doi:10.1177/002221949002300203 PMID:2303742

Mastropieri, M. A., Scruggs, T. E., Levin, J. R., Gaffney, J., & McLoone, B. (1985). Mnemonic vocabulary instruction for learning disabled students. *Learning Disability Quarterly*, *8*(1), 57–63. doi:10.2307/1510908

McLoone, B., Scruggs, T. E., Mastropeieri, M. A., & Zucker, S. F. (1986). Memory strategy instruction and training with learning disabled adolescents. *Learning Disabilities Research*, *2*(1), 45–53.

Orthner, D. K., Jones-Sanpei, H., Akos, P., & Rose, R. A. (2013). Improving middle school student engagement through career-relevant instruction in the core curriculum. *The Journal of Educational Research*, *106*(1), 27–38. doi:10.1080/00220671.2012.658454

Pany, D., & Jenkins, J. R. (1978). Learning word meaning comparison of instructional procedures. *Learning Disability Quarterly*, *1*(2), 21–32. doi:10.2307/1510304

Pany, D., Jenkins, J. R., & Schreck, J. (1982). Vocabulary instruction: Effects of word knowledge and reading comprehension. *Learning Disability Quarterly*, *5*(3), 202–215. doi:10.2307/1510288

Potter, W. J., & Levine-Donnerstein, D. (1999). Rethinking validity and reliability in content analysis. *Journal of Applied Communication Research*, *27*(3), 258–284. doi:10.1080/00909889909365539

Pullen, P. C., Tuckwiller, E. D., Konold, T. R., Maynard, K. L., & Coyne, M. D. (2010). A tiered intervention model for early vocabulary instruction: The effects of tiered instruction for young students at risk for reading disability. *Learning Disabilities Research & Practice*, *25*(3), 110–123. doi:10.1111/j.1540-5826.2010.00309.x

Rutherford, J. & Ahlgren, A. (1990). *Science for all Americans*.

Schleppegrell, M. (2001). Linguistic features of the language of schooling. *Linguistics and Education*, *12*(4), 431–459. doi:10.1016/S0898-5898(01)00073-0

Schuster, J. W., Stevens, K. B., & Doak, P. K. (1990). Using constant time delay to teach word definitions. *The Journal of Special Education*, *24*(3), 306–318. doi:10.1177/002246699002400305

Scruggs, T. E., Brigham, F. J., & Mastropieri, M. A. (2013). Common Core Science Standards: Implications for Students with Learning Disabilities. *Learning Disabilities Research & Practice*, *28*(1), 49–57. doi:10.1111/ldrp.12002

Scruggs, T. E., Mastropieri, M. A., Bakken, J. P., & Brigham, F. J. (1993). Reading versus doing: The relative effects of textbook-based and inquiry approaches to science learning in special education classrooms. *The Journal of Special Education*, *27*(1), 1–15. doi:10.1177/002246699302700101

Seifert, K., & Espin, C. (2012). Improving reading of science text for secondary students with learning disabilities effects of text reading, vocabulary learning, and combined approaches to instruction. *Learning Disability Quarterly*, *35*(4), 236–247. doi:10.1177/0731948712444275

Viet, D. T., Scrugges, T. E., & Matropieri, M. A. (1986). Extended mnemonic instruction with learning disabled students. *Journal of Educational Psychology*, *78*(4), 300–308. doi:10.1037/0022-0663.78.4.300

Weber, R. P. (1990). *Basic content analysis* (2nd ed.). Newbery Park, CA: Sage Publications. doi:10.4135/9781412983488

Wignell, P., Martin, J. R., & Eggins, S. (1993). The discourse of geography: Ordering and explaining the experiential world. In M. A. K. Halliday & J. R. Martin (Eds.), *Writing science: Literacy and discursive power* (pp. 136–165). Pittsburgh, PA: University of Pittsburgh Press.

Zwiers, J. (2008). Building academic language: Essential practices for content classrooms, grades 5-12. San Francisco, CA: John Wiley & Sons.

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