THE SENIOR URBAN EDUCATION RESEARCH FELLOWSHIP SERIES

WordSift: Supporting Instruction and Learning through Technology in San Francisco

Kenji Hakuta

Council of the Great City Schools

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THE COUNCIL OF THE GREAT CITY SCHOOLS

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The Council of the Great City Schools is the only national organization exclusively representing the needs of urban public schools. Founded in 1956 and incorporated in 1961, the Council is located in Washington, D.C., where it works to promote urban education through legislation, research, media relations, instruction, management, technology, and other special projects.

TABLE OF CONTENTS

FIGURES

OVERVIEW

THE SENIOR URBAN EDUCATION RESEARCH FELLOWSHIP PROGRAM

Large urban public school districts play a significant role in the American education system. The largest 65 urban school systems in the country – comprising less than one half of one percent of the nearly seventeen thousand school districts that exist across the United States – educate about 14 percent of the nation's K-12 public school students, approximately a quarter of its economically disadvantaged students, a third of its African American students, a quarter of its Hispanic students, and a third of its English Language Learners.[1] Clearly, any attempt to improve achievement and to reduce racial and economic achievement gaps across the United States must involve these school districts as a major focus of action.

These school districts face a number of serious, systematic challenges. To better understand the problems in urban education and to develop more effective and sustainable solutions, urban districts need a program of rigorous scientific inquiry focusing on what works to improve academic outcomes in the urban context. Moreover, in order to produce such evidence and to move public education forward generally, the standards of evidence in education research must be raised in such a way as to bring questions regarding the effectiveness of educational interventions and strategies to the fore and to promote careful scrutiny and rigorous analysis of the causal inferences surrounding attempts to answer them.

It has been argued that, in order to move such an effort forward, a community of researchers, committed to a set of principles regarding evidentiary standards, must be developed and nurtured. We contend further that, in order to produce a base of scientific knowledge that is both rigorously derived and directly relevant to improving achievement in urban school districts, this community of inquiry must be expanded to include both scholars and practitioners in urban education.

Though a great deal of education research is produced every year, there is a genuine dearth of knowledge regarding how to address some of the fundamental challenges urban school districts face in educating children, working to close achievement gaps, and striving to meet the challenges of *No Child Left Behind.* Moreover, while there is a history of process-related research around issues affecting urban schools, relatively few studies carefully identify key program components, document implementation efforts, and carefully examine the effects of well-designed interventions in important programmatic areas on key student outcomes such as academic achievement. In sum, there is an absence of methodologically sound, policy-relevant research to help guide practice by identifying the conditions, resources, and necessary steps for effectively mounting initiatives to raise student achievement.

In order to address this need, the Council of the Great City Schools, through a grant from the Institute for Education Sciences, established the Senior Urban Education Research Fellowship (SUERF) program.

The Senior Urban Education Research Fellowship was designed to facilitate partnerships between scholars and practitioners focused on producing research that is both rigorous in nature and relevant to the specific challenges facing large urban school districts. We believe such partnerships have the potential to produce better, more practically useful research in at least three ways. First, by deepening researchers' understanding of the contexts within which they are working, the program may help them maximize the impact of their work in the places where it is needed the most. Second, by helping senior staff in urban districts become better consumers of research, we hope to increase the extent to which the available evidence is used to inform policy and practice, and the extent to which urban districts continue to invest in research. Third, by executing well-designed studies aimed at the key challenges identified by the districts themselves, we hope to produce reliable evidence and practical guidance that can help improve student achievement.

[1] Council of the Great City Schools (2010). *Beating the Odds: An Analysis of Student Performance on State Assessment and NAEP.* Results from the 2008-2009 School Year. Washington, DC.

The primary goals for the Senior Urban Education Research Fellowship are to:

- promote high quality scientific inquiry into the questions and challenges facing urban school districts;
- facilitate and encourage collaboration, communication, and ongoing partnerships between senior researchers and leaders in urban school districts;
- demonstrate how collaboration between scholars and urban districts can generate reliable results and enrich both research and practice;
- produce a set of high quality studies that yield practical guidance for urban school districts;
- contribute to an ongoing discussion regarding research priorities in urban education; and
- promote the development of a "community of inquiry", including researchers and practitioners alike, committed to both a set of norms and principles regarding standards of evidence and a set of priorities for relevant, applied research in urban education.

The SUERF program benefitted greatly from the guidance and support of a Research Advisory Committee made up of experts and leaders from large urban school districts and the education research community. The committee included Dr. Katherine Blasik, Dr. Carol Johnson, Dr. Kent McGuire, Dr. Richard Murnane, Dr. Andrew Porter, and Dr. Melissa Roderick. This extraordinary group helped to identify and define the objectives and structure of the fellowship program, and we thank them for lending their considerable insight and expertise to this endeavor.

The following volume of the Senior Urban Education Research Fellowship Series documents the work of Dr. Kenji Hakuta, working in collaboration with the San Francisco Unified School District under the auspices of the Strategic Education Research Partnership (SERP). Both the research and reporting is the sole intellectual property of Dr. Hakuta, and reflects his personal experience and perspective as an education researcher working in collaboration with SFUSD.

Dr. Hakuta's work developing and piloting the *WordSift* tool in San Francisco makes an important contribution to the growing field of instructional technology. In recognition of the role academic language plays in student achievement, he has designed this tool as a resource for content area instructors, helping them to become teachers of the academic language of their discipline. The need to support and advance academic literacy instruction across the curriculum is a fundamental challenge facing researchers and educators alike, and technology and innovation will likely play a significant role in our efforts to reform and improve. We hope you will find this report both interesting and relevant to your own work in urban education.

Thank you.

Michael Casserly
Executive Director
Council of the Great City Schools

ABOUT THE SENIOR URBAN EDUCATION RESEARCH FELLOW

Kenji Hakuta is the Lee J. Jacks Professor of Education at Stanford University. An experimental psycholinguist by training, he is best known for his work in the areas of bilingualism and the acquisition of English in immigrant students. He is the author of numerous research papers and books, including *Mirror of Language: The Debate on Bilingualism and In Other Words: The Science and Psychology of Second Language Acquisition.* He chaired a National Academy of Sciences report *Improving Schooling for Language-Minority Children,* and co-edited a book on affirmative action in higher education, *Compelling Interest: Examining the Evidence on Racial Dynamics in Higher Education.* Hakuta is also active in education policy. He has testified to Congress and other public bodies on a variety of topics, including language policy, the education of language minority students, affirmative action in higher education, and improvement of quality in educational research. He has served as an expert witness in education litigation involving language minority students. Hakuta received his BA Magna Cum Laude in Psychology and Social Relations, and his Ph.D. in Experimental Psychology, both from Harvard University. He has been on the faculty at Stanford since 1989, except for three years (2003-2006) when he helped start the University of California at Merced as its Founding Dean of Social Sciences, Humanities and Arts. He is an elected Member of the National Academy of Education, Fellow of the American Association for the Advancement of Science (Linguistics and Language Sciences), and Fellow of the American Education Research Association.

ABOUT THE RESEARCH PARTNERSHIP

THE STRATEGIC EDUCATION RESEARCH PARTNERSHIP

This work was conducted in the context of a larger research partnership at the San Francisco Unified District organized by the Strategic Education Research Partnership (SERP). SERP was conceived and incubated at the National Academy of Sciences, and began operating as an independent institute in 2005. Its ambitious mission is to create an infrastructure for problem-solving research, development, and implementation in education. The SERP partnership model is unique in several respects:

- ***The SERP model assumes that the development and maintenance of effective partnerships between researchers and practitioners is itself a form of expertise that must be developed and nurtured over time.*** Knowledge and experience must be accumulated regarding the trajectory of trust building, and the negotiation of agendas. Policies and practices must be developed that place the district in the lead on defining problems for attention, and researchers in the lead on designing research. It must nurture a sense of shared responsibility for designing approaches to improvement. Expertise must be developed on the types and frequency of interaction required for sustained commitment to the partnership, the participants who must be at the table to support progress, the sources of competing attention that must be taken into account, and the predicable obstacles that can derail the effort or diminish its productivity. Thus, a major SERP role is forming and maintaining researcher-district relations.
- ***The SERP model assumes that a third party organization charged with coordination can ensure the goals of the partnership are primary at all times.*** There are strong incentives for both researchers and education practitioners to respond to pressures and rewards in their own institutional and professional contexts. And if university researchers or school district administrators fail in the collaborative effort, their primary source of professional identity is largely unaffected. A coordinating organization fails if the collaboration fails, creating incentives to persist through the most difficult challenges, and search for solutions that will strengthen the long run prospects of the collaboration.
- ***The SERP Model assumes that building a knowledge base will require an active effort to link sites–not just a sharing of information, but a reshaping and retesting of ideas.*** The coordinating SERP organization takes on responsibility for ensuring that each new site has access to the research tools and instruments developed in other sites, and that knowledge and experience that emerge from one site, as well as the interventions and tools developed, are actively carried to other sites.

SERP AND THE SAN FRANCISCO UNIFIED SCHOOL DISTRICT

The existence of the SERP-San Francisco field site within the San Francisco Unified School District (SFUSD) was crucial to the development and initial testing of *WordSift*. The SERP partnership with the district began in January 2007, and the primary focus of the SERP-SFUSD work during the period of this project was defined as addressing the achievement gap in middle schools, especially in math and science, and the language and literacy needed to support the closing of the gap. The problem was defined through the District's recognition that its gap between high- and low-achieving students is among the highest in California urban districts, and that much of the low end of the achievement spectrum was due to the performance of African-American and Latino students.

The SERP work in science and science literacy is built on the premise that narrowing that gap will require a high level of specificity regarding what students who do well in science know, and what those who do poorly need to know. The work makes a further assumption that much of what is taught is not critical to mastery of the core ideas, and that progress in narrowing the gap will require the identification of a subset of "core concepts" that should be given intensive focus in all classrooms. Finally, it is assumed that teachers need a set of tools and instructional strategies to teach this core content and monitor student learning effectively.

Over the past two years through these SERP activities, the science co-developer teachers, district supervisors and administrators, and researchers have moved toward a system of knowledge and trust-building that begins to address these important issues in instruction and assessment. Through work with the Berkeley Evaluation & Assessment Research Center (BEAR) at University of California at Berkeley, (Mark Wilson, Director), the co-developers have created explicit progress maps in a number of domains of science instruction in the 6th and 8th grade that correspond to learning progressions for students.

In this context, a group of us working on the language characteristics and demands of the curriculum have elevated teacher awareness of these issues and taken the first steps in addressing these gaps. Professor David Pearson and Post Doctoral fellow Marnie Nair from University of California at Berkeley participated in the initial work in identifying language needs. Karen Thompson, a graduate student from Stanford, provided early analysis of the linguistic complexity of the science textbooks being used. *WordSift* was created as part of this effort, to help address the recognition that teachers of science needed tools help to become teachers of the academic language of their discipline.

The costs of developing and piloting this tool were covered by grants to SERP and the present fellowship grant from the Council of Great City Schools through the Senior Urban Research Fellowship Program, funded by IES, from 2007 to 2009. The previously established relationship with the SFUSD administration and with the instructional leaders in SFUSD schools made possible a highly collaborative process for developing *WordSift*, which included tool design and developing uses for teachers and students. SERP has supported the use of this tool with the current group of teacher co-developers, having them use the tool in 6 collaborating schools, collecting and processing feedback from teachers in those schools, and incorporating the feedback into the design of the tool.

SERP played a key role in the work described here. SERP has built a strong framework to facilitate communications between the practitioners in SFUSD and the research team so that there is a regular feedback loop between the district and the researchers. These include period meetings focused on the design nature of the research and practice work, as well as subject-specific working groups that oversee the direction and progress of the research work. In addition, a core team of district and research leaders meets regularly to discuss the needs of district and the progress of ongoing research efforts. The core team provides the general guidance and permission for work within the school district so that the research work is pertinent to the needs of the teachers and principals and aligned to the goals of the district strategic plan.

EXECUTIVE SUMMARY

In developing a tool to help address academic language development, the team began by identifying the challenges of presenting science text to English Language Learners and students who struggle with reading. The goal was to balance the practical and logistical challenges of identifying, teaching, and learning academic and content vocabulary with the opportunities posed by web-based visualization technologies. For example, content area teachers do not always feel comfortable teaching language and vocabulary, and may require instructional prompts and examples of sentences in which specific vocabulary appear to scaffold their role as language teachers.

We involved teachers early on in this development process, and through a series of co-developer meetings with a panel of science teachers in the San Francisco Unified School District, endeavored to create a truly teacher-centric instructional tool. We also confronted the realities of the urban school setting, where resources are often a challenge and teachers vary in their experience and comfort level with classroom technology.

The result was *WordSift*, a web-based interface that creates a visual, interactive representation of selected text. Based on any English text entered into a "copy and paste" box, *WordSift* rapidly returns a visual display—or Tag Cloud-- that displays the top 50 words in alphabetical order, with the relative frequency of each word indicated by text size. The order of words in the cloud can be rearranged dynamically in a number of ways, including by frequency in the English language, by those most commonly appearing in subject matter areas, and by those belonging to various academic word listings or glossaries. *WordSift* also produces related Google Image and Video Searches, a Visual Thesaurus® display, and example sentences.

Through regular meetings with our panel of teacher collaborators, a number of potential uses of *WordSift* were identified as useful to support instruction for teachers and reading comprehension for students. These included lesson preparation, the development of group activities for teachers, and the ability to preview text and access additional literacy support for students. *WordSift* was launched to the public on January 15, 2009. Usage statistics and teacher reviews of *WordSift* are discussed briefly in Section II.

In addition to developing *WordSift* and looking at how it could be applied in the classroom, our effort also extended to the development of research to evaluate the effectiveness of *WordSift* on student reading comprehension of science text. In the spring of 2010, we implemented a systematic study with the science co-developers to see whether previewing a science text with *WordSift* would improve the reading comprehension of their students relative to when they previewed text by other means. Early results suggest that the variation observed in reading comprehension assessment scores was not significantly related to differences based on exposure to *WordSift*, but rather to differences among characteristics of the students and the classes and schools in which they are enrolled.

Interestingly, gender appeared to significantly mediate the treatment effect, resulting in a significant negative treatment effect for girls and a slightly positive (though not significant) treatment effect for boys. For future iterations of the web-based vocabulary tool, we may choose to pilot test it specifically with girls to get their feedback about design and features that appeal to them.

Although disappointing, it is important to remember that this is just one implementation of *WordSift* (a whole-class demonstration, followed by a reading passage and overall comprehension of the text), and only a first attempt to investigate the tool's impact on learning. We discuss several avenues for future evaluation, including studying the use of the tool in classrooms with more English learners, looking at long-term vocabulary retention, and testing the effect of each of the different functions of *WordSift* individually.

In conclusion, we try to put our work developing, implementing, and evaluating *WordSift* into context. While this tool represents the potential instructional technology holds to transform classroom learning and advance academic vocabulary development, the two pillars of the project – language and technology – are really means to the end of access to subject matter content. To address this challenge, we need to build a culture in schools and districts where all teachers take responsibility for the language development of their students, and have access to the resources they need to approach this task. Districts and researchers alike would also benefit from involving teachers as collaborators and key stakeholders in the process of identifying new, innovative classroom tools for increasing student achievement and engagement in learning.

INTRODUCTION

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ADDRESSING THE NEED FOR ACADEMIC LANGUAGE DEVELOPMENT

The power of vocabulary in predicting cognitive command of phonological, orthographic, and semantic processing as well as reading rates and other tasks are well documented (Nation & Snowling, 2004; Yang & Perfetti, 2006). Walter Kintsch's work on situation modeling from text also demonstrates the importance of higher order reading comprehension abilities and its relationship to vocabulary (Kintsch, 2086; Perfetti, Landi & Oakhill, 2005), while Catherine Snow and her colleagues have demonstrated increasing correlations between vocabulary scores and reading comprehension scores as student move from primary to secondary grades (Snow, Porche, Tabors & Harris, 2007).

The challenges of vocabulary are now fairly well mapped. By the middle school grades, students are expected to read and understand expository texts in various content areas with demanding vocabulary (Gardner, 2004). There is often a "Matthew effect," with the rich getting richer with respect to vocabulary and, ultimately, reading comprehension (Nagy & Anderson, 1984; Nagy & Herman, 1987; McKeown, 1985; Stanovich, 1986; Swanborn & de Glopper, 2002).

Fortunately, there is evidence that vocabulary instruction can have an important and lasting impact on student word learning (Beck, Perfetti & McKeown, 1982; Carlo et al, 2004). And while this is true for all students, it is especially true for English Language Learners.

Of special interest to researchers and educators seeking to address the challenge of academic literacy and vocabulary are academic words (Coxhead, 2000) that cut across subject matter areas (e.g., *affirm, interpret, deny, evidence, conclusion, theory, factor, process*) in contrast to subject-specific words such as *mitosis, plate tectonics or prepositional phrase.* These words are of special interest because they are unlikely to be identified in glossaries in many subject area textbooks, yet they are crucial for understanding the meaning of the text.

Other vocabulary categories of interest are subject-specific lists (e.g., Marzano & Pickering, 2005), such as Biemiller's list of "Words Worth Teaching," based on the work of Isabel Becks and her colleagues on the *Living Word Vocabulary* and his own empirical work identifying key words (Beck, McKeown & Kucan, 2002; Biemiller, 2005, 2006). With increased capacity for automated word frequency counts in an ever-increasing database of texts, there is now increased capacity in the field to target specific words for specific students, based on their backgrounds and the instructional subject area. Such lists enable explicit instruction of specific vocabulary in the context of content area instruction.

In addition to the challenges of academic vocabulary development, educators specializing in English Language Learners are faced with an even greater instructional challenge: a substantial group of students who are "stuck" at the intermediate level of English language proficiency, leading to labels such as long-term ELLs or "lifers". [2]

[2] These students most likely face similar challenges as students who are monolingual English-speakers (many speakers of non-Standard English) do, but accentuated by their classification as ELLs.

From a pedagogical viewpoint, an important key to addressing this problem lies in the realization that English language development for these students – while the primary responsibility of the ESL/ELD teacher or specialist, especially for ELL students in the beginning levels of English language development – needs to be an overarching objective for all teachers of English Language Learners – the so-called "mainstream" teachers in elementary school, or the subject area teachers in language arts, math, science, social studies, and electives in the secondary grades. Language development needs to occur in context, and content area learning provides the best context for it to occur.

But can we expect mainstream and content area teachers to take on this shared responsibility? Teacher practice is the product of a complex set of situations, beginning in teacher preparation programs (in which considerable separation of responsibilities for "mainstream" and "ELL students" take root) and the culture of the school created by its demographic composition, district expectations and the site leadership and professional support.

A key challenge is to help content teachers define a new identity for themselves – as a language teacher of their discipline.

Addressing this challenge of helping regular content teachers become effective teachers of academic language and vocabulary is the main goal of this project. Our work in San Francisco public schools addresses one of the greatest challenges facing educators of English Language Learners: how to grow and enrich the academic vocabulary of their students across the grade levels, and especially through academic content instruction. To this end, our goal is to provide language tools and strategies that can be easily embedded into their existing practice as content teachers.

PART I:
DEVELOPMENT OF A TEACHER-CENTRIC LANGUAGE DEVELOPMENT TOOL

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In developing a tool to help address this need for academic language development, the team began by identifying the challenges of presenting science text to English Language Learners and students who struggle with reading. In particular, the team focused on the practical and logistical tasks of identifying, teaching, and learning academic and content vocabulary.

For example, content area teachers do not always feel comfortable teaching language and vocabulary, and require instructional prompts and examples of sentences in which specific vocabulary appear to scaffold their role as language teachers. In addition, teachers rarely have time to read through whole science texts in preparation for a lesson and pick out the top academic or high frequency words, nor do they necessarily know what the academic words are in selected texts.

At the same time, students who identify unfamiliar vocabulary often turn to a dictionary or thesaurus for its definition. For English learners in particular, one of the strategies developed for Specially Designed Academic Instruction in English (SDAIE) is supporting vocabulary development through associating words with images and visualizations. Yet in both the traditional hardcopy and online formats, dictionary definitions are static, one-dimensional, and include phrases or sentences that may or may not support students' understanding of the word. Similarly, a thesaurus can confound students with static lists of words related to the original word but no more meaningful to the student. The dynamic nature of words, and the relationships to images, concepts, and other words can easily be obscured by these traditional formats.

The team endeavored to balance these types of student and teacher challenges with the opportunities posed by web-based visualization technologies. The result was *WordSift*, a web-based tool that creates a visual representation based on any English text entered into a "copy and paste" box, rapidly returning a visual display that allows the user to explore the text. There are other visual tools that have served as predecessors, including TagCrowd (http://tagcrowd.com/), Wordle (http://www.wordle.net/), and VocabGrabber (http://www.visualthesaurus.com/vocabgrabber/), but this is the only site that integrates web-based images and is developed from the very beginning with the objective of supporting K-12 teaching and learning.

Based on the idea and direction of the principal investigator, Kenji Hakuta, the website was produced by Greg Wientjes, a doctoral student in Stanford's Learning Design and Technology program. Two doctoral students with significant prior experience in teaching English Language Learners – Diego Roman and Karen Thompson – provided additional design support to make the site friendly to teachers.

The development process also benefitted greatly from a series of co-developer meetings with a panel of science teachers in the San Francisco Unified School District during the 2008-2009 school year. Initially, the teachers were asked for reactions and observations, and through a continuous feedback process, a number of potential uses of *WordSift* were identified as useful to support instruction for teachers and reading comprehension for students. For example, the initial version of *WordSift* only marked words from the Academic Word List, but teachers expressed a strong interest in having discipline-based words marked as well, a feature that was added.

We also confronted the realities of the urban school setting, where high quality LCD projectors were not uniformly available (some teachers, for example, had to print out the output onto overhead transparencies in order to share the WordSift output) and the bandwidth of computer labs was not sufficient for all students to simultaneously connect to the Internet. We also aimed to take into account the fact that teachers vary considerably in their comfort level with technology, which figured largely into the design principals we followed when creating the tool. Specifically, we aimed to maximize the uptake by a broad group of teachers by:

- **Keeping it simple,** with minimal clutter on the screen and maximum ease of use, requiring only the ability to browse, cut, and paste.
- **Maximizing the visual experience** by linking words in a visually appealing way with images.

- **Making it fast,** as long wait times are frustrating for both students and teachers and disrupt the flow of instruction.
- **Being interactive, spontaneous and engaging,** encouraging spontaneous talk, interaction and queries.
- **Being projector-friendly.** *WordSift* screenshots are designed to also yield functional screen projections for classrooms using a variety of projectors. This function has also served to remind us not to add a lot of clutter to the screen, as this would limit its horizontal size.
- **Creating a "wow!!!" sensation.** This may not sound very scientific, but we value this as the initial reaction of first-time users of *WordSift*, which is then followed by the interaction with the text that allows deeper processing of its meaning.

A Closer Look at the Design Features of WordSift

The easiest way for the reader to understand the features of *WordSift* would be to go online and try it out – http://www.WordSift.com. *WordSift* takes text that is pasted into the input box and creates the following displays:

Tag Cloud

A Tag Cloud of the top 50 words in the text, excluding function words (such as is, of, at, the – the full list of "stop words" that are blocked from the display can be found under Word Lists on the home page of WordSift). The words in the cloud are initially displayed in alphabetical order, and their relative frequency is indicated by text size. Singular and plural nouns are, for the most part, counted together. The order of words in the cloud can be rearranged dynamically by frequency in the English language by hitting the Common-to-Rare or Rare-to-Common button at the bottom of the cloud display. Currently, we use the word frequency list from Project Gutenberg because of its sheer size (it is the word frequency count from all books in Google's ambitious effort to make all books available online), although we are considering adding a list more targeted to textbooks.

Words in the cloud can also be marked as those most commonly appearing in subject matter areas. We have created an initial list from language arts, math, science and social studies. Words from the General Service List (GSL) and the Academic Word List (AWL) can also be marked. This dynamic quality allows the teacher or student to quickly see the key vocabulary in the text, look for low frequency words that could cause difficulty for the student, and identify key academic words.

This tag cloud solves several problems: it saves time for teachers in populating the top frequency text; it highlights targeted vocabulary types (the academic word list, the low frequency words, and subject-specific words) that are different from the subject area glossaries typically highlighted in textbooks; and it creates a quick way for the teacher to assess whether any key vocabulary words might present a challenge to their students.

Google Image and Video Searches

The results of Google searches are also displayed, automatically entering the two most frequent words as the search terms. The top 8 results from the images search are displayed. The search can be directly changed by entering or deleting words in the "Search" box in the panel. Also, clicking on any word in the tag cloud will automatically refresh the display with the search result for that word.

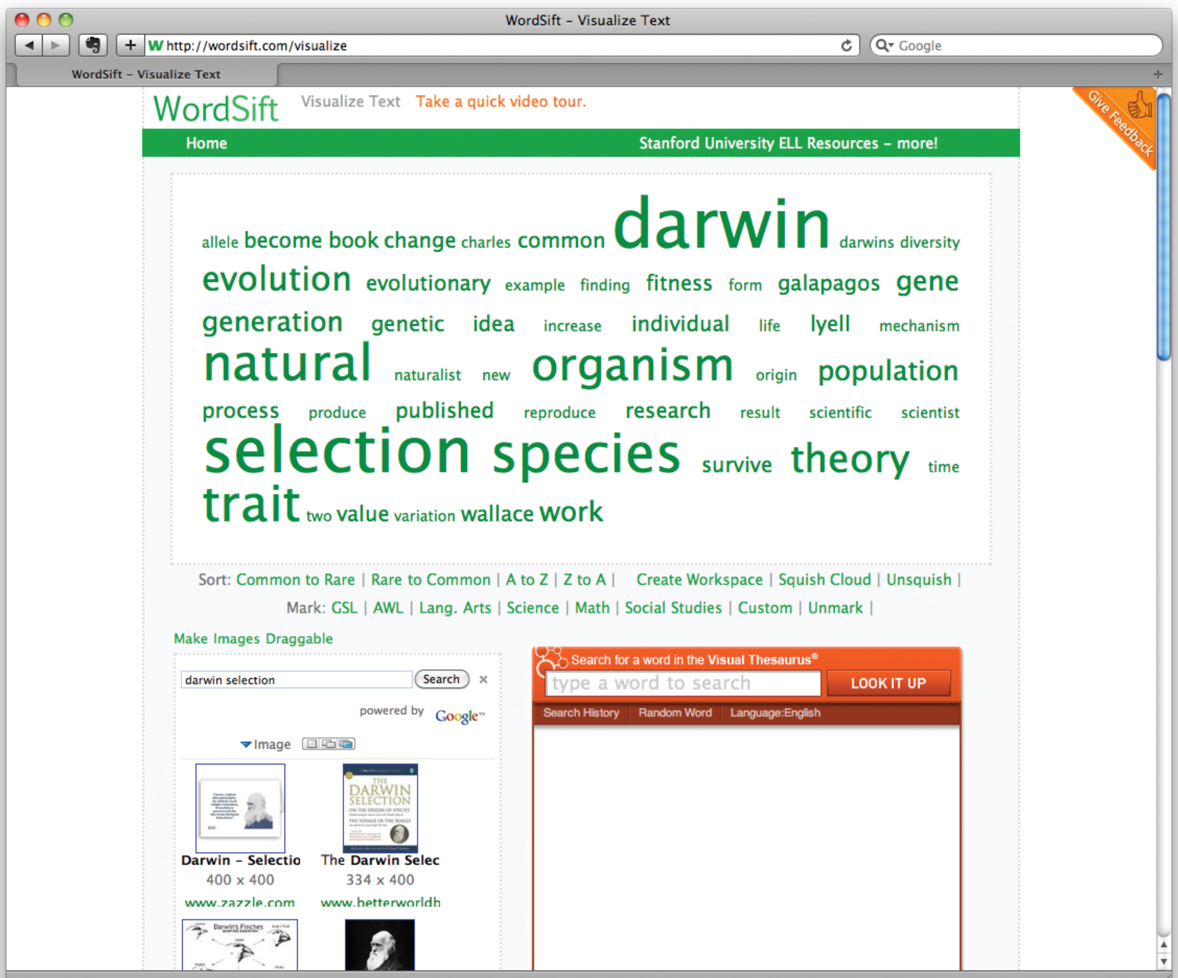
We have found that the image search frequently results in photos that are of very close relevance to the topic of the text. Even results that seem to be somewhat off base can be used as a way of talking about why the program might have chosen it. For example, Figure 1 demonstrates the results of a search on "Darwin and Evolution," which produced a cloud with "Darwin" and "selection" as the top two words, as well as pictures representing evolution. The teacher can use this to start a discussion about images that represent the concept of natural selection. Further refinement of the search can be made by typing in additional or different key words into the search box – changing it to "natural selection" gets more images that get closer to representations of the process of natural selection.

PART I: DEVELOPMENT OF A TEACHER-CENTRIC LANGUAGE DEVELOPMENT TOOL

The video results, meanwhile, are "hidden" and can be accessed by clicking on "Videos" below. This is because the images can be strictly filtered to avoid inappropriate content for students, whereas the videos are less predictable. Many school districts block YouTube, but this can be a very rewarding part of the exercise if the teacher can use it as a source of talk about language, rather than as a distraction. If teachers preview videos in an unblocked environment (such as at home or a different server at school) then they can download appropriate videos to show in class. We are currently exploring ways in which unblocked sites, such as TeacherTube and various public broadcasting websites, can be easily accessed on *WordSift*.

This function of Google Images and Video Searches provide additional supports for students so they are not confronted with only text definitions of vocabulary, but related visual representations of the vocabulary. Also, while abstract words may be difficult to display in images – words such as "respect" or "imagination," Google Images has developed a method through its Google Image Labeler that essentially creates a database of images that have strong association across a large number of individuals. This enables a discussion of abstract words using pictures, and students and teachers are able to talk about how people would have paired the abstract word with the resulting images.

FIGURE 1: SCREENSHOT OF THE RESULT OF WORDSIFT TEXT ANALYSIS



Visual Thesaurus®

he most frequent word is entered into the Visual Thesaurus ® and the result is displayed as a word web. The Visual Thesaurus is a product based on WordNet, a digital dictionary and thesaurus created by George Miller and his colleagues (Fellbaum, 1999). In *WordSift*, the free widget made available from the Visual Thesaurus is embedded (with permission). The VT widget displays the word, plus related words including antonyms and synonyms.

The Visual Thesaurus® display is interactive: the definition of each word on the display pops up when the cursor is scrolled over it, and a click on any word on the web re-configures the display to bring that word to the center. This display is just a sampler taken from the Visual Thesaurus® website and does not contain all of the other features available in the full product. By clicking on the full version, these additional features can be accessed.

One potentially useful feature enables the user to hear the word by clicking on the speaker icon next to the word. Another feature will provide an overlay of words from selected languages, including Spanish. It is a potentially powerful way of working with bilingual students on vocabulary development, particularly in identifying cognates, and it can be used to enhance development in both languages. Use of these full features is limited to approximately 7 attempts without purchasing the product. After that, going back to *WordSift* and re-initiating the open the full version button will refresh the function.

The VT creates an interactive platform for students to visualize the relationships between words. The sound feature on the full version of VT is also helpful in helping students hear the pronunciation of words, since most students (or adults, for that matter) have difficulty decoding the phonetic representation of words in regular dictionaries.

Example Sentences

Examples from the source text containing the most frequent word in the text is displayed under the Visual Thesaurus word web. The key word is marked in green. All relevant examples from the input text are listed.

One intended use of this feature is to organize the text to preview key vocabulary. This feature can quickly show different meanings of the same word so that, when presented with the full list of sentences from the text in which a given word appears, teachers can talk about the different sentence frames and about different nuances of the word. For example, in an article on climate change, here are two sentences that use "area": (1) Weather scientists project that the polar regions of the Northern Hemisphere will heat up more than other areas of the planet, and glaciers and sea ice will shrink as a result. (2) The area covered by sea ice during summer has declined by 15 to 20 percent in the last 30 years, and is projected to disappear almost completely late in the 21st century. The first meaning of area is "region" whereas the second meaning refers to a specific quantity, in terms of surface area. A look at "area" under in the Visual Thesaurus box shows that these are two of the major distinctive branches from the word.

Tailoring the Results

The Google results, the VT, and the Example Sentences are all dynamically linked to the word clicked on the tag cloud, enabling rapid exploration of the features of any word. We are presently working on a feature that would enable "drag-and-drop" capabilities into a workspace, so that words and images can be collected, saved, and printed. This would enable the teacher to create quick assessments, and for students to create quick outlines for writing assignments.

PART II:
IMPLEMENTATION AND PATTERNS OF USAGE

PART II: IMPLEMENTATION AND PATTERNS OF USAGE

As mentioned in the previous section, *WordSift* was developed through an extended collaboration with teachers and administrators from the San Francisco Unified School District (SFUSD) under the auspices of the Strategic Education Research Partnership (SERP). Our teacher collaborators included four 6th grade science teachers (Karen Clayman, Lisa Ernst, Patricia Kudritzki, and Stephie Prout) and five 8th grade teachers (Joel Austin, David Brody, Michael Fox, Sally Meneely, and Lisa Beth Watkins) supported by SFUSD Middle School Science Curriculum Specialist Deborah Farkas, Mathematics and Science Supervisor Jeanne D'Arcy, and SERP/SFUSD Assistant Director Tina Cheuk.

Teacher reviews of their participation in this process were obtained systematically for some sessions. The regular collaborative meetings resulted in the identification of some important uses for *WordSift*:

Lesson preparation: A teacher can use *WordSift* to review assigned text to identify challenging words or concepts prior to a lesson, and identify images and videos to use in class. The videos can be especially useful in the preview function since many schools do not allow access to YouTube, but a teacher can download useful videos (such as a science lab demonstration) onto his or her laptop computer from home.

Previewing text: In a whole class setting or individually, students can preview text. Reading comprehension research suggests that previewing text is a useful strategy for improving comprehension. Using *WordSift* to identify the key vocabulary and playing with the images and to use the example source sentence feature to "skim" the text can help students who might otherwise struggle with the complexity of the text.

Group activities: Teachers have found simple activities using small portions of *WordSift* useful. For example, one teacher has developed a simple routine in which she gives students the TagCloud, and has them working in small groups to write or draw a page using the words in the cloud. Another possibility would be to take the Visual Thesaurus display of a word web and have students identify and discuss related words.

Literacy support: Individual students can use *WordSift* as they read text, or as they write a response or summary. Adult users of *WordSift* have reported using *WordSift* for their own purposes to skim text (as one teacher said, "I don't skim, I sift") and also to review their own writing drafts.

Assessment: Whole-class vocabulary assessment can be done on-the-fly by showing the images from selected words, having them identify unfamiliar words, and having students talk about which picture is the best representation of a given word. Teachers can also tailor their own assessments by copying and pasting the images, words, and sentences identified by *WordSift* into a separate file (such as in Word or Powerpoint) and printing it out for student work.

Teacher evaluations were gathered at the end of each workshop to identify lingering questions and concerns. For example, it was quite clear that discipline-oriented teachers had some difficulty seeing the value of focusing on academic words rather than the words of their discipline, and this resulted in a clearer explanation of this distinction on the site as well as in our decision to list the words from each discipline on the main page of the sift results.

DISSEMINATION AND REVIEWS OF *WORDSIFT*

WordSift was launched to the public on January 15, 2009 through a distribution list of about 500 people in the field of education, primarily with interests in supporting ELL students. Since then, it has spread mostly through word of mouth, links from other websites, Twitter, and formal reviews in publications and websites. As of February, 2011, *WordSift* has had approximately 120,000 absolute unique visits, over 500,000 page views, with an average of longer than 3 minutes per visit. Predictably, the uses are higher on weekdays than on weekends.

The website has received attention through a variety of channels including the following (that have driven considerable traffic to us): The School Library Journal, AccELLerate from the National Clearinghouse for English Language Acquisition (which has also scheduled a featured Webinar presentation on *WordSift* on October 23, 2009), ASCD Express, and www.killerstartups.com that featured us on June 2, 2009, and I have had a steady stream of requests for permission to place screenshots on blogs.

We have had excellent reviews posted on our website through Kampyle, a feedback mechanism that attempts to sample 10% of our users. Out of over 500 responses we have received, the average response is over 4.5 on a scale of 5. Comments left on the site are also overwhelmingly positive. I have also received e-mail feedback, although this is more likely to be positively biased.

The main negative concern expressed by users had to do with potentially inappropriate pictures or videos that appear with respect to explicit violence or sexual content. We addressed this concern with a strong filter on Google Images, and we also removed the thumbnails from the video search results, which are less capable of being filtered. Since instituting those changes, we have not had any complaints about inappropriate materials, although we always encourage teachers to preview the materials whenever possible.

Most importantly, teachers appear to be maintaining their use of the tool, and many are playing an active role in the process of implementation. Most of the teachers we have been working with have volunteered to develop workshops for other teachers on uses of *WordSift*, and have suggested that they reach out to teachers in Social Studies as well as high school and upper elementary teachers. These teachers have also presented at the California Association for Bilingual Education, the California Science Teachers Association, and the upcoming annual meeting of the National Science Teachers Association.

PART III:

EARLY EFFORTS TO EVALUATE THE EFFICACY OF *WORDSIFT*

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In addition to developing *WordSift* and looking at how it could be applied in the classroom, our effort also extended to the development of research to evaluate the effectiveness of *WordSift* on student reading comprehension of science text. In the spring of 2010, we implemented a systematic study with the science co-developers to see whether previewing a science text with *WordSift* would improve the reading comprehension of their students. Through collaborative effort with the SERP co-developer teachers, we came up with an experimental design that was realistic in the context of their instruction. We describe the experimental study below.

THE EXPERIMENT

This experiment was spread out over two class sessions of approximately 50 minutes, and each student participant experienced both the treatment and control conditions. In the treatment condition, teachers led students in interacting with *WordSift*, into which a particular passage from a grade-level science textbook had been entered. Students completed a preview worksheet based on the *WordSift* display. Then students read the passage individually and answered a series of comprehension questions about what they read. In the control condition, teachers also led students in completing a preview worksheet for a science textbook passage, this time without the benefit of the *WordSift* display. Then, as in the treatment condition, students read the passage and answered comprehension questions about what they read. The texts and conditions were counterbalanced to eliminate text and order effects. Assignment to conditions occurred at the class level. All aspects of the experimental design process, from the selection of the textbook excerpts to the development of the comprehension assessments and scoring rubrics, were conducted collaboratively with the nine middle school teachers.

DATA SOURCES

Our analysis used assessment data from 479 students, for a total of 958 observations, nested within 19 classrooms of eight different teachers. Here we report results for the sixth grade assessment data, which consists of 394 observations nested within 197 students who are enrolled in eight different classes taught by four teachers.

Two assessments were designed, one for each of the two reading passages, one on fossil fuels and one on solar energy. Each assessment consisted of two open-response questions and two multiple-choice questions. Questions for the assessments were drawn from the science textbook itself, as well as from the suggestions of teachers and district content specialists. Each open-response question was scored on a four-point rubric, which was developed and refined over the course of repeated meetings with teachers. Multiple-choice questions were scored as correct or incorrect. These assessments were scored by teachers and researchers after a scoring calibration process including an inter-rater reliability check. Scores for assessment items one and two (the open-ended response items) were each converted to separate z-scores. Scores for assessment items three and four (the multiple-choice items) were summed, and this sum was also converted to a z score. We then checked the reliability of the three scales by computing Cronbach's alpha separately for each of the two assessments. For the fossil fuel assessment, Cronbach's alpha was 0.567, and for the solar energy assessment Cronbach's alpha was 0.672.

RESULTS

We analyzed the reading comprehension results using hierarchical linear modeling (HLM). HLM allows us to account for the nested structure of our data, since it makes no assumption that observations are independent. Since our data consists of observations (i.e. reading comprehension assessment scores) nested within students nested within class periods, we constructed a three-level HLM model.

First, to determine the portion of variability associated with each level – observations, students, and class periods – we constructed an unconditional HLM model, which indicated that 55% of the total variance in assessment scores is between students and between class periods (more specifically, 17% is between students and 38% is between class periods). Next, we added variables at the observation level: one that indicates whether a particular observation occurred with or without the treatment and another that indicated whether the observation occurred on day 1 or day 2 of the experiment. Then we entered student-level variables, controlling for gender and participation in gifted programs, as well as whether the student experienced the treatment on day 1 or day 2 of the experiment and which text the student read first.[3] Additionally, we checked whether these student-level variables mediated the treatment effect. Finally, we entered classroom-level variables, controlling for schools' standardized test scores and schools' ethnic diversity.

The HLM results suggest that WordSift did not have a significant effect on students' reading comprehension ($p > .05$).

Two student-level variables – gender and participation in the gifted program – were significantly related to students' reading comprehension scores.[4] HLM also allows us to enter classroom- and school-level variables, which indicated that schools' standardized test scores and schools' ethnic diversity also have a significant relationship with students' reading comprehension scores ($p < .001$). Thus, it appears that the variation we observed here in reading comprehension assessment scores is not significantly related to differences based on exposure to WordSift but rather to differences among characteristics of the students and the classes and schools in which they are enrolled.

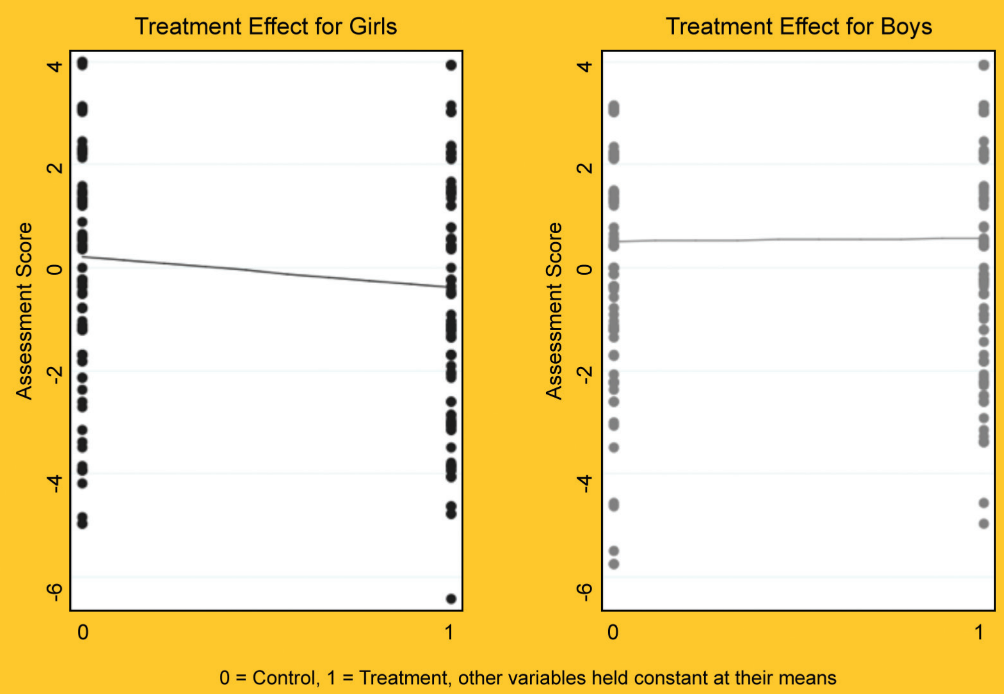
Interestingly, in the HLM model, gender significantly mediated the treatment effect, resulting in a significant negative treatment effect for girls and a slightly positive (though not significant) treatment effect for boys ($p > .05$). After controlling for the other observation-, student-, and school-level factors in our model, boys scored an average of .055 points higher on reading comprehension assessments after using *WordSift*. Girls, however, scored an average of .586 points lower after using WordSift. Prior research suggests that girls tend to experience and interact with educational technology differently boys and typically have less experience with and less positive attitudes towards computers. For future iterations of the web-based vocabulary tool, we may choose to pilot test it specifically with girls to get their feedback about design and features that appeal to them.

[3] The indicator variables for text order, treatment order, and assessment day were not significant in any of our models. Nonetheless, we retained these variables in our models to control away any possible variability associated with the design itself.

[4] Although we are particularly interested in the effect of the web-based vocabulary tool for English Langualge Learners, this sample of sixth graders contained only seven ELLs (3.6% of the sample), limiting our ability to detect treatment effects specific to this population. In future experiments, we will include classrooms with more ELLs.

PART III: EARLY EFFORTS TO EVALUATE THE EFFICACY OF *WORDSIFT*

FIGURE 2: EFFECT OF WEB-BASED VOCABULARY TOOL ON READING COMPREHENSION ASSESSMENT SCORES BY GENDER.



CONCLUSION AND NEXT STEPS IN EVALUATION PROCESS

Although the results of this particular experiment were not significant except for one possibly interesting finding regarding gender, it is important to remember that this is just one implementation of WordSift (a whole-class demonstration, followed by a reading passage and overall comprehension of the text), and only a first attempt to investigate the tool's impact on learning. The limited number of English learners in the sample analyzed here prevented us from fully exploring how the web-based vocabulary tool affects the reading comprehension of this population, and in future experiments we hope to include classrooms with more English learners.

Moreover, this particular evaluation was only designed to measure short-term vocabulary development, not retention. It may be that both the treatment and comparison groups did about equally well reading a passage and then answering questions, but future research would benefit from studying whether instructional technology such as the *WordSift* tool, which is designed as an interactive platform to engage students more fully in the learning process, has any differential long term impact on academic vocabulary retention.

Future evaluations may also be undertaken to determine whether *WordSift* shows an effect on students' reading comprehension when used in other ways. For example, does *WordSift* show an effect if students interact with it individually in a computer lab before reading? We may also investigate whether different lengths of interaction with *WordSift* produce different effects on reading comprehension. Each of the possible functions of *WordSift* can also be tested independently, and depending on the results, the usage as well as the website itself can be modified accordingly.

DISCUSSION

DISCUSSION

Over the course of our work developing *WordSift*, documenting its use in the classroom, and evaluating its impact on student learning, we were aiming to harness the power of web-based technology to transform the experience of classroom learning in content areas to include the meaningful development of academic vocabulary and literacy – particularly for English Language Learners. From the perspective of a researcher committed to finding innovative ways to support student learning, it is clear that research and investment in technology holds great potential as a means of improving academic achievement and student engagement.

Yet it is worth noting that that the two pillars of the project – language and technology – played the appropriate role of being the background rather than the foreground of the discussion, as they are really means to the end of access to core academic content. That is to say, one of the greatest challenges in addressing the needs of students in general, and English Language Learners in particular, is the problem of having content teachers see themselves as playing a role in the language development of their students, in addition to the development of content knowledge (Dutro & Kinsella, 2010). Likewise, it is easy to get enamored by the technology itself, and to lose sight of the fact that the technology should be in the service of learning goals.

The transparency and user-friendliness of *WordSift* was designed to do just that: keep the content in the foreground without unnecessarily calling attention to the distracting details of linguistics or technology.

The tool also seeks to account for the realities of urban public schools, where teachers vary considerably both in their comfort level in using technology and in the technological capacity of their classrooms and computer labs. An advantage of *WordSift*, in retrospect, was the fact that it only requires an Internet connection and an updated browser. Implementation does not require licensing or special hardware, and we worked hard to address early technology glitches and streamline the design to make it fast, simple to use, and engaging. Clearly, this is an advantage for widespread adoption, and we hope that *WordSift* is well positioned to reach and support even more classrooms in the coming years.

This project was also, at its core, a study in collaboration, and the active role played by the teachers through each phase of development, implementation, and evaluation of the *WordSift* tool cannot be overstated. Disappointing as the results were of the first experiment in terms of effectiveness, the project has stimulated an interest on the part of the teachers and the district in continued exploration of the iterative cycle of instruction and evaluation. As one teacher enthusiastically remarked at one point when we were analyzing the data on the spot during one of our work sessions, "this is the most exciting form of professional development I've ever had!"

This, in itself, is a particularly important lesson learned in our work in San Francisco given the vital role that hands-on work with teachers plays in supporting the use of technology in the classroom, as with any instructional tool or program. Because of the dynamic nature of the collaboration, I believe that even the teachers who were not initially comfortable with technology quickly came around and developed an enthusiasm for the tool. This created an environment where, as a team, we became genuinely interested in tracking its potential uses in the classroom and assessing its impact on student learning. Although incorporating this level of collaboration in the design and rollout of instructional technology entails a great amount of effort and commitment, overall the work became more meaningful to both the district and to the research team.

REFERENCES

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Anglin, J. (1994). Vocabulary development: A morphological analysis. Monographs of the Society for Research in Child Development, 58(10).

August, D., & Shanahan, T. (2006). Developing literacy in second-language learners: Report of the National Literacy Panel on Language-Minority Children and Youth. Mahwah, NJ: Lawrence Erlbaum.

Beck, I., Perfetti, C., & McKeown, M. (1982). Effects of long-term vocabulary instruction on lexical access and reading comprehension. Journal of Educational Psychology, 74(4), 506-521.

Biemiller, A., & Slonim, N. (2001). Estimating root word vocabulary growth in normative and advantaged populations: Evidence for a common sequence of vocabulary acquisition. Journal of Educational Psychology, 93(3), 498-520.

Blei, D, Ng, A. & Jordan, M. (2003). Latent Dirichlet allocation. Journal of Machine Learning Research, 3:993–1022.

Butler, Y. G., & Hakuta, K. (2006). Cognitive factors in children's L1 and L2 reading. Academic Exchange Quarterly, 10(1), 23-27.

Carlo, M., August, D., McLaughlin, B., Snow, C., Dressler, C., Lippman, D., et al. (2004). Closing the gap: Addressing the vocabulary needs of English-language learners in bilingual and mainstream classrooms. Reading Research Quarterly, 39(2), 188-215.

Coxhead, Averil (2000) A New Academic Word List. TESOL Quarterly, 34(2): 213-238.

Dutro, S. & Kinsella, K. (2010). English Language Development: Issues and Implementation at Grades Six through Twelve. In Improving Education for English Learners: Research-Based Approaches. In Improving Education for English Learners: Research-Based Approaches. California Department of Education.

Educational Testing Service (2008). Addressing Achievement Gaps: The Language Acquisition and Educational Achievement of English-Language Learners, 16(2), 1-15. ETS Policy Information Center.

Farr, J. N., Jenkins, J. J., and Paterson, D. G. (1951), Simplification of Flesch Reading Ease Formula, Journal of Applied Psychology, Volume 35, Number 5, (October), pp. 333-337

Fellbaum, C. (1998). (Ed.) WordNet: An electronic lexical database. Cambrdige, MA: MIT Press.

Gardner, D. (2004). Vocabulary input through extensive reading: A comparison of words found in children's narrative and expository reading materials. Applied Linguistics, 25(1), 1-37.

Hart, B., & Risley, T. (1995). Meaningful differences in the everyday experience of young American children. Baltimore, MD: Brookes Publishing Company.

Heer, J., Card, S. K., & Landay. J. A. (2005). Prefuse: A Toolkit for Interactive Information Visualization.ACM Human Factors in Computing Systems (CHI), 421-430.

Heer, J. . (2008). The Prefuse Flare Visualization Toolkit. http://flare.prefuse.org/

Heyns, B. (1978). Summer learning and the effects of schooling. New York: Academic Press.

Kamil, M. L. (2003). Adolescents and literacy: Reading for the 21st century. Washington, DC: Alliance for Excellent Education.

Kintsch, W. (1986). Learning from text. Cognition and instruction, 3(2), 87-108.

Landauer, T. K., Foltz, P. W., & Laham, D. (1998). Introduction to Latent Semantic Analysis. Discourse Processes, 25, 259-284.

Lawrence, J. (in press). Summer reading: Predicting adolescent word learning from aptitude reading amount and text type. Journal of Educational Psychology.

McKeown, M. (1985). The acquisition of word meaning from context by children of high and low ability. Reading Research Quarterly, 20(4), 482-496.

Manning, C. & Schütze, H. (1999). Foundations of Statistical Natural Language Processing, MIT Press. Cambridge, MA.

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

Nagy, W., & Anderson, R. C. (1984). How many words are there in printed school English? Reading Research Quarterly, 19(3), 304-330.

Nagy, W., & Herman, P. (1987). Breadth and depth of vocabulary knowledge: Implications for acquisition and instruction. In M. McKeown & M. E. Curtis (Eds.), The Nature of Vocabulary Acquisition (Vol. 19-35). Hillsdale, NJ: Lawrence Erlbaum.

Nation, I. (2006). How large a vocabulary is needed for reading and listening? Canadian Modern Language Review/ La Revue canadienne des langues vivantes, 63(1), 59-82.

Nation, K., & Snowling, M. (2004). Beyond phonological skills: Broader language skills contribute to the development of reading. Journal of Research in Reading, 27(4), 342-356.

Pan, B., Rowe, M., Singer, J., & Snow, C. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. Child Development, 76(4), 763-782.

Perfetti, C. A., Landi, N., & Oakhill, J. (2005). The acquisition of reading comprehension skill. In M. Snowling & C. Hulme (Eds.), The science of reading: A handbook (pp. 227-247). Malden, MA: Blackwell Publishing.

Snow, C. E., Porche, M. V., Tabors, P., & Harris, S. (2007). Is literacy enough?: Pathways to academic success for adolescents. Baltimore, MD: Paul H. Brookes Publishing Co.

RAND Reading Study Group. (2002). Reading for understanding: Toward an R&D program in reading comprehension. Santa Monica, CA: Rand.

Stanovich, K. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. Reading Research Quarterly, 21, 360-407.

Swanborn, M., & de Glopper, K. (2002). Impact of reading purpose on incidental word learning from context. Language Learning, 52(1), 95-117.

Yang, C.-L., & Perfetti, C. (2006). Reading skill and the acquisition of high quality representations of new words. Paper presented at the Society of the Scientific Study of Reading, Vancouver, Canada.

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