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CAN SOFTWARE SUPPORT CHILDREN'S VOCABULARY DEVELOPMENT?

Julie Wood
Harvard University

ABSTRACT

A number of software programs on the market claim to foster literacy development. However, we know little about the pedagogical underpinnings of such products, particularly the extent to which they are aligned with current research for both L1 and L2 learners. This study "lifts the lid off" 16 well-reviewed software products designed for elementary grade students -- those products that make explicit claims about developing students' lexical knowledge and those that do not. The study also examines the potential of technology (e.g., hypertext, animations) to enhance vocabulary learning.

The following guidelines, derived from research, were used to examine each product. Does instruction relate the new to the known? Does it promote active in-depth processing? Does it provide multiple exposures of new words? Does it teach students to be strategic readers? And does it promote additional reading? Findings indicated that many products that made no explicit claims about fostering vocabulary learning, in fact, incorporated more guidelines than many that made explicit claims. Those in the latter group often merely varied a drill and practice routine rather than helping students *really know* a word. Findings also indicated that the potential of technology to help students understand word meanings has yet to be fully exploited.

> *… anybody who writes down to children is simply wasting ... time. You have to write up, not down. Children are demanding … Children love words that give them a hard time, provided they are in a context that absorbs their attention.* --E. B. White (1969)

INTRODUCTION

Literacy experts share the belief that vocabulary knowledge and the ability to comprehend text are inextricably linked -- that the breadth and depth of a student's vocabulary is a key predictor of his or her ability to understand a wide range of texts (e.g., Anderson & Freebody, 1981; Thorndike, 1973). This is true for both native speakers (L1) of English and second Language (L2) learners (Coady, 1993; Stoller & Grabe, 1993).

In today's classrooms, vocabulary instruction is increasingly supplemented by software products, yet little is known about the underlying teaching strategies employed by these products or the nature of the vocabulary they present. The present study represents an extensive analysis of both the underlying teaching strategies employed by a variety of software products and the kinds of words they present to L1 and L2 students.

How can software packages and their potential impact on vocabulary development be assessed objectively? In this study I establish criteria for the effectiveness of vocabulary teaching and evaluate samples of available software chosen for their potential effectiveness given existing research. I have also examined the character and grade levels of vocabulary words presented in these products.

In this paper, I present the findings from a content analysis of 16 software products, designed for students in third to fifth grade, which have been highly recommended by teachers and other proponents of educational technology. Because these introduce a substantial number of new vocabulary words, they lend themselves to intensive examination. I have focused on grades 3 through 5 because traditionally, vocabulary development begins to play an important role in reading comprehension during this period; in third grade the instructional emphasis shifts from decoding to the reading of more complex narrative and expository passages.

The number of software products on the market is growing exponentially. In 1996, a record-breaking 693 educational software titles were released ("The Bright Future of Children's Software," 1997). In reviewing 16 software products for this study I have tried to "lift the lid" off each and peer inside, applying a literacy perspective. In so doing, I have tried to discern the elaborate webs that lie beneath the surface "flash": here a connection to semantically-related words to describe Ancient Rome; there a connection to dialogue from *Charlotte's Web*. What sorts of vocabulary words do these products emphasize? What sort of connective tissue is used to connect vast networks of ideas? What sort of support structures, if any, are in place for learners who hope to increase their vocabulary by engaging with these products?

This study was also driven by my desire to understand the relationship between what computer advocates tell us (and what many of us believe intuitively) about the potential for software products that can broaden our understanding of the world and what software companies actually deliver. By taking a penetrating look at this relationship, determining the ways in which software can contribute to vocabulary learning, and in what ways it loses its pedagogical bearings, we can better advise the designers of such products. Given the tremendous increase in the use of computers and educational software in classrooms, there is much at stake. It is urgent that the literacy community accept responsibility for the critical evaluation of the tools that teachers will use to help teach the next generation of children to read.

I synthesize the findings of this content analysis with regard to the nature of the vocabulary being taught, and I systematically investigate the extent to which the explicit and implicit vocabulary instruction reflects research findings about effective teaching strategies.

While my analysis offers a window on the nature of the words presented via software as receptive vocabulary (through reading and listening), their level of difficulty, and the pedagogical underpinnings of each product, an evaluation of the *efficacy* of each product is more difficult and beyond the scope of this study. At this preliminary stage of analysis, we can only speculate about each product's potential for enhancing vocabulary development, on the basis of the data derived from a close examination of each product.

The following three research questions were the focus of this study:

1. *Explicit pedagogical strategies.* What *explicit* strategies for teaching vocabulary are used by 6 out of 16 products in this study? How consistent are these strategies with those recommended by the literacy community for developing vocabulary?

2. *Implicit pedagogical strategies.* What *implicit* strategies for teaching vocabulary are used by 10 out of 16 products in this study? How consistent are these strategies with those recommended by the literacy community for developing vocabulary?

3. *Innovative qualities of media.* In what ways can innovative, media-based teaching strategies (e.g., hypertext, animations) contribute to vocabulary instruction in all 16 products in this study?

In examining each research question, I have drawn upon my work as an elementary school teacher, reading consultant, developer and author of materials (both print-based and multimedia) for educational publishers, and my academic studies. In addition, working with reading-disabled students as Director of the Harvard Literacy Laboratory has intensified my quest to devise rational ways to evaluate the plethora of educational software on the market. By using empirical evidence about literacy learning as the main criteria, one can make knowledgeable decisions about which software products are likely to both motivate students and support their development as readers and writers.

BACKGROUND TO THE STUDY

Theoretical Framework

The interactionist view of language processing, which draws heavily on Piaget's (1971) theory of accommodation, guides my research. This theory posits that children construct meaning by assimilating information into their existing schemata as well as by accommodating existing schemata to new knowledge. Piaget's definition of schema also

applies to the reading process: To comprehend texts, readers must integrate new knowledge into a network of prior knowledge (e.g., Anderson & Pearson, 1984; Wilson & Anderson, 1986). Thus, reading is an active process in which the reader interacts with text and constructs meaning, making sense of new information by relating it to the known.

How Does Activating Readers' Schemas Improve Their Comprehension?

Wilson and Anderson (1986) hypothesize that activating schemas aids the reader by allowing him or her to analyze print while using *prior knowledge* to construct meaning from written text. In essence, a schema "provides ideational scaffolding -- text fits into slots within the schema, directs allocation of attention, enables inferential elaboration, allows orderly searches of memory, facilitates editing and summarizing, and permits inferential reconstruction" (Wilson & Anderson, 1986, pp. 35-36). Thus, we can infer that ideational scaffolding also aids the reader in vocabulary development -- that new words are assimilated into existing slots within the readers' schema allowing for vocabulary growth which enhances readers' ability to comprehend text.

Reading and Language as Developmental Processes

Vocabulary development is a dynamic process. Current educational theory holds that reading and language arts are ongoing developmental processes, shaped and molded by both home and school environments. According to Carroll (1977), language comprehension must be central to any discussion of reading comprehension. Further, Carroll asserts, the acquisition of vocabulary, language, and literacy cannot be viewed as separate events; together they form the basis of a synergistic process in which language development provides a foundation for vocabulary development, which in turn stimulates cognitive growth.

Dynamic Nature of Word Knowledge

What do we mean when we say a child *knows* a word? Is it enough for children to be able to use a new word in a sentence and provide a definition? Stahl (1985, 1986) has identified three levels of word mastery: (a) *association processing* (which involves introducing a synonym for the new word or showing how it relates to a particular text); (b) *comprehension processing* (which helps students demonstrate their understanding of a new word through activities, e.g., finding an antonym, filling in blanks with the appropriate word, classifying the word -- in short, demonstrating an understanding beyond rote memorization); and (c) *generation processing* (which involves using a word in a novel way that reflects deep understanding of its meaning). Within Stahl's framework, generation processing is the most cognitively challenging since it requires a student to retrieve a new word spontaneously and use it correctly in a novel context, a much more difficult task than reciting a definition.

The Debate About Effective Vocabulary Teaching

The argument over the most effective vocabulary teaching strategy has been referred to as the "fertility versus futility debate" (cf. Baumann & Kame'enui, 1991). Advocates of *fertile* vocabulary instruction cite several empirical studies suggesting the greater efficacy of direct instruction. Those on the *futile* side of the debate argue in favor of vocabulary development within a broader educational framework that provides opportunities for students to map word meanings onto existing schemas (e.g., Nagy, Anderson, & Hermann, 1987).

In this study, I followed in the tradition of Chall, Snow, Barnes, Chandler, Goodman, Hemphill, & Jacobs (1982) who advocate teaching practices that combine both direct instruction of unfamiliar words and incidental learning of vocabulary in natural contexts. Chall et al. argue that neither explicit instruction of a specific subset of word meanings nor incidental learning of vocabulary through literacy practices, such as extensive reading, is a sufficient strategy for vocabulary learning when used exclusively. Instead, rich learning environments that promote deep understandings of words and their semantic relationships are best created by applying both approaches in concert. For this reason, I have paid special attention to products that have successfully combined these two approaches in thoughtful ways.

Implications of the Research for L2 Learners

Many experts in second language acquisition lament the fact that few experts have turned their attention to the relationship between vocabulary learning and comprehension (Bensoussan & Laufer, 1984; Coady, 1993; Meara, 1980, 1984). Recently, however, several experts concur that there are many parallels in language learning -- specifically related to theory and instructio -- between L1 and L2 students. Such practices include teaching students how to figure out words in context, providing multiple exposures to new words in a variety of contexts, and explicit instruction of core vocabulary (Coady, 1993). Further, many experts now believe that, as with L1 learners, L2 readers learn best through the interactive model of reading, which involves both a top-down and bottom-up processing model. This model provides students with the tools they need to decode words and retrieve their meaning at the bottom-up level and interpret what they read through a top-down process. As studies have shown with L1 readers, proficient readers are more adept in constructing meaning from text (Coady, 1993) than those who struggle with decoding. As Stanovich (1986, cited in Coady, 1993) explains, good readers can devote more of their attention to cognitive processes than struggling readers because they automatically recognize words and have greater lexical knowledge, thereby increasing their understanding of texts. In sum, experts advocate increased emphasis on vocabulary teaching for both native and non-native speakers of English, using both implicit and explicit teaching strategies (Stoller & Grabe, 1993).

Establishing Evaluative Criteria

Working within the interactionist view of language processing, I have developed five criteria for evaluating the nature of the vocabulary instruction in each software product in my study (Appendix A). In developing my criteria I have synthesized the research findings on vocabulary and reading comprehension, drawing heavily from the work of Baumann and Kame'enui (1991), Beck and McKeown (1991), Lipson and Wixson (1991), Nagy (1989), and Stahl and Fairbanks (1986). Analysis of these studies and other experimental data suggest that particular strategies are more successful than others.

Guideline 1: Does it relate the new to the known?
Guideline 2: Does it promote active, in-depth processing? This includes (a) association processing, (b) comprehension processing, and (c) generation processing.
Guideline 3: Does it provide multiple exposures of new words?
Guideline 4: Does it teach students to be strategic readers?
Guideline 5: Does it promote additional reading?

RESEARCH DESIGN FOR A CONTENT ANALYSIS

Overview of the Software Products in My Sample

I included 16 software products in my study, a number large enough for purposes of reliability, yet consistent with the time and resource constraints of a paper. It is important to note that all these titles are still commercially available as of this writing, although some have been updated.

I divided the 16 titles into two different categories as follows:

Direct-Approach Group. Programs whose publishers make *explicit claims* about vocabulary instruction (n=6), presumably for native English speakers. These products include a variety of approaches, such as browsing through an interactive dictionary, studying word origins, and learning grammar.

Indirect-Approach Group. Programs that make *no explicit claims* about teaching vocabulary, but do incorporate unfamiliar words in thematically organized environments in children's literature, science, and social studies (n=10).

METHODOLOGY

Process for Selecting Products

I wanted to sample the entire field. In so doing, I reviewed over 40 potential software titles before making final selections for each category. The process of selecting a representative sample by previewing a wide range of titles allowed me to establish the following criteria: (a) appropriateness for the target age group; (b) the publisher's overall claims about the skills they purport to teach; and (c) outstanding reviews given by impartial publications such as *The Computer Museum Guide to the Best Software for Kids* (Miranker & Elliott, 1995) and *Children's Software Revue.* Such reviews, which often take into account children's responses to a particular piece of software, also served as a filter for eliminating products that may be educationally sound but inherently boring. That is, the reviewers have already evaluated each product's "kid appeal." Let me add, however, that the process was not completely straightforward; although some products appeared to be strong candidates for my study at first, upon closer examination I rejected them for reasons such as not presenting enough potentially new words, an overwhelming number of navigational options, or a propensity for crashing. And unfortunately, given that the software was designed for L1 vocabulary learners, I was unable to analyze the 16 products from the standpoint of English language learners.

Process for Selecting Target Words

From each software product in the *Direct-Approach Group,* I randomly selected a subset of 36 representative target words. I believe this number is high enough to ensure adequate coverage but low enough to be manageable within the scope of this study.

The words I selected for each product represent a subset of those that are highlighted (by the publisher) within on-screen text. In each case, I made a final selection after extensive exploration of the product to determine its scope and the mechanisms through which it introduces new words (see Appendix B). In *Midnight Rescue!* for example, I first played several rounds of the game and examined support material (i.e., the "Hard Words" icon that serves as a glossary). Then I selected 36 highlighted words (e.g., *evidence, tournament)* from comprehension passages that are central to the game. This procedure allowed me to approximate a typical student experience and select a subset of the words the student would be likely to encounter.

Selecting software in the *Indirect-Approach Group* was more complex, since target words have not always been highlighted by the publisher. For products that *do* contain highlighted words I proceeded as with the Direct-Approach Group. For products that *do not* contain highlighted words, I systematically analyzed the thematic content and selected 36 lexically

challenging words that are supported by online text and support material (see Appendix B). In *Planetary Taxi,* for example, I first played four games which allowed me to access information about each planet and the solar system. Next, I examined content-specific words (e.g., *Venus, gravity)* which are contextualized through the informational passages students would be expected to read in order to deliver their "passengers" to the right planets. In addition to content-specific vocabulary words, I also selected several general vocabulary words (e.g., *temperature, diameter)* which are also emphasized in the accompanying material.

Determining the Level of Difficulty of Each Target Word

Before attempting to understand how each word was taught, it was necessary to examine the nature of each of the 576 target words and determine its level of difficulty by consulting these word lists:

1. *The Dale List of 3,000 Familiar Words* (Chall & Dale, 1995) which lists the words that teachers believe can be read and understood by 80% of children in fourth grade.

2. *The Ginn Word Book for Teachers* (Johnson, Moe, & Baumann, 1983), which categorizes 9,000 words according to grade level (1-6), based on difficulty and frequency of use in texts and oral language. I have used the "textbook ratings" as they are more closely applicable to educational software than ratings from storybooks and speech.

3. *The Living Word Book* (Dale & O'Rourke, 1981), a word difficulty measure which classifies 44,000 words according to grade level (4-12). This resource proved particularly valuable for examining words with multiple meanings. For example, the word *keep,* a target word in the *Macmillan Multimedia Dictionary,* when used as a verb is rated at the fourth grade level; however, when *keep* is used as a noun (as in *the stronghold of a castle),* it is rated at the 12th grade level -- eight levels higher!

First, I recorded the ratings recommended by these word lists for all potential target words in all 16 products to establish whether they are likely to be unfamiliar at a particular grade level (see Appendixes C1-C16). Second, I described the instructional presentation of each target word using the *Taxonomy of Vocabulary Teaching* (see Appendixes D1 and D2). Third, I analyzed each target word's instructional presentation according to the *Criteria for Evaluating Teaching Strategies in Selected Software Products* (Appendix A). Last, I analyzed the qualitative ratings from the criteria evaluation scale to determine the extent to which the software products in both the Direct-Approach Group and the Indirect-Approach Group are consistent with recommended strategies for teaching vocabulary.

Reliability of Coding

I did all the coding for the products in this study. To assess external reliability for my results on both the *Taxonomy of Vocabulary Teaching* and the *Criteria for Evaluating Teaching Strategies*, a second coder, Kelly Hasson (an experienced elementary school teacher and recent graduate of the Harvard Graduate School of Education Master's program), also evaluated approximately one third of the software products in each category (*n*=5), and one third (*n*=12) of all selected target words, using criteria identical to mine. The first interrater reliability was 0.51, using Cohen's Kappa, which was applied to an agreement matrix to adjust for the factor of chance agreement when determining reliability (Bakeman & Gottman, 1986). However, analysis of the agreement matrix indicated systematic clusters off the diagonal, indicating a confusion between the categories *seldom* and *occasionally* due to a lack of sufficient distinction between the two codes. Therefore, these two categories were collapsed and the Cohen's Kappa recalculated to produce an interrater reliability of 0.69 percent, which is within acceptable limits.

Synthesis of Coded Information

Synthesis involved (a) comparing the percentages of recommended teaching strategies employed by products in each category and (b) examining both recommended *print-based strategies* embedded in products and commonly used untested *media-based strategies* (Appendix E).

Table 1: Percentages of Target Words at Each Grade Level

PRODUCT	**Target Age ***	**Dale List**	**Gr. 1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13+**	**Not listed**
Direct-Approach Group																
Let's Explore the Farm	3-8	61%	0%	0%	8%	17%	3%	6%	0%	0%	0%	0%	0%	3%	3%	3%
Macmillan Dictionary	6-12	42%	0%	0%	6%	17%	3%	14%	0%	0%	0%	8%	0%	11%	0%	0%
Recess in Greece	7-12	8%	0%	0%	14%	14%	0%	8%	0%	6%	0%	3%	0%	6%	6%	36%
Grammar Rock	6-10	39%	0%	14%	11%	11%	3%	6%	0%	6%	0%	3%	0%	0%	6%	3%
Midnight Rescue!	7-10	11%	0%	6%	19%	17%	17%	8%	0%	19%	0%	0%	0%	3%	0%	0%
Word Attack 3	10-adult	6%	0%	0%	6%	8%	3%	8%	0%	14%	0%	19%	0%	17%	17%	3%

Indirect-Approach Group																
Alien Tales	9-13	11%	3%	0%	14%	42%	14%	11%	0%	0%	0%	0%	0%	0%	6%	0%
Ancient Lands	8-adult	0%	0%	0%	0%	31%	0%	14%	0%	17%	0%	11%	0%	8%	6%	14%
Encyclopedia of Nature	8-adult	11%	3%	0%	0%	19%	3%	14%	0%	14%	0%	6%	0%	19%	3%	8%
Multimedia Bug Book	5-10	6%	0%	0%	3%	31%	0%	11%	11%	11%	0%	17%	6%	6%	8%	8%
Planetary Taxi	8 and up	11%	0%	3%	9%	17%	8%	11%	0%	6%	0%	0%	0%	3%	6%	17%
Reading Search	7-10	14%	0%	8%	3%	33%	0%	22%	0%	3%	0%	0%	0%	12%	6%	0%
Way Things Work	8-adult	25%	0%	3%	0%	14%	3%	11%	0%	3%	0%	8%	0%	8%	0%	28%
What's the Secret?	7 and up	8%	0%	2%	6%	22%	0%	19%	0%	6%	0%	8%	0%	14%	8%	8%
Wrath of the Gods	9-adult	6%	0%	0%	11%	17%	8%	8%	0%	14%	0%	3%	3%	0%	6%	25%
Zurk's Rainforest Lab	5-9	11%	0%	8%	11%	6%	0%	3%	0%	17%	0%	3%	0%	6%	17%	17%

* As recommended by the publisher

MATERIALS

Determining a Grade Level for Each Target Word

To guide my analysis I developed the following three criteria in an attempt to resolve several dilemmas that emerged from the data. Briefly, these included: (a) *Nouns Versus Proper Nouns*, (b) *Complex Target Words*, and (c) *Compound Words.*

Analysis of Target Words

The analysis of the sample target words in this study includes a close examination of (a) the way in which each product organizes potentially new vocabulary words, and (b) the level of difficulty of each of 576 sample target words culled from 16 software products. (See Appendices C1-C16 for a complete list of target words and their grade levels in each product.)

Summary of Sample Target Word Analysis

The 576 sample target words in this study provide a prism through which to examine the nature of vocabulary words used in educational software products currently found in today's schools (Figure 1). Five salient patterns emerged in most of the 16 products studied.

1. Sample vocabulary words frequently reflect a wide range of levels of difficulty, sometimes spanning as many as 13-15 grade levels within one product. In many products, potentially new words far exceed the reading levels of the intended audience.

2. The sample target words in four out of six products in the Direct-Approach Group are presented without a central content area focus. In contrast, the organization of all 10 products in the Indirect-Approach Group reflect thematic relationships, typically with hyperlinks to semantically-related words.

3. Many of the products in the Direct-Approach group emphasized general vocabulary words (e.g., *carrot, December*), as opposed to products in the Indirect-Approach Group, which often emphasized subject-specific vocabulary (e.g., *discus, papyrus*).

4. Many sample target words -- from products in both groups -- are either unlisted in the published word lists used in this study or are listed at advanced levels. However, these more obscure words are not necessarily lexically complex. Given that the published lists draw heavily upon word frequency, which doesn't allow for individual rates of word learning, a child who has a great interest in bugs may already have learned names such as *praying mantis* (listed at grade 8), and *cicada* (listed at grade 13) by reading books about his or her hobby; learning these words does not represent a task involving lexical complexity. Thus, it is unfortunate that these published lists do not differentiate between words that are simply labels for content-specific items and words that are in fact infrequently encountered because they refer to more sophisticated concepts (e.g., *democracy).*

5. With the exception of *Recess in Greece,* sample target words in the Direct-Approach Group tend to be more consistent with the developmental levels of the intended audience than are those in the Indirect-Approach Group. In the latter group, 8 out of 10 products contain as many as 8-28% exotic words each.

Close examination of the sample target words provides insights about the nature and level of difficulty of the vocabulary words used in the products in this study raises important questions about the general *utility* of these words. Will an understanding of the new vocabulary emphasized in each product serve students well in particular "domains of knowledge" (c.f. Beck & McKeown, 1991, p. 810)? Or will trying to grasp the meanings of these exotic words frustrate children who are not yet ready to deduce their meanings?

Moreover, critical questions remain about the *way* in which these sample target words are presented to students, the availability of online scaffolding for a wide range of learners, and the potential of multimedia to add an important dimension to vocabulary development.

RESULTS

In the present content analysis of each software product in both the Direct-Approach Group and the Indirect-Approach Group, I evaluated the extent to which each product's underlying pedagogy conforms to the five guidelines recommended by literacy experts.

In general, analysis of the software in the Direct-Approach Group (Table 1) revealed an underlying pedagogy consistent with many of the teaching strategies found in traditional print products (e.g., rote memorization of word meanings, fill-in-the-blank puzzles, and matching words to their definitions).

Analysis of software in the Indirect-Approach Group falls under the rubric of a more incidental teaching model for vocabulary instruction, although in many cases direct instruction is available through online glossaries or characters who offer word meanings.

Research has shown that children can be taught new word meanings through rote methods involving synonyms and definitions (e.g., McKeown, Beck, Omanson, & Pople, 1985; Pany & Jenkins, 1978; Stahl, 1983). Operating within the interactionist view of language processing, in which a deeper understanding of words is the objective, it may be that software products in the Indirect-Approach Group prove to be a more effective means of achieving this goal than software in the Direct-Approach Group. However, in the case of L2 learners, one can speculate that there is great value in the repetition and immediate access to definitions for unknown words, especially when those words are rarely used in English (cf. Stoller & Grabe, 1993).

While a qualitative description of software in both categories in response to each guideline is beyond the scope of this study, I would be happy to provide a detailed analysis for interested readers.

First-Order Answers to the Research Questions of Section 1

For Research Questions 1 and 2 the data are combined and distilled in Figure 1.

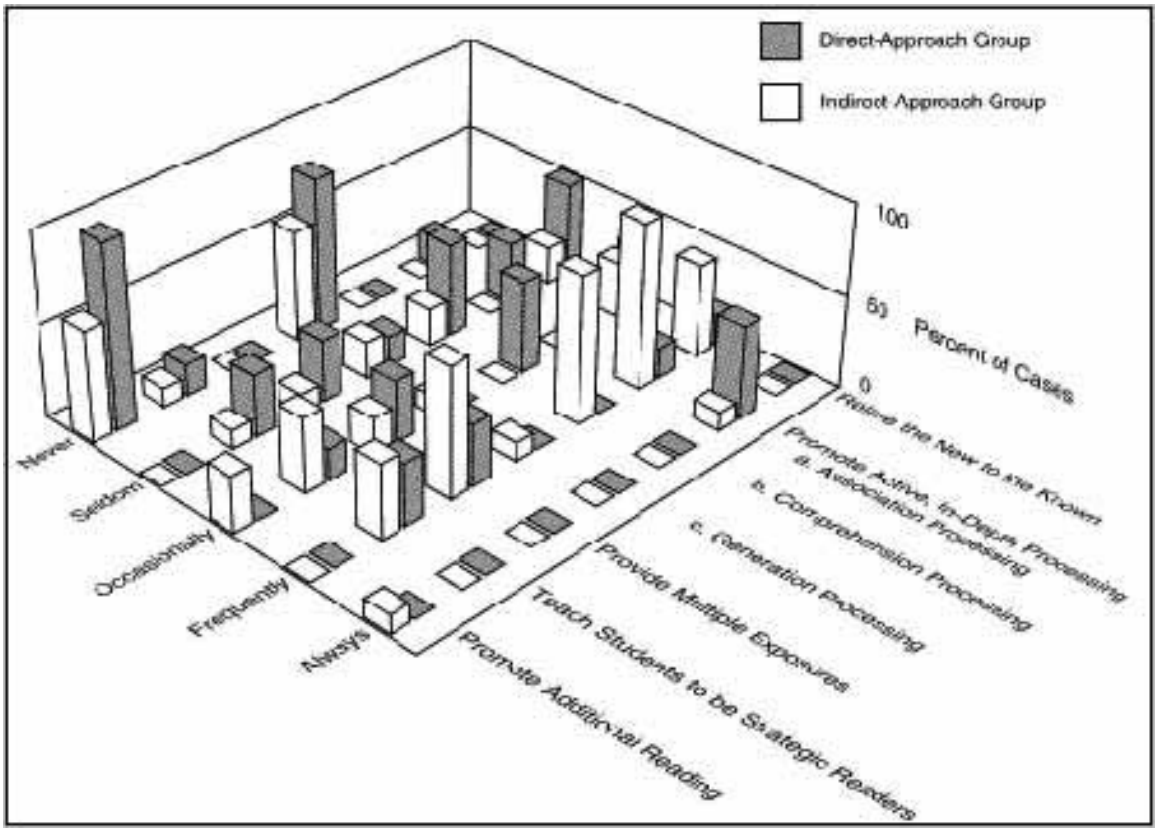

Figure 1. Following recommended guidelines for teaching vocabulary: Software in both groups

As Figure 1 demonstrates, overall, products in the Indirect-Approach Group adhere more closely to recommended literacy practices than those in the Direct-Approach Group. (See Appendix F for a ranking of products according to the five recommended guidelines).

Products in both groups employ a limited number of vocabulary learning strategies, with heavy reliance on relating the new to the known, association processing, comprehension processing, and providing multiple exposures. Instances of activities which require deep thinking, such as full concept knowledge (Kame'enui, Dixon, & Carmine, 1987) and generation processing (Stahl, 1986) are rare. The same is true in regard to instances in which these software products stimulate interest in further reading about a related topic.

Research Question 3

My third research question asked: In what ways can innovative, media-based teaching strategies (e.g., hypertext, animations) contribute to vocabulary instruction in all 16 products this study? The most salient findings are summarized below.

Animations. Many of the animations reviewed were gratuitous in nature, attempting to captivate children but not to illuminate word meaning: for example, a Greek statue that comes to life and tells a joke or a flamboyant quiz show host whose speech is full of puns. Some animations, however, played a more central role in adding visual (and often auditory) information to word meanings. In *What's the Secret?,* for example, an animation is used to show the laws of physics at work (including technical terms) in propelling a roller coaster. Similarly, in *Zurk's Rainforest Lab,* animations allow the user to "travel" from the floor of the rainforest to the tops of trees to learn the names of the changing flora and fauna.

Video Clips of Related Information. The majority of products offered video clips that are primarily educational in content. Such clips offer vivid demonstrations aimed at helping children grasp sophisticated concepts. Video clips are typically accompanied by voice-over text that elaborates a relevant theme (e.g., *Planetary Taxi* offers NASA footage accompanied by a voice-over describing the features of a particular planet). When such clips are directly related to content they make a valuable contribution that is unparalleled in print products.

Sound Components. Although many sound components merely provide entertainment value, some are designed to foster multi-modal vocabulary learning. In the latter group, sound is used for educational purposes; a click of the mouse causes a word to be pronounced, a narrator to read aloud, or a character to provide a narrative thread to help the learner contextualize the passages. The potential for this feature to reinforce vocabulary knowledge is enormous, particularly for L2 learners and children with special needs.

Hyperlinks to Related Information. The most important, innovative feature of the software in this study consists of hyperlinks, a radical departure from linear text. Through hyperlinks, users are encouraged to access a wealth of related information, often in the form of icons labeled, for example, "click here to find out more." In contrast to a traditional book format, hyperlinks beckon readers to digress from the treatment at hand and search through related data bases. For example, a child who explores *camcorders* in *The Way Things Work* is offered hyperlinks to the scientific principles underlying a camcorder, related inventions, and inventors. Such hyperlinks may promote vocabulary learning by allowing children to (1) more readily tap into prior knowledge, (2) create semantic webs, (3) experience a new word in a variety of contexts, and (4) take charge of their own learning by selecting the links that satisfy their curiosity.

Ability to Create One's Own Pathway Through Information. It is often through the use of hyperlinks (above) that students have opportunities to pursue their own interests via software. Young entomologists, for example, can search for information about specific insects in the *Multimedia Bug Book*, while enthusiastic readers can select which books they'd like to be quizzed on in *Alien Tales.* Thus, software can be a powerful ally for students who wish to pursue particular topics -- learning new words, then, becomes a natural adjunct to self-selected explorations.

The Ability to Pause, Repeat Information, or Replay Video Clips. These capabilities make software virtually "flunk proof." Such features have great potential for teaching new words to children who benefit from several repetitions using a variety of modalities.

Hints or Clues Related to Word Meaning. A stock device employed by many products in this study is a character who serves as a "tour guide." These guides typically offer two different kinds of advice, navigational and content-specific. The former is important for finding one's way through the software, but is unrelated to word learning. The latter can provide scaffolding for word learning by offering segues from one "scene" to another, clues about finding more information, and explicit definitions.

Pragmatically speaking, hints and clues prevent users from becoming stuck on one task. They can point children in the right direction and help them interpret information once they get there.

Multimodal Presentation of Information. Products that emphasize multimodal learning, often by combining many of the features discussed above, perhaps make the greatest contribution to dynamic vocabulary learning. Mulitimodal features not only help keep children actively engaged in their own learning, but also accommodate a range of learning styles by offering several entry points: When children can see new words in context, hear them pronounced, type them into a journal, and cut and paste an accompanying illustration (or create their own), the potential for learning can be dramatically increased.

Online Definitions, Glossaries, or Thesauruses. These traditionally-based reference tools are strongest when they are enhanced by voice-over readings and illustrations. As in their print counterparts, however, there is an overreliance on words that may be significantly more difficult than the target word.

Although these resources supply the potential for on-the-spot word learning, these tools could be strengthened by using definitions that make greater use of analogies and other strategies that would more effectively tap into students' prior knowledge lexical repertoires.

In sum, many of the key features these multimedia products use to scaffold the process of gaining word knowledge hold great promise. In the words of Rose (1995), "Children … need plenty of opportunities for guided practice with the scaffolds that will allow them to succeed

in real acts of meaning making" (p. 7). It is only through future studies involving both L1 and L2 learners that we will be able to more accurately pinpoint the importance of the special features found in many software products, and determine which are most effective for vocabulary learning.

CONCLUSIONS

I have drawn three main conclusions from this study related to the nature of the 576 sample target words in the study (both in the Direct-Approach and Indirect-Approach Groups), overall strengths and weaknesses of the 16 product examined, and the potential of many products in this study to scaffold students' vocabulary learning when embedded in a supportive context.

The Nature of the Vocabulary Words Found in the Products in this Study

Six salient patterns were found in most of the 16 products studied.

1. Sample vocabulary words frequently reflect a wide range of levels of difficulty, sometimes spanning as many as 15 grade levels within one product. In many products, potentially new words far exceed the reading levels of the intended audience. This approach could impede learning for L2 learners for whom learning high-frequency words is often more beneficial than learning rare, or advanced vocabulary (Stoller & Grabe, 1993).

2. A related problem is that although the topic may be of interest for a target age group, a lack of lexical knowledge may prevent L2 learners from using the software in meaningful ways.

3. The sample target words in four out of six products in the Direct-Approach Group are presented without a central content area focus. In contrast, in the Indirect-Approach Group all 10 products are organized to reflect thematic relationships, typically with hyperlinks to semantically-related words.

4. Many of the products in the Direct-Approach group emphasized general vocabulary words, as opposed to products in the Indirect-Approach Group, which often emphasized subject-specific vocabulary.

5. Many sample target words -- from products in both groups -- are either unlisted in the published word lists used in this study or are listed at advanced levels. However, these more obscure words are not necessarily lexically complex. Perhaps this finding relates to the fact that most of the products in this group are content specific in contrast to the reading/language arts products which tend to be more general in nature.

6. With the exception of *Recess in Greece*, sample target words in the Direct-Approach Group appear to be more consistent with the developmental levels of the intended audience than are those in the Indirect-Approach Group.

Strengths and Weaknesses of the Software Products in this Study

Software products in the Indirect-Approach Group, on balance, adhere more closely to recommended literacy practices than do those in the other group. The differences between the two categories are particularly pronounced for three guidelines: (a) Relate the new to the known; (b) Promote active, in-depth processing; and (c) Teach students to be strategic readers.

Software products in both categories rely heavily on a limited range of teaching strategies. Strategies involving definitional information about new words are the most prevalent, while those requiring more cognitive demands are rare. Commonly used strategies involve rote learning devices, such as matching words with definitions, answering multiple choice questions, and filling in blanks, with few opportunities for deep processing of new words.

The Potential Contribution of Media

My analysis suggests that new technologies offer great potential to enhance vocabulary instruction. Some capabilities are unique to technology; they cannot be accomplished through print products. At present, however, these capabilities have yet exploited to the fullest extent.

Game-like formats, for example, can be more effective at capturing children's attention than textbooks and workbooks; they provide external stimulation, rich graphics, and online rewards. However, while games can provide multiple exposures to new words and activate prior knowledge, they are often formulaic, relying heavily on gimmicks.

Hyperlinks can offer students rich opportunities to encounter new words in multiple contexts by allowing them quick access to text and graphic. In *What's the Secret?* for example, children who wish to learn more about bees can study bee stings, a bee's anatomy, and killer bees. Such extensions, when well designed, can add great depth particularly in the area of content-specific vocabulary words.

Devices that allow users to click on words to hear them pronounced (and sometimes defined), can enhance understandings about new words. Such "hot spots" can be a powerful learning tool, particularly when used in combination with other modalities. What all of the products in this study lack, however, is a means for students to record and listen to their own voices for further reinforcement.

Animations can demonstrate the inner-workings of the human heart, and provide us with a glimpse of life in Ancient Egypt. When animations are combined with interesting and informative narrations, the potential for word learning is greatly increased.

New technologies can also provide immediate access to vast amounts of information. In *Planetary Taxi*, for example, students can access NASA videos, models of the solar system, and information about individual planets through text, photographs, and voice-over narration. My content analysis has also illuminated what elements are *not* yet present in these software products. Considering the protean capabilities of new technologies, it is now within our grasp to design more powerful tools to develop students' lexical knowledge. Possibilities include:

1. **To stimulate the deep processing of new words.** My study raises questions about whether children are involved in these products in ways that capture their minds. As Perkins (1996) points out in describing the limitations of what he terms "technoglitz,"

   > Deep learning calls for more than software worlds to explore. It calls for a crisp vision of meaningful goals, tasks that demand *thoughtful engagement* [italics added] and serve those goals, informative feedback that advances learners' understanding and capabilities, connections to students' everyday lives and to diverse subject areas... (p. 32)

   Perkins' call for "thoughtful engagement" pinpoints what is lacking in much of the software in this study. If, as in *Midnight Rescue!* and *Word Attack 3*, the games prove more enticing than the content, and if, as in *Planetary Taxi* and *Alien Tales*, the flamboyant characters and special effects compete with subject matter for attention, much of the educational value is lost. New software should be developed and evaluated with an eye toward the ways in which it can stimulate "deep learning."

2. **To provide opportunities to apply new words to novel situations, including those involving writing.** Only three software products connect reading with writing. The absence of online journals and notebooks, word processing capabilities for composition, and other opportunities for written expression, drastically limit opportunities for learners to use new words in authentic literacy contexts. One can speculate that as technological tools become more powerful they will be able to do more than check for matching items, correct responses in fill-the-blank formats, and crossword puzzles. At present, however, the feedback mechanisms that are often employed by developers are rather primitive.

3. **To foster independent reading on related topics.** The availability of online annotated bibliographies or students' own book reviews could encourage them to seek additional information using books.

4. **To encourage students to express new knowledge in ways that help shape and mold products according to their individual learning needs**. Activities such as reading into a microphone, writing responses in journals, and creating informational slide shows with original narration offer students powerful ways to express their ideas. Current products offer students few ways to leave their unique imprint on the activities they have engaged in.

5. **Accommodation of all types of learners, including those who are physically challenged.** The products in this study have not begun to meet the industry standards established by products such as *WiggleWorks* (1994), in which students can select different modes of learning based on individual needs. As products such as *WiggleWorks* clearly demonstrate, software has the ability to offer options for customization through, for example, read-aloud features, different type sizes, and special modifications for people who have difficulty manipulating a mouse. The developers of the products reviewed here have missed a critical opportunity to exploit media's capabilities to better serve all types of learners.

6. **Encouragement of students to engage in projects that promote verbal expression, writing of new words, and other forms of creative expression *away* from the computer.** Computers can only do so much. What happens when children finish working with a piece of software and engage in other classroom tasks? The software products in this study, with the exception of *What's the Secret?* with its annotated bibliographies and project ideas, have not attempted to create a bridge between the online activities and extensions that would call into play newly-acquired lexical knowledge.

Limitations of the Study

Although this content analysis suggests the enormous potential of media to foster vocabulary development, more comprehensive studies are needed. It is crucial that a research agenda for the future include evaluating the efficacy of these products when used with a wide range of learners.

DISCUSSION

Can L1 and L2 children learn vocabulary best through the computer? Not in my estimation. The present results suggest caution in relying on computers alone to foster vocabulary growth; teachers are sorely needed to help mediate vocabulary learning through these new technological tools. Teachers can interact with students in ways that "smart machines" cannot--they can provide a meaningful context for students to apply their new understandings about words through authentic literacy tasks. They can capitalize on students' interests by matching them to software products that introduce specialized vocabulary words, building on their interests, and ultimately helping them fill in lexical gaps. The child who is interested in Mars, for example, can explore *Planetary Taxi* and be transported to multimedia activities based on this topic.

Additionally, teachers can speak to the social nature of vocabulary learning by engaging students in conversations that allow them to apply new word knowledge. Teachers can facilitate deep processing of new vocabulary within the framework of the interactionist view of language development through which social interactions play a key role. In so doing, they can help students connect word meanings to the semantic networks already in place.

Another strategy for using computers to help promote deep understandings of new words involves the widespread availability of communication tools, such as the Internet and its accompanying e-mail capabilities. Teachers are increasingly tapping into this medium to promote innovative, literacy-related projects such as computer-mediated cultural exchanges (e.g., Sayers, 1995), book discussions with peers, and "conversations" with well-known children's authors through the BOOKREAD project (Jody & Saccardi, 1996). Such interactions support vocabulary growth by offering novel, authentic contexts for communication, which can promote deep processing of new words.

This study underscores the need for educators to be involved in the overall design of software; they are the ones who will ultimately be integrating educational products into existing curricula. An historical look at basal readers shows that although reading textbooks have had a long and tumultuous history, the companies that develop them have always included literacy experts from around the country in the role of series authors. Such authors are involved in every aspect of product design and development; they are responsible for creating a blueprint that will establish the pedagogical foundation of a kindergarten through grade 8 reading series. As part of their role, these authors also suggest ways to incorporate pertinent research findings and effective teaching practices into the overall design. I have observed this process from close range as an editor of basal readers and can vouch for the degree of influence authors wield over the series as a whole.

In contrast, several of the software products in this study seem to have been developed independently by software designers. Once users get beyond the sweeping educational claims on the package and skillfully-rendered characters, they discover that the educational underpinnings are often not strong enough to support in-depth learning; there is sometimes more sleight of hand than substance. As Papert of MIT (1996) points out, hundreds of badly produced "edutainment" products on the market were designed for profit, not for learning.

Finally, if our goal is to create software products that support a diverse population, then I believe software designers need to have a first-hand understanding of various types of discourse patterns, cultural values, and interactional styles of the potential users (c.f. Fradd & Lee, 1999). In a sense, software products can serve as a powerful transmitter of knowledge; as such they should reflect diverse languages and cultures (Bartolomé, 1998).

Only through further research about using media to support vocabulary learning can we hope to understand its potential to foster in-depth knowledge about words. Close collaboration between educators and developers is critical if we are to then bridge the chasm between theory and practice and create products that reflect prevailing beliefs about effective vocabulary instruction for a multicultural population.

APPENDIX A: Criteria for Evaluating Vocabulary Teaching Strategies in Selected Software Products

Title of Software Being Evaluated _____

Guidelines for Vocabulary Instruction

Guideline 1: *Relate the new to the known*	never	seldom	occasionally	frequently	always
New vocabulary words are presented in a way that builds on students' previously acquired word knowledge; instruction helps students map new word meanings to their own experiences.					
Guideline 2: *Promote active, in-depth processing*	never	seldom	occasionally	frequently	always

Students are encouraged to become involved in constructing the meanings of new words rather than being taught through rote memorization of word meanings for greater retention (cf. Craik & Lockhart, 1972).

Within this framework, three levels have been identified (Stahl, 1986): *association processing* which involves introducing a synonym for the new word or showing how it relates to a particular context; *comprehension processing* which helps students apply their understanding of a new word to a particular context; and *generation processing* which helps students use the new word in a novel way that demonstrates a deep understanding of its meaning.

Guideline 3: *Provide multiple exposures*	never	seldom	occasionally	frequently	always

Students are repeatedly exposed to information about word meanings as well as multiple exposures to words in a variety of contexts and settings.

Guideline 4: *Teach students to be strategic readers*	never	seldom	occasionally	frequently	always

Students are encouraged to develop an awareness of various independent strategies they can to learn the meanings of new words and become actively engaged in their own learning.

Guideline 5*: Promote additional reading*	never	seldom	occasionally	frequently	always

Students are encouraged to extend their learning through independent reading (Nagy, 1988).

NOTE: To create these criteria, I have drawn upon and expanded the guidelines proposed by Lipson & Wixson's (1991) *Assessment & instruction of reading disability: An interactive approach.*

APPENDIX B: Software Titles
Software Titles in the Direct-Approach Group[1]

1. ***Let's Explore the Farm*** (Humongous). This interactive[2] experience offers children (ages 3-8) opportunities for creative play while visiting a farm. Options include visiting a big red barn, watching a cow being milked, and looking inside a chicken coop. As children click objects related to each topic, Buzzy the Knowledge Bug reads the printed description. Five games help children improve their spelling, sharpen their memory skills, learn to mix colors, and increase vocabulary.

2. ***Macmillan Dictionary for Children*** (Simon & Schuster). This multimedia dictionary (ages 6-12) features over 12,000 words, 1,000 pictures, and 400 sound effects. Some pages include hyperlinks[3] which offer connections to semantically related words or word derivations. Several word games are included.

3. ***Recess in Greece*** (Morgan Interactive). Children (ages 7-12) are introduced to Greek civilization and learn how it has influenced the modern world through word origins, math, mythology, philosophy, and the arts. The activities revolve around Morgan, a rambunctious chimp, who is pulled through the classroom chalkboard into ancient Greece. The students' mission is to help Morgan return to the 20th century. They encounter quizzes along the way (e.g., "word builder," which tests knowledge of Greek roots found in many words in English).

4. ***Schoolhouse Rock: Grammar Rock*** (Creative Wonders). Children (ages 6-10) practice grammar skills that have been introduced through selecting tunes on a video juke box. Users then visit the "Verb Theatre," "Lolly's Adverb Shop," "Pronoun Pet Shop," and seven other learning centers designed to develop vocabulary and improve reading skills. (Based on the Emmy award-winning television series.).

5. ***Super Solvers: Midnight Rescue!*** (The Learning Company). Children (ages 7-10) are challenged to catch the Master of Mischief by using thinking, reading, and reasoning skills during a timed video game format. The program emphasizes reading for main ideas, recalling key facts, drawing inferences, and building vocabulary.

6. ***Word Attack 3*** (Davidson). Advertised as a "vocabulary builder," students (ages 10 to adult) engage in crossword puzzles and arcade games to master definitions, spellings, and pronunciations of thousands of new words categorized by subject and level of difficulty.

Software Titles in the Indirect-Approach Group

1. ***Alien Tales*** (Broderbund). This is a game designed to focus on three areas: building interest in good literature, reinforcing reading comprehension, and developing deductive reasoning skills. Children (ages 9-13) must outsmart comical extraterrestrials who pose as the authors of outstanding children's literature (e.g., *Charlotte's Web).* Contains excerpts from over 30 classics and Newbury Award Winners.

2. ***Ancient Lands*** (Microsoft). Children (age 8-adult) explore the ancient world and learn what life was like, for example, soldiers and servants, through rich images, sound, animation, interactive articles, and videos which span the period from the dawn of Egypt to the fall of Rome.

3. ***Eyewitness Encyclopedia of Nature*** (DK Multimedia). Children (age 8-adult) learn about the world of nature by exploring hundreds of species of animals and plants and the habitats in which they live. Users can access hundreds of illustrated articles on all the major animal and plant groups. Over 2 hours of video included, and 70,000 words presented.

6. ***Multimedia Bug Book*** (Swifte). Children (age 5-10) help capture bugs that have escaped by learning to identify them, describe them, and keep them captive. Children are encouraged to conduct an in-depth study of each species by exploring related sounds, video clips, and photographs.

7. ***Planetary Taxi*** (Voyager). Children (age 8 and up) become taxi drivers in outer space. To deliver their passengers to the correct planetary destinations children must find the answers to scientific questions (e.g., Where does a golf ball fly the farthest or freeze the fastest?). NASA footage of recent space missions included.

8. ***Reading Search*** (Great Wave). Children (age 7-12) go back in time to serve as field agents who help retrieve lost folktales. They explore the Mayan civilization, a Tlingit tribe, and an ancient Chinese Dynasty palace, using their reading and cognitive skills to find clues and gather artifacts.

7. ***The Way Things Work*** (Houghton Mifflin). Based on the trade book by David Macaulay, this software allows students (age 8-adult) to explore science and technology by looking at various machines (e.g., a gearbox, a camcorder) and learning about their inner-workings and scientific principles.

8. ***What's the Secret?*** (3M Software). Based on the PBS science show for children, *Newton's Apple*, this software provides children (age 7 and up) with ways to explore everyday mysteries (e.g., What makes bees sting? What happens during a heart transplant?). *What's the Secret?* aims to help children explore the interconnected worlds of science and nature by choosing their own paths through subjects such as physics, math, and acoustics.

9. ***Wrath of the Gods*** (Luminaria). Students (ages 9-adult) take on the role of a hero on a quest to regain their kingdom in this adventure game based on Greek myths. Life-like characters and photo-realism create the sense of being in a movie while solving ancient mysteries.

10. ***Zurk's Rainforest Lab*** (Soleil). A rainforest adventure designed to motivate children (ages 5-9) to learn about life science, math, and language skills while simultaneously developing reading, writing, and critical thinking skills. Children can alternate among three languages (English, Spanish, and French) as they explore a photo album or jungle scene, participate in an egg hunt, and solve a sorting activity or pattern puzzle.

NOTES

return1 The product descriptions in both categories have been culled from packaging, advertising copy, and my own review.

return2 The term *interactive* is used throughout this study to refer to an option offered the user to *modify* the direction a program takes according to his or her needs and interests. In *Alien Tales,* for example, students can select their opponent, a decision that alters the course of the game as well as the particular book to be featured.

return3 *Hyperlinks* are a form of *interactivity.* The user clicks a mouse on "hot spots" and is instantly transported to databases (e.g., textual information, video material, or photographs). Often such hyperlinks provide ready access to other related hyperlinks, and so on.

APPENDIX C: Grade Level Analysis of Target Vocabulary Randomly Selected from Various Software

APPENDIX C1 *Let's Explore the Farm* (Direct-approach Group)
APPENDIX C2 *Macmillan Dictionary* (Direct-approach Group)
APPENDIX C3 *Recess in Greece* (Direct-approach Group)

APPENDIX C4 *Schoolhouse Rock: Grammar Rock* (Direct-approach Group)
APPENDIX C5 *Living Word Book* (Direct-approach Group)
APPENDIX C6 *Word Attack 3* (Direct-approach Group)
APPENDIX C7 *Alien Tales* (Indirect-approach Group)
APPENDIX C8 *Ancient Lands* (Indirect-approach Group)
APPENDIX C9 *Eyewitness Encyclopedia of Nature* (Indirect-approach Group)
APPENDIX C10 *Multimedia Bug Book* (Indirect-approach Group)
APPENDIX C11 *Planetary Taxi* (Indirect-approach Group)
APPENDIX C12 *Reading Search* (Indirect-approach Group)
APPENDIX C13 *The Way Things Work* (Indirect-approach Group)
APPENDIX C14 *What's the Secret?* (Indirect-approach Group)
APPENDIX C15 *Wrath of the Gods* (Indirect-approach Group)
APPENDIX C16 *Zurk's Rainforest Lab* (Indirect-approach Group)

APPENDIX D1: Taxonomy of Methods for Teaching Vocabulary - Traditional Methods for Introducing or Reinforcing Words (Adapted from Watts [1995])

Target Word _____
Software Program _____
Level of difficulty _____ according to _____ Dale-Chall 3,000 words

_____ Ginn Lexicon
_____ Living Word Vocabulary.
_____ Other (specify source)

_____ ***Definitional***

_____ Dictionary
_____ Glossary
_____ Thesaurus
_____ Word Bank/Data base of words

_____ Read _____ Heard _____ Written _____ Spoken

_____ ***Contextual***

_____ Sentence
_____ Passage
_____ Fill-in-blank
_____ Discussion
_____ Picture

_____ Read _____ Heard _____ Written _____ Spoken

_____ ***Organizational/Based on Semantic Framework***

_____ Semantic Map/Semantic Network
_____ Semantic Feature Analysis
_____ Categorization/Classification
_____ Analogies
_____ Examples/Non-Examples
_____ Synonyms/Antonyms
_____ Homophones
_____ Figurative Language
_____ Word Play

_____ ***Mnemonics***

_____ Paired Association
_____ Keyword Methods

_____ ***Structure***

_____ Roots & Affixes
_____ Compound Words
_____ Contractions
_____ Etymology/Derivation

Comments:

APPENDIX D2: Taxonomy of Methods for Teaching Vocabulary - Technical Features Used to Introduce or Reinforce Word Meaning

Continuation of evaluation of _____ *(vocabulary word)*

_____ *Animation(s)*

1.
2.
3.

_____ *Video clips* of related info. with voice-over incorporating target word

1.
2.
3.
4.

_____ *Sound components* (e. g., pronouncing word, reading text)

1.
2.
3.

_____ *Hyperlinks* to related information (i.e., semantic webbing capabilities)

1.
2.
3.

_____ *Ability to create one's own pathway through information*

1.
2.
3.

_____ *Ability to pause, repeat information, or replay video clips*

_____ *Hints or clues* related to word meaning via messages or characters.

1.
2.
3.

_____ *Multimodal presentation of information; combination of at least 2 elements:* speech, sound, visual, and tactile (e.g., dragging objects or writing)

1.
2.
3.
4.

_____ *On-line definition, glossary, or thesaurus*

1. sound capabilities?
2. exemplar sentence?

_____ *Other*

APPENDIX E: Coding - Vocabulary Teaching Strategies in Selected Software Products (Guidelines 1-5)

Guideline 1: Relate the New to the Known

Never used	If 0 words (out of 36) use this strategy.
Seldom Used	If 1-11 words (out of 36) use this strategy.
Occasionally Used	If 12-24 words (out of 36) use this strategy.
Frequently Used	If 25-35 words (out of 36) use this strategy.
Always Used	If 36 words (out of 36) use this strategy.

Guideline 2: Promote Active, In-depth Processing

2a: Association Processing:

Using the same parameters as Guideline 1, the number of target words that provide definitional information, synonyms,antonyms.

2b: Comprehension Processing:

Using the same parameters as Guideline 1, the number of target words that provide opportunities to apply new word knowledge to journals on-line games, and/or experiments.

2c: Generation Processing:

Using the same parameters as Guideline 1, the number of target words that provide opportunities to reflect on new word knowledge and apply it to a novel context or to another domain (e.g., art, writing, music).

Guideline 3: Provide Multiple Exposures

Never used	If only one entry point for learning target words is provided.
Seldom Used	If 2 entry points for learning target words are provided.
Occasionally Used	If 3-4 entry points for learning target words are provided.
Frequently Used	If 5-6 entry points for learning target words are provided.
Always Used	If 7 or more entry points for learning target words are provided.

Guideline 4: Teach Students to Be Strategic Readers

Never used	If 0 opportunities to practice strategic reading skills (e.g., skimming texts to find word meanings, using a glossary, creating a word web, applying morphemic analysis, using context clues) are offered.
Seldom Used	If 2 strategies are offered.
Occasionally Used	If 3 strategies are offered.
Frequently Used:	If 4 strategies are offered.
Always Used	If 5 or more strategies are offered.

Guideline 5: Promote Additional Reading

Never used	If children are encouraged to read books about related topics in 0 instances (on line).
Seldom Used	If children are encouraged to read books about related topics in 1 instance (on line).
Occasionally Used	If children are encouraged to read books about related topics in 2 instances (on line).
Frequently Used	If children are encouraged to read books about related topics in 3 instances (on line).
Always Used	If children are encouraged to read books about related topics in 4 or more instances (on line).

APPENDIX F: Ranking of Software Products According to Criteria Used in this Study

Title	Score	Group
Planetary Taxi	19	Indirect Approach
What's the Secret?	18	Indirect Approach
Multimedia Bug Book	17	Indirect Approach
Encyclopedia of Nature	16	Indirect Approach
Zurk's Rainforest Lab	16	Indirect Approach
Alien Tales	15	Indirect Approach
Ancient Lands	15	Indirect Approach
Way Things Work	14	Indirect Approach
Recess in Greece	12	Direct Approach
Schoolhouse Rock	12	Direct Approach
Word Attack 3	11	Direct Approach
Wrath of the Gods	11	Indirect Approach
Macmillan Dictionary	10	Direct Approach
Reading Search	8	Indirect Approach
Let's Explore the Farm	8	Direct Approach
Midnight Rescue	7	Direct Approach

Note: Rankings were calculated according to the evaluation forms found in Appendix A, Criteria for Evaluating Vocabulary Teaching Strategies in Selected Software Products. The points were counted as follow: 0 for *never*, 1 for *seldom*, 2 for *occasionally*, 3 for *frequently*, and 4 for *always;* thus a high rating indicates a product that adheres closely to the criteria used in this study.

ABOUT THE AUTHOR

Julie Wood, Lecturer in Education, Harvard Graduate School of Education is a researcher and instructor in education, specializing in both early literacy and technology in schools. She has taught elementary school and has developed educational products, both print and media-based, for teachers and children. Her areas of expertise include children's literacy development, the integration of new technologies into educational settings and teacher professional development in the use of technology. She is a cofounder of a summer Literacy Institute for struggling readers and writers in a charter school in Dorchester, Massachusetts, Director of the America Reads program at MIT, and a contributing editor for Instructor Magazine. Currently she is writing a book, *CyberKids: Struggling Readers and Writers and How Computers Can Help,* for Heinemann Publishers.

E-mail: woodju@gse.harvard.edu

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