Authentic, Individualized Practice for English as a Second Language Vocabulary

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The REAP Tutor

- Intelligent Tutoring System for ESL Vocabulary Practice.
- Provides authentic reading passages containing target vocabulary in context.
- Gathers, filters, and selects from corpus of readings taken from Web.
The REAP Tutor

- Students work through an individualized series of readings.
- Target words are highlighted.
- Definitions available for all words.
- Practice vocabulary exercises follow each reading.
Two Main Challenges

- Need to estimate set of words that the student most needs to learn.
- Need to provide readings for effective practice of those words.
What words should REAP teach?

- REAP teaches from Academic Word List (Coxhead, 2000)
  - (However, not tied to particular list)

Academic Word List has 570 head words

- abandon, abstract, academy, access, accommodate, accompany, accumulate, accurate, achieve, acknowledge, acquire, adapt, adequate, adjacent, adjust, administrate, adult, advocate, affect, aggregate, aid, albeit, allocate, alter, alternative, ambiguous, amend, analogy, analyse, annual, anticipate, apparent, append, appreciate, approach, appropriate, approximate, arbitrary, area, aspect, assemble, assess, assign, assist, assume, assure, attach, attain, attitude, attribute, author, authority, automate, available, aware, behalf, benefit, bias, bond, brief, bulk, capable, capacity, category, cease, challenge, chapter, chart, chemical, circumstance, cite, civil, clarify, classic, clause, code, coherent, coincide, collapse, colleague, commence, comment, commission, commit, commodity, communicate, community, compatible, compensate, compile, complement, complex, component, compound, comprehensive, comprise, compute, conceive, concentrate, concept, conclude, concurrent, conduct, confer, confine, confirm, conflict, conform, consent, consequent, considerable, consist, constant, constitute, construe, construct, consult, consume, contact, contemporary, context, contract, contradict, contrary, contrast, contribute, controversy, convene, converse, convert, convince, cooperate, coordinate, core, corporate, correspond, couple, create, credit, criteria, crucial, culture, currency, cycle, data, debate, decade, decline, deduce, define, definite, demonstrate, denote, deny, depress, derive, design, despite, detect, deviate, device, devote, differentiate, dimension, diminish, discrete, discriminate, displace, display, dispose, distinct, distort, distribute, diverse, document, domain, domestic, dominate, draft, drama, duration, dynamic, economy, edit, element, eliminate, emerge, emphasis, empirical, enable, encounter, energy, enforce, enhance, enormous, ensure, entity, environment, equate, equip, equivalent, erode, error, establish, estate, estimate, ethic, ethnic, evaluate, eventual, evident, evolve, exceed, exclude, exhibit, expand, expert, explicit, exploit, export, expose, external, extract, facilitate, factor, feature, federal, fee, file, final, finance, finite, flexible, fluctuate, focus, format, formula, forthcoming, found, foundation, framework, function, fund, fundamental, furthermore, gender, generate, generation, globe, goal, grade, grant, guarantee, guideline, hence, hierarchy, highlight, hypothesis, identical, identify, ideology, ignorant, illustrate, image, immigrate, impact, implement, impose, implicit, imply, impose, incentive, incidence, incline, income, incorporate, index, indicate, individual, induce, inevitable, infer, infrastructure, inherent, inhibit, initial, initiate, injure, innovate, input, insert, insight, inspect, instance, institute, instruct, integral, integrate, integrity, intelligent, intense, interact, intermediate, internal, interpret, interval, intervene, intrinsic, invest, investigate, invoke, involve, isolate, issue, item, job, journal, justify, label, labour, layer, lecture, legal, legislate, levy, liberal, licence, likewise, link, locate, logic, maintain, major, manipulate, manual, margin, mature, maximise, mechanism, media, mediate, medical, medium, mental, method, migrate, military, minimal, minimise, minimum, ministry, minor, mode, modify, monitor, motive, mutual, negate, network, neutral, nevertheless, nonetheless, norm, normal, notion, notwithstanding, nuclear, objective, obtain, obvious, occupy, occur, odd, offset, ongoing, option, orient, outcome, output, overall, overlap, overseas, panel, paradigm, paragraph, parallel, parameter, participate, partner, passive, perceive, percent, period, persist, perspective, phase, phenomenon, philosophy, physical, plus, policy, portion, pose, positive, potential, practitioner, precede, precise, predict, predominant, preliminary, presume, previous, primary, prime, principal, principle, prior, priority, proceed, process, professional, prohibit, project, promote, proportion, prospect, protocol, psychology, publication, publish, purchase, pursue, qualitative, quote, radical, random, range, ratio, rational, react, recover, refine, regime, region, register, regulate, reinforce, reject, release, relevant, reluctance, rely, remove, require, research, reside, resolve, resource, respond, restore, restrain, restrict, retain, reveal, revenue, reverse, revise, revolution, rigid, role, route, scenario, schedule, scheme, scope, section, sector, secure, seek, select, sequence, series, sex, shift, significant, similar, simulate, site, so-called, sole, somewhat, source, specific, specify, sphere, stable, statistic, status, straightforward, strategy, stress, structure, style, submit, subordinate, subsequent, subsidy, substitute, successor, sufficient, sum, summary, supplement, survey, survive, suspend; sustain, symbol, tape, target, task, team, technical, technique, technology, temporary, tense, terminate, text, theme, theory, thereby, thesis, topic, trace, tradition, transfer, transform, transit, transmit, transport, trend, trigger, ultimate, undergo, underlie, undertake, uniform, unify, unique, utilise, valid, vary, vehicle, version, via, violate, virtual, visible, vision, visual, volume, voluntary, welfare, whereas, whereby, widespread
Problem: Most students know completely different sets of words, depending on:
- Courses, textbook,
- Native language,
- Real-world experience,
- Different lengths of language study, etc.

Need to individualized instruction based on a list of words that the student does not know.
Adaptive Tutoring

- Learner Modeling techniques such as Knowledge Tracing (Corbett & Anderson, 1995) can be used to estimate knowledge.
- Can allow tutor to adapt its curriculum based on student performance.
- Require performance/assessment data in order for instruction to be individualized.
Challenges of Individualization

- Initially, no performance data is available.
- Need list of ~100 unknown words to select optimal practice readings.
  - If only a short list, words may not occur together in REAP’s corpus (e.g., “dimension,” “prohibit”)
  - Want to avoid texts with only one word.
- Assessing each word is time-consuming.
  - Multiple-choice cloze questions take 30-60 sec.
  - (AWL has 570 items)
A Self-Assessment Pre-test

- Need to *quickly* find unknown words.
- REAP uses self-assessments on pre-test until it has a sufficiently long target word list.
  - “Do you know the word X?”
  - 5-10 seconds per word.
  - Can create list of ~100 unknown words in ~20 min.
- Later, use learner modeling to adapt.
Are Self-Assessments Accurate?

- Self-assessments:
  - Accurate when student claims that given word is **not** known.
  - **Not** accurate when student claims given word is **is** known.
Two Main Challenges

- Need to estimate set of words that the student most needs to learn.
- Need to provide readings for effective practice of those words.
Creating a Corpus of Readings

- REAP creates a corpus of readings from Web pages containing target words.
- Needs large corpus (10,000+ texts) for adequate coverage of words.
- Sends queries with sets of target words to search engines.
- Downloads, annotates, indexes the results offline.

(Collins-Thompson & Callan, 2004)
Constraints on Readings

- General Constraints
  - Mostly offline when corpus is created.
  - About 1% of texts remain after filtering.

- Specific Constraints
  - Mostly online when students interact with REAP.
General Constraints on Readings

- Reading level range (e.g., L1 grades 5-8)
- Reading length (200-2000 words)
- Inappropriate content
- Duplicate content
- Text Quality
Reading Difficulty Measure

- Unigram language modeling approach to readability (Collins-Thompson and Callan, 2005).
- Generative (naïve bayes) language model for each difficulty level.
- For given text, finds closest model.
- Trained from labeled dataset (English L1, ESL, French, etc.)
Text Quality of Readings

- Many Web pages are just lists of products, navigation menus, tables.
- Students need cohesive text in well-formed sentences and paragraphs.
- Measures: language modeling, HTML syntax, whether text can be parsed.
Specific Constraints

- Individual Target Word Lists
- Personal Interests
REAP must select texts from its corpus that contain a given student’s unknown words.

- Uses Lemur Search Engine Toolkit (www.lemurproject.org)
- Challenge to find texts with $\geq 3$ target words.
Personal Interests

- Students see vocabulary words in contexts that interest them.
- *Arts*: "For an artist who has *endured* so many years of obscurity..."
- *Business*: "As California has *endured* a burst tech bubble, costly energy crisis and a staggering burden on its business community..."
REAP uses SVM-Light toolkit (Joachims, 1999) to classify potential readings by topic.
- Done offline when corpus is created.
- Uses training data from general topic categories of Open Directory Project (dmoz.org).
REAP prefers texts that match personal interests specified in a questionnaire.

Please mark which topics you want to see readings about.

<table>
<thead>
<tr>
<th>Category</th>
<th>Examples</th>
<th>Not interested at all</th>
<th>Not very interested</th>
<th>Neither</th>
<th>Somewhat Interested</th>
<th>Very Interested</th>
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</thead>
<tbody>
<tr>
<td>Arts</td>
<td>literature, movies, TV, music</td>
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<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Business</td>
<td>investing, market, real estate</td>
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<td>Computers</td>
<td>hardware, software, Internet</td>
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<td>Games</td>
<td>video games, gambling</td>
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<td>Health</td>
<td>fitness, medicine, nutrition</td>
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<tr>
<td>Home</td>
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<tr>
<td>Recreation</td>
<td>travel, outdoors, boating</td>
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<tr>
<td>Science</td>
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<tr>
<td>Society</td>
<td>politics, religion, sociology</td>
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<tr>
<td>Sports</td>
<td>baseball, football, basketball</td>
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</tbody>
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Continue
Usage of REAP

- REAP is currently used at English Language Institute at University of Pittsburgh
- Used at ELI since Summer 2005
- 2 reading classes of 25-50 students each
- Part of Pittsburgh Science of Learning Center
Learning Gains

- Higher post-test scores for practiced words than unpracticed.
- Currently analyzing results from study comparing REAP to classroom learning.

\[
LG = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}
\]
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Logical Architecture

Student

Web Interface

Target Word List

Tutor Logic

Pre-test Module

Web Crawler

Document Retrieval

Question Generation

Filtering Modules

Student Model

Document Repository

Question Index

Action Log
Select the word that best completes the phrase below:

The ___ of a few good players made the team better than they were the year before.
Approaches to Measuring Text Quality

- **HTML Formatting**
  - “Does text only appear in tables and links?”
  - Problem: formatting varies by page’s author

- **Parsing**
  - “Can a parser find likely trees for the text?”
  - Problem: full parsing is slow

- **Language Modeling**
  - “Do the sequences of parts of speech look like well-formed sentences?”
    - “article adjective noun verb” (good text)
    - “noun noun noun noun” (product list)
  - Problem: maybe not fine-grained enough