

Thinkmap, Inc.

Benjamin Zimmer

SCIENCE OF LEARNING

Vocabulary.com takes advantage of the latest research in the science of learning to create an unprecedented resource for building vocabulary: it is the fastest and most efficient way to master new words.

How Vocabulary.com Uses the Science of Learning to Boost Vocabulary Instruction

Vocabulary.com takes advantage of the latest research in the science of learning to create an unprecedented resource for building vocabulary: it is the fastest and most efficient way to master new words. Vocabulary improvement helps students to read, write, speak, and think more effectively, and it establishes a scaffolding on which students can build comprehension. Vocabulary.com has been designed with an eye to expanding vocabulary size for every type of learner, making educational improvement a realizable goal for all. This is accomplished by an *adaptive* strategy to vocabulary instruction that is customized to the learner's particular needs. To this end, Vocabulary.com personalizes the learning process itself. The adaptive learning system uses a "big data" approach to make intelligent choices about what words a particular user needs to master, what questions to ask about those words, and when to ask the questions.

The adaptive learning system represents a breakthrough in the field of *computer-assisted language learning* (Levy 1997, Hubbard 2009). The development of the interactive online learning interface makes cutting-edge research in the field available as a practical application for educators to use in differentiated instruction, allowing student advancement in vocabulary instruction both inside and outside the classroom.

The Technology Behind Vocabulary.com — And Why It Works

Research on vocabulary acquisition has shown that students require repeated exposure to words that they are learning, with the words presented incrementally and in a variety of contexts. By seeing how a word is used according to its different senses, students can then understand how the word functions in new contexts (Nagy, Herman & Anderson 1985).

Vocabulary.com is specifically designed to provide this kind of incremental exposure to words and their meanings, focusing only on the words that a student needs to learn and working on those words, with a variety of questions, until the student achieves mastery. There are five main technological innovations that make this possible.

Adaptive learning:

Vocabulary.com quickly adapts to the level of the user by means of item response theory (IRT), so that the learner's time is not wasted by vocabulary items too far above or below his or her proficiency. IRT is the central model in computerized adaptive testing (currently used in the US for such standardized tests as the GRE and GMAT), and it allows appropriate questions to be presented to test-takers, zeroing in quickly to their skill level based on their successive responses. For such an approach to work effectively, a large pool of questions must be continually calibrated, scored according to difficulty and

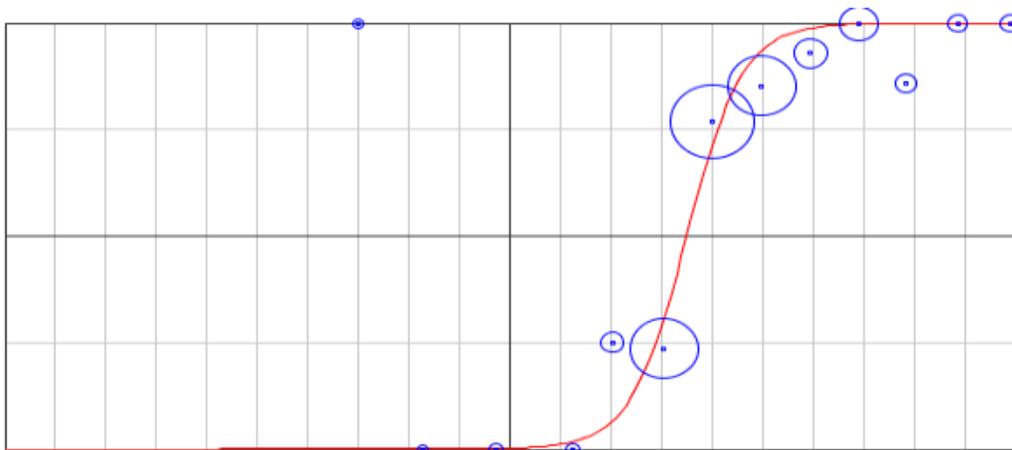
discrimination (i.e., how well a question discriminates between users of different ability levels). Vocabulary.com has an ever-increasing pool of questions numbering more than 100,000, and the voluminous user data collected over millions of sessions provides accurate models for the appropriate questions to present to a vocabulary learner at any given time.

For each question, a graph is generated to plot the distribution of right and wrong answers across different ability levels, and a curve is drawn to fit the data. A curve that rises very steeply indicates that a question is a good discriminator, accurately separating higher levels from lower levels of user proficiency. Below is an example of a highly discriminating question for the word *exuberant*. (Users' ability levels are plotted on the x-axis and the frequency of correct answers on the y-axis.)

The serenity of the fifth movement Andante is in stark contrast to the whirlwind of the _____ finale.

Source: New York Times

<input checked="" type="radio"/> exuberant	Look Up
<input type="radio"/> equitable	Look Up
<input type="radio"/> indisputable	Look Up
<input type="radio"/> dormant	Look Up



Such question graphs are continually redrawn to incorporate new player data, so that each question can be dynamically re-calibrated to assess its difficulty and discrimination as it is answered by more and more users.

Spaced repetition

The principle of spaced repetition is used by Vocabulary.com as an effective method of reinforcing vocabulary knowledge. When the adaptive learning process has pinpointed vocabulary items that the learner needs to master, Vocabulary.com continues to present questions on those items, spaced over time to ensure proper review of those items so that the user can commit them to memory. The key to spaced repetition is that students are re-exposed to information about a word so that its meanings become more fixed mentally. The technique of “retrieval practice” further reinforces learning of vocabulary items, repeating questions to strengthen memory. One experiment found that language learners who studied vocabulary words using the retrieval practice strategy remembered 80 percent of the studied words, compared to about a third of studied words remembered by learners using more conventional study methods (Karpicke & Roediger 2008, Paul 2011).

Variety of questions and contexts

Successful vocabulary learning requires exposure to a wide variety of usage contexts in order to build word knowledge that is rich and flexible. Understanding how words work in a broader linguistic framework has been shown to provide vital cues in understanding meaning as students encounter new words (Beck, McKeown, & Kucan, 2008). For that reason the pool of Vocabulary.com questions encompasses not only definitions for different word senses but also synonyms, antonyms, and example sentences drawn from our ever-growing corpus of texts, ranging from classic literature to the latest news sources. Appreciating real-world usage of words encourages deeper learning, allowing newly learned words to join a student’s active vocabulary (Miller 1999; Nagy, Anderson, & Herman 1987).

The rich resources of the Vocabulary.com Dictionary provide further contextual information on words, going far beyond traditional dictionary definitions. Word pages in the Vocabulary.com Dictionary feature more conversational explanations of words in addition to typical definitions, along with audio pronunciations, “word families” of inflectionally and derivationally related forms (indicating relative corpus frequency for each form), and corpus example sentences arranged by genre and topic. By integrating such lexicographical resources into the Vocabulary.com adaptive learning system, vocabulary learners are encouraged to dig deeper into words and their meanings, opening up new opportunities for enriched learning beyond the vocabulary questions themselves.

Gamification

The game mechanics of Vocabulary.com keep learners intensely engaged, as awards and achievements offer incentive to continue play. The enjoyable nature of the game play encourages longer and more frequent sessions, a key to successful learning over time. Teachers and students alike have characterized learning on Vocabulary.com as a fun and addictive experience. Since repeated exposure is key to retaining knowledge of new words, we strive to make the Vocabulary.com interface an environment that students will want to return to on their own accord and spend time accumulating points, badges, and achievements. Leaderboards provide added incentive, encouraging students to keep playing to maintain a competitive edge.

Customization

Learning on Vocabulary.com is not only an *adaptive* experience (adjusting automatically to the learner's proficiency) but an *adaptable* one (open to user customization). Users can create their own custom-made vocabulary lists to study from and then learn those lists in the same gamified environment as the main Vocabulary.com Challenge. This also allows teachers to focus on those vocabulary items that are appropriate to their students' particular needs. A learning environment that is both adaptable and adaptive can lend itself to vocabulary instruction in a way that transcends static flash cards and the rote memorization of word lists.

How Vocabulary.com Makes a Difference, Inside and Outside the Classroom

I've been teaching over 20 years and I've tried so many different things, on the computer and off. Our kids tend to struggle with word learning these days because they don't read as much as we used to. It's an area of need, but how do you do it without reading? Then I thought of Vocabulary.com... I've enjoyed the way the words are presented and the game quality that keeps you going. I knew there was the capability of making your own list. When I saw how easy it was, I thought, Why not try this?

— Deborah Ryles, English teacher, Correia Middle School, San Diego, CA

I'm excited. I really didn't think that I'd ever find anything that worked, but Vocabulary.com is everything that I've always wanted: it engages my students, it is dynamic, it leads to understanding by explaining word definitions, it champions retention by constantly revisiting words, and, perhaps most importantly, it's fun. The kids are beginning to look at words in a different light; a new culture of excitement has been formed around introducing classmates to an impressive or hilarious word.

— Daniel Spacher, English teacher, Red Jacket Middle School, Shortsville, NY

The “behind the scenes” proprietary technology of Vocabulary.com is designed to bring the science of learning to students and educators in a practical way, integrating with new pedagogical approaches and curricular requirements. We recognize that teachers have limited classroom time to devote to vocabulary instruction, but small investments in improving student vocabulary can reap large rewards in improving student comprehension and literacy across all disciplines. Research has shown that differences in students' vocabulary levels correlate strongly with their academic achievement (Baumann

& Kameenui 1991), and for this reason Vocabulary.com can serve as a vital tool in an educator’s arsenal for improving achievement levels for all students.

Currently, most school environments are unable to teach vocabulary effectively and systematically, despite the obvious benefits of vocabulary instruction (Hirsch 2013). Researchers have determined that the optimal way to learn vocabulary is through a systematic approach that complements curriculum, and that students should focus on the words that they are encountering and that are at their skill level. Doing so in the school environment is time consuming, however, and may not be possible with typical school resources.

Because students come into the system with differing abilities, educators often end up “teaching to the middle.” Such an undifferentiated approach means that some students will already know the words being taught, while others will find the vocabulary instruction to be too advanced. The lack of systematic review also presents a hindrance to efficient teaching. This is an acute problem in terms of the curriculum for a given class and even more so for long-term student preparation for standardized tests and entrance exams. Considering that students need to learn thousands of words before graduating, there is simply not enough time to teach vocabulary using traditional pedagogical methods such as workbooks and flashcards.

Through its adaptive learning system, Vocabulary.com can develop and refine individual learning roadmaps for each student, a key requirement of effective *differentiated instruction* (Levy 2008). Every activity on Vocabulary.com further increases our understanding of student skills, and the data that we collect and analyze can then be used to determine the appropriate activities presented to students according to their ability levels. Despite the simple user interface of Vocabulary.com, there are thousands of sophisticated calculations that happen every time a student interacts with the site. This information is combined with the data that we have collected from over 100 million questions answered, and as a result, the overall experience for students is always improving.

I like that it differentiates learning. Some of my English learners are writing all of the words on the list down. Some are writing just 10. If by some chance you know all 10, you have to find 10 more in the reading that you don’t know. It’s self-governing.

— Deborah Ryles, English teacher, Correia Middle School, San Diego, CA

Being able to speed up vocabulary is great because they [the students] can do this on their own, and it self-differentiates.

— Marc Ginsberg, English teacher, Cedar Shoals High School, Athens, GA

Because Vocabulary.com can provide differentiated instruction to match individual student needs, educators can then devote their classroom time to teaching the subject matter without having to interrupt it with undifferentiated vocabulary instruction. Vocabulary.com is designed to be used as part of a teacher's everyday curriculum and instruction, but it can also be used independently by students with teacher support as part of a *blended learning system* (Thome 2003).

It took my students about a minute and a half to create their own user names, and then they were out of the gates running. The points started stacking up and the badges began to appear, and then, like a swarm of bats, my kiddos instinctively explored every crevice available. One of my girls discovered that you can search through and subscribe to specific word lists, and then her friend announced that you could make your own word lists... The real surprise, though, was when I saw the students' stats the following day; they had signed in to this site when they got home.

— Daniel Spacher, English teacher, Red Jacket Middle School, Shortsville, NY

As a blended learning tool, Vocabulary.com allows teachers to focus their efforts in the classroom on teaching the subject matter, whether that is literature, social studies, or science. As long as students are using Vocabulary.com, the teacher won't have to resort to time-wasting worksheets, busy work, or rote memorization.

A further benefit of Vocabulary.com is that students can preview the vocabulary before studying a particular text, such as a novel or speech, and Vocabulary.com will flag the words that present the most difficulty to students. Thus, teachers can focus class time on only those words that students have trouble with, ensuring that students can navigate their meanings to ensure a fuller comprehension of the text.

We tried introducing a list to [students] as just the words. I wanted them to find meanings and draw graphics to go with each word, but it turned out to be very intensive and I wondered how much were they really learning or using. Now, we've decided to introduce the lists on Vocabulary.com first, so they can sift out the words they're having trouble with. Then we have them do the work on just those words on their own. They pick words from the list that they feel they most need to study.

— Deborah Ryles, English teacher, Correia Middle School, San Diego, CA

The latest [Common Core State Standards](#) recognize the importance of providing this type of scaffolding for students, with vocabulary at the center of improving literacy and comprehension. Vocabulary.com is

committed to making this scaffolding available to all students and giving teachers the requisite tools to expand their students' vocabulary in the most efficient and engaging way possible.

From the very first day the students and I worked with Vocabulary.com, I noticed an invigorated, buzzing energy in my classroom. When I walked in at 8 a.m., two students were comparing the points they'd accumulated thus far... They even laughed about the explanations of specific words... I certainly didn't recall this rollicking cheer in vocabulary review sessions of the past.

Perhaps the most surprising outcome was the empowerment my students gained through the site. They clearly felt in control of their own independent learning process... I introduced Vocabulary.com simply to give a face-lift to my tired vocabulary instruction. I hadn't anticipated my students would "unlock" the ultimate achievement in the process: delight and power through word learning.

— Sara Walsh, English teacher, EF International Academy, Tarrytown, NY

How Vocabulary.com Provides Formative Assessment

Traditionally, vocabulary instruction has been built around *summative assessment*: evaluating student achievement based on a final exam at the end of a unit, or on an entrance exam or other standardized test. Summative assessments offer no feedback or follow-up. However, educational experts have recently stressed the importance of providing *formative assessment* in the language arts classroom, so that students can be evaluated individually on an ongoing basis in order to direct future learning (Benjamin 2008).

Vocabulary.com places this type of flexible, ongoing assessment at the front and center of the educational process. From the perspective of students engaged in question-answering, Vocabulary.com appears to them as game-play, but it is game-play that is continuously evaluating the students' progress. As they answer questions, students get immediate feedback about their word knowledge. The application keeps track of students' trouble words, making it possible for students to see a list of those words and review them.

Even more significantly, these trouble words are highlighted for teachers as well. Through Vocabulary.com's tracking tools for educators, teachers see not only how much work the students have completed, but also which words are especially challenging to master, so that they will know which words to focus on during class time.

The data tools that Vocabulary.com provides to educators make it possible for teachers to track the progress of their students in real time as they work their way through differentiated learning programs. Being able to monitor student progress in this fashion transforms vocabulary learning into a system that accurately and efficiently responds to student needs. Such accountability is a key to ensuring that

students, regardless of their background or learning style, will build toward success in their vocabulary growth.

References

- Baumann, J. F., & Kameenui, E. J. (1991). Research on vocabulary instruction: Ode to Voltaire. In J. Flood, J. M. Jensen, D. Lapp, & J. R. Squire (Eds.), *Handbook of research on teaching the English language arts* (pp. 604–632). New York, NY: Macmillan.
- Beck, I. L., McKeown, M. G., & Kucan, L. (2002). *Bringing words to life: Robust vocabulary instruction*. New York, NY: Guilford.
- Beck, I. L., McKeown, M. G., & Kucan, L. (2008). *Creating robust vocabulary: Frequently asked questions and extended examples*. New York, NY: Guilford.
- Benjamin, A. (2008). *Formative assessment for English language arts: a guide for middle and high school teachers*. Larchmont, NY: Eye on Education.
- Herman, P. A., Anderson, R. C., Pearson, P. D., & Nagy, W. E. (1987). Incidental acquisition of word meaning from expositions with varied text features. *Reading Research Quarterly*, 22, 263–284.
- Hirsch, E. D. (2013). A wealth of words. *City Journal* 23.1, Winter. Manhattan Institute.
- Hubbard, P., ed. (2009). *Computer assisted language learning: Critical Concepts in Linguistics, Volumes I-IV*. London & New York: Routledge.
- Karpicke, J. D., & Roediger, H. L. (2008). The critical importance of retrieval for learning. *Science*, 319, 966–968.
- Levy, H. M. (2008). Meeting the needs of all students through differentiated instruction: Helping every child reach and exceed standards. *The Clearing House*, 81(4), 161-164.
- Levy, M. (1997). *Computer-assisted language learning: context and conceptualization*. Oxford: Oxford University Press.
- Miller, G. A. (1999). On knowing a word. *Annual Review of Psychology*, 50, 1–19.

Nagy, W. E., Anderson, R. C., & Herman, P. A. (1987). Learning word meanings from context during normal reading. *American Educational Research Journal*, 24, 237–270.

Nagy, W. E., Herman, P., & Anderson, R. C. (1985). Learning words from context. *Reading Research Quarterly*, 20, 233–253.

Paul, Annie Murphy (2011). The trouble with homework. *New York Times*, Sunday Review, Sep. 10.

Thome, K. (2003). *Blended learning. How to integrate online and traditional learning*. London: Kogan Page.