Internet and Literacy in the Developing World: Delivering the Teacher with the Text

By Tom Cobb

□ In developing world training and education, cheap Internet resources may be able to replace many elements of expensive infrastructure. For example, with a growing proportion of the world's supply of scholarly writing now available online, it is probably unnecessary for universities to maintain up-to-date libraries. The savings to be realized, however, may not in all cases be automatic. The universe of online text comes mainly in universal languages such as English or French, at a level that may be challenging to learners for whom these are second or third languages, so that the cost of libraries is merely shifted to the cost of literacy training. A way to avoid this is to link Internet-based texts to Internet-based learning resources (electronic dictionaries, text-to-speech pronunciations, self-quizzes, etc.). This research and development case study proposes a free, reliable, and publicly accessible technology for doing this, a context and a reason for doing it, and an estimate of the pace and scale of literacy development that can potentially be achieved at low or no cost.

Feasibility of Internet Learning in the Developing World

At international conferences, the advantages in principle of the Internet in developing world training and education are often discussed. Online learning can reach learners in remote areas, deliver a world of books, manuals, and research articles, put learners in contact with their peers worldwide, and make it unnecessary for talented youths to complete their studies in Europe or North America from whence they may not return—all at a cost that is low compared to the alternatives. But in developing-world learning institutions there is often a clearer vision of the difficulties in practice. Some of these are on the level of infrastructure and technology, but I will argue these are not as serious as sometimes believed. A problem that may be harder to deal with is the lack of

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provision for literacy training in Internet-based learning schemes. Online learning reaches learners more successfully than ever before, but at the same time isolates them in a world of text in an unfamiliar or semifamiliar language (usually English).

But first the easy problem—is the Internet even a relevant topic in the least developed parts of the developing world? I was recently invited to give a presentation on the uses of the Internet in African literacy training, at the Third Pan-African Congress on *Reading for All,* at Kampala, Uganda. When I discussed some of the themes of my presentation with North American colleagues, they questioned whether the Internet was any kind of priority in African education. Is not surfing the Web a diversion of resources from more pressing concerns? At the time I had no facts to base an answer on, but this soon changed. Within an hour of arriving in Uganda, I had changed money at an ATM, seen hundreds of people talking and messaging on mobile telephones, and been driven past a dozen busy Internet cafes. On my return, to check whether this highly present vehicle of information transmission extended from the street into educational thinking, I conducted a short literature review on the status of Internet-based learning in Africa. Launching a search from the key words *ICTs* (information and communication technologies) and *education* for the years 2000–2003 in the following journals, *The Journal of International and Comparative Education (Compare), The International Journal of Educational Development, Educational Technology Research and Development,* and *Information Development,* I found detailed reports of dozens if not hundreds of Internet learning experiments and projects under way in almost every part of Africa.

A commitment to ICTs as a precondition for development is present in almost every official African development document of the past 10 years or more. The New Partnership for Africa's Development (NEPAD) Conference of 2001 rates improved access to ICTs as the number two priority after infrastructure (p. 25–27). Increased access to the Internet specifically is the focus of the United Nations Development Program's (1996) Internet Initiative for Africa, which along with Cisco Corporation is providing "network technology skills and training facilities to prepare students for the 21st century workplace" in 15 African countries. A commitment to ICTs in education specifically is an official component of the Framework for Action of the landmark Education For All (EFA) conference held in Dakar, Senegal, in 2000 (the six EFA objectives emerging from that conference are supported by 12 how-to principles, 10th among these being to "harness new information and communication technologies to help achieve EFA goals.") Beyond official pronouncements, ICTs are a key component of a number of ongoing training or education projects, includ-

ing the 26 sites of the World Bank's African Virtual University (AVU; King, 2002).

A degree of utopianism about the promise of information technology (IT) accompanies the planning phase of many of these projects. Here is a characteristic vision statement from a distance learning project in Mozambique (Buendía & Juvane, 2001):

> In all sectors of economic and social life, the need is felt for evolving skills articulated with more up-to-date knowledge and know-how. In this sense, education is the main route into the world of work. The need to train people capable of evolving, of adapting to a world undergoing rapid change, and master these changes, is increasingly imperative. From this perspective, the ability to learn throughout life becomes crucial. Schools should direct their training function so as to ensure that their pupils learn how to learn. This new context demands that societies multiply and diversify educational opportunities, becoming genuine educational societies. New information technologies, when integrated into education, can transform this utopia into reality. (p. 28)

There is a mechanism implicit in the vision—development depends on a new conception of learning, and a new conception of learning depends on the use of information technologies—some version of which underlies several of the project plans that were discussed in these journals. The details of this mechanism are not always specified, and perhaps related to this, the postplanning reports tended to be divided between optimism and pessimism as to what was actually being achieved. Some of these will be outlined in the next section. To conclude a previous concern, however, a little on-the-spot research showed the reluctance of my North American colleagues to talk about the Internet in Africa to be somewhat uninformed.

Many of the IT-based learning projects I reviewed reported on some level of difficulty resulting from Africa's daunting lack of infrastructure (shortage of telephone lines, frequent power outages, etc.). Western commentators complain that African (particularly sub-Saharan) governments often have no IT development policy and tend to grant monopolies to Internet service providers (ISPs) who keep prices artificially high, blocking broad access. African commentators complain that that many ICT-based projects require proprietary software that, although donated, arrives out of date and requiring almost immediate update, and must be followed by new hardware that can run the software, which of course has not been budgeted. More broadly, these critics also note that many IT-based education projects, including the World Bank AVU, are developed in a top-down process with learning materials designed

elsewhere (in Europe or North America) and then adapted, with varying degrees of success (Amutabi & Oketch, 2003), sometimes recreating a high-tech version of colonial education. A recurring problem of such top-down models is a failure to investigate the position of target learners, particularly with regard to literacy and independent study capacities.

But for every problem in the research literature, there appeared to be a solution. On infrastructure: The cell phone is ubiquitous in many or most African countries, such that the continent may never require universal hard wiring. On proprietary software: Developing countries are learning to use free and open source software in educational projects, including Apache, Sendmail, Perl, and Microsoft's Internet Information Server, all of which are free, well supported at no cost via the Internet, and run successfully on dated machinery (Carmichael & Honour, 2002). On ISP monopolies: Have these survived in the case of cell phones or other wireless technologies (Hayden, Rientjes, Ryder, & Wall, 2001)? On top-down instructional design: Many donor groups, particularly those from Europe, are switching to bottom-up models, with learning materials developed in close touch with local consultants (such as projects supported by the Dutch International Institute for Communications & Development projects, or by the German Foundation for International Development reported in Ballantyne (2002). One problem that I did not see many solutions for, however, was the position of the learner who was meant to be the beneficiary of all these schemes—particularly with regard to reading ability in the language of instruction.

Almost every report of a failed distance-learning project that I came across made at least some mention of inadequate or nonexistent literacy provision. In a report on several International Development Research Centre educational projects in six countries (Botswana, Kenya, Mali, Nigeria, South Africa, and Tanzania), Kwaa Prah (2003) identified literacy provision as the key problem: "The most commonly identified technical problems arising from inadequate language planning include the inappropriateness of technical terms in LOI [language of instruction], the complexity of syntactic patterns in textbooks, the poor quality and irrelevance of textbooks." Literacy, in this context, normally refers to English, French, or Portuguese literacy. One solution to this problem would be to make a local language the medium of instruction, where there is a local language that is sufficiently widespread (as Kiswahili is in Tanzania, as argued by Rubagumya, 1991, and for other language groups by Kwaa Prah).

A problem with relying on local languages in this way, despite advantages in the early stages of any learning project, is that as learning approaches the advanced stages, the number of texts to be translated into the local language quickly becomes unmanageable. The other option, language training in one of the former colonial languages (mainly English but also French or, occasion-

ally, Portuguese) seems to many to be the more attractive option, especially with the increasing availability of texts in these languages as Google Print (Google Book Search, 2003) and similar projects scan the entire contents of the libraries of major universities (Michigan, Harvard, Oxford) and cities (New York Public Library) onto the Internet for free, universal access.

However, although much of the developing world provides at least some basic training in a European language, usually English, it is not clear that learning basic English is adequate preparation for learning advanced content *in* English. Probably the foremost authority on English literacy in Africa, Kate Parry, has conducted a number of studies showing the limitations of the basic English training that many Nigerians, Ugandans, and others even in former British colonies have received. Parry (1987), using ability to learn new words from a text as the measure of comprehension, showed that "Nigerian students reading in English (their third language) had great difficulty in inferring the meanings of unfamiliar words, [even where] these represented less than 1% of the whole text." Predictably, literacy problems show up in major educational development projects. Amutabi and Oketch (2003), among others, criticized a World Bank AVU project in Kenya in the following terms: "Kenya has a literacy level [in English] of 65%, in some rural districts as low as 30%. For the AVU to be received enthusiastically, *literacy levels should have been addressed first. . . .*" [emphasis added]. But addressed how? Advanced English language training could be provided through courses and classrooms, but this would undercut the cost reduction of using Internet-based learning in the first place. The argument of this article is that formal training may not be necessary, because in addition to text and other content the Internet also contains a number of language learning tools that can be integrated into texts so that learners can move from basic to advanced reading ability on their own.

The Internet is a vast repository of excellent, free language-learning resources. Online dictionaries now abound, many of them specifically language-learning dictionaries, aimed at different levels of learner, the result of large amounts of investment and research (e.g., the *Cambridge Advanced Learners' Dictionary*). Any number of texts are available online with accompanying sound files that can be played on free software (such as RealPlayer or Windows Media Player). Text-to-speech ability can now be carried over the Internet, making it possible to hear an accurate pronunciation for any printed word (thanks to the free Speech Plug-In developed by Macromedia Inc.). Online networked resources such as forums or shared databases make it possible for learners to pool resources, whether word lookups or collaborative problem-solving efforts. On the downside, however, not all available resources are totally free, not all have been shown by research to be useful, and those that are useful are distributed all over the Web rather than being inte-

grated into coherent, usable learning packages. The focuses of the present research and development project are (a) to propose a way of selecting useful resources, (b) to achieve a usable integration that can be deployed at country or institutional level with minimal training and no cost, and (c) to provide an initial idea of its effectiveness for learners with basic language ability in English or French but who would have difficulty reading a complex text.

Designs and Advantages of Resource-Assisted Reading

The concept of resource-assisted or multimedia-assisted reading had been a topic in the research and development literature since roughly the mid-1990s. Studies by Knight (1994), Hulstijn, Hollander, and Greidanus (1996), Lyman-Hagar and Davis (1996), Chun and Plass (1996a), and Lomicka (1998) have developed and tested software packages for reading with the various resources that a computer can make available, and in addition have developed useful measures for establishing the effectiveness of such systems with learners who are learning or consolidating a second language. These packages present learners with texts linked to click-up options for some or all of the text's words, leading to definitions, pictures, small videos, or other types of information, both singly and in combination. A principle measure has been to calculate the incidental vocabulary growth for learners who believe they are reading for general comprehension (rather than for vocabulary growth). Vocabulary knowledge is typically measured in terms of either recognition (of a correct definition, or the context that goes with a particular word, etc.) or production (the ability to use a word), or both, immediately after reading or at a delay, or both. The principles underlying the vocabulary measure are the tight relationship between vocabulary knowledge and reading ability (Nation, 2001).

A brief summary of the empirical research on vocabulary growth from reading with click-on resources is as follows. The normal baseline growth of even basic knowledge (meaning recognition) for new words from level-appropriate reading with uncontrolled dictionary use is rather modest, in the range of 5% of the items available for learning on the basis of a single exposure, whether in a first language (Nagy, Herman, & Anderson, 1987) or a second (Horst, Cobb, & Meara, 1998). This then is the baseline that the resource-assisted reading research tries to beat by some orders of magnitude in order to show its worth. The gains for resource-assisted reading have generally been strong. First, in terms of facilitation, easy access to resources, through a computer click as opposed to a lengthy lookup, has been shown to double or even triple their use (Goyette, 1995; Hulstijn et al., 1996). Second, in terms of learning, Knight's (1994) study found that high-verbal learners, after reading a text on a computer screen with a computer dictionary available, were able to rec-

ognize 55% of new items and produce acceptable definitions for 21% of them. Chun and Plass (1996b) had their participants use a system (Cyberbuch) that offered a suite of click-on resources (definitions, pictures, and video clips) with a German literary text by Boll (1981). After using this system for two consecutive class periods participants were apparently able to surpass these rates, with 77% of new items learned to recognition level and 25% to production level. Either of these gains is impressive. Such results would be less impressive if they could be simply attributed to time-on-task, but another study that looked at the time factor found that extensive use of click-on online resources did not increase reading time significantly over that of a control group (e.g., Goyette). Indeed the point of click-on resources is that they allow an extremely brief departure from the text.

On the implementation level, however, there are problems with making much use of these impressive findings. First, the reading systems reported in the literature (e.g., Chun & Plass, 1996a; 1997; Lyman-Hagar & Davis, 1996) are one-off developments, where enormous amounts of time have been devoted to producing very rich resources for a handful of target words in one or two shortish texts, and requiring expensive or hard-to-get systems (e.g., Chun & Plass, 1996b) that cannot easily be reengineered to provide similar resources for a different text, let alone a different language. Second, some of the resources that are most expensive to develop seem to be the least useful for learning. Chun and Plass's (1996a) word explanations through video seem to have been more confusing than anything else for the subjects in the experiment, according to their own findings. (This is entirely predictable for anyone who has read philosopher Quine's *gavagai* parable (1960): some African tribesmen draw a visiting explorer's attention to a passing rabbit while saying the word *gavagai,* leaving the explorer to ponder whether this word refers to rabbits, to food, to small animals, to sudden movements, etc.) And although pictures tagged to words were more effective than video, the 36 target words happened to be mainly picturable words (*coast, box, high tide,* and *lobster*) whereas academic learner lookups in fact are mainly not picturable (for example, the five most looked-up words in the *Cambridge Advanced Learner's Dictionary* in 2004 were *advice, liaise, effect, regard,* and *comply).* The interest in picture support appears to stem from a theoretical interest of the researchers in cognitive integration of visual and textual information (elaborated at length in Chun & Plass, 1997), rather than any immediate desire to effect near-term improvements in reading pedagogy.

Another less theoretical but possibly more effective and immediate orientation to developing a resource-assisted reading tutor is to observe what human tutors do when helping someone learn to read, and then see how much of that can be incorporated as a suite of free, reusable, text-integrated resources. Peer

tutoring has often been shown to be one of the most effective strategies in reading instruction (e.g., Brown, Palincsar & Armbruster, 1984) and has recently become prominent in the development education literature as a way of providing high-impact, low-cost instruction in areas such as numeracy and literacy (see Banerjee, Cole, Duflo, & Leigh's 2005 study of the Balsakhi program of peer tutoring in India). What do peer reading tutors do? My research (elaborated more fully in Cobb, Greaves, & Horst, 2001) suggests that peer tutors explain many, many words; read and reread many words aloud, both singly and in longer passages; raise awareness of lexical patterning, such as collocations (e.g., the difference between *look up* and *look at*); and perform a number of motivational and metacognitive support functions, such as reminding the tutee that this word has already been seen previously in the text, or helping with a vocabulary notebook in flashcard format, and so on. The pedagogy characteristically revolves around lexis, with surprisingly few references to grammatical distinctions, yet seems to involve almost no recourse to pictures.

How much of this peer tutoring can be reverse engineered as a computer program using free resources available on the Internet with all and any texts that a user anywhere in reach of the Internet may be interested or required to read? Surprisingly, quite a bit. At my Compleat Lexical Tutor Web site (Cobb, 2003; www.lextutor.ca), any ESL learner, teacher, or course designer can input any text file (plus complete accompanying sound file if available, as is increasingly the case) into a routine known as Hypertext Builder. This routine uses open source code to wire together a free-standing Web page with every word in the text click-linked (a) to text-to-speech for pronunciation of words and phrases, (b) to a concordance of previous occurrences of the word, which incidentally highlights collocational patterning, (c) to a simple online database with quiz-building option, and (d) to a range of learner dictionaries. At the Hypertext Home Page (www.lextutor.ca/hypertext), several trial interfaces, resources, and languages are wired together in a range of experimental combinations, which users worldwide are accessing and helping to refine. But can these free, reusable resources *in principle* match the impressive results clocked up by the expensive resources approach of, for example, Chun and Plass (1996a; 1997; 77% of available words learned to recognition level, 25% to production level)?

Testing a Free-Resource Electronic Reading Tutor

Design. This study is a case-study pre–post comparison of two readers working with and without a suite of Internet-provided free resources. Some reasons

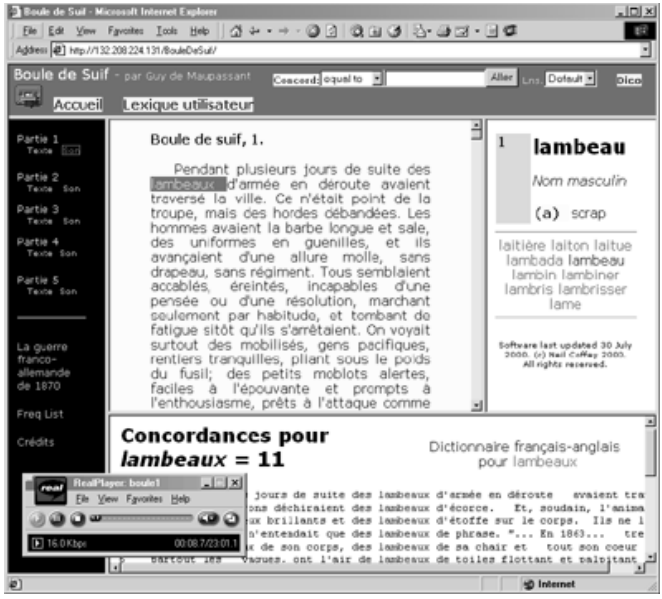
for choosing a case-study approach are outlined below, as well as a range of other methodological issues in this type of experiment.

Participants. Both participants were Anglophone adult, university graduate, intermediate learners of other European languages. The learner working with assisted resources (hereafter called Assisted) was learning French; the learner working unassisted (hereafter called Unassisted) was learning German. Both had basic knowledge of the language, but could read in it only with some difficulty (as shown by lookups, rereads, etc.). Both were aware that vocabulary growth was one of the goals of the exercise.

Materials. The texts chosen for this study were novellas or short novels written in the target languages. The French novella read by Assisted was de Maupassant's *Boule de Suif* (1870), with 13,418 words; the German novella *Der Besenbinder von Rychiswyl* (Gotthelf, 1852) of 9,500 words read by Unassisted. The interface for Unassisted's German reading was the usual situation of reading in a second or foreign language, that is, a paper book with whatever offline resources the reader wished to use or had available. The interface chosen for Assisted's French reading is shown in Figure 1 (and can be experienced live in a slightly updated version at http://www.lextutor.ca/bouledesuif/). The complete text of *Boule de Suif* was pasted into Hypertext Builder chapter by chapter (a 10-min operation) accompanied by digitized sound files (Deguire, *Le Livre qui Parle*). Each chapter can be read and listened to before, after, or simultansouly via the (free) RealPlayer plug-in shown. The sound file can be paused or replayed at any time.

To give more detailed attention to individual word pronunciations, the reader can click on any word or phrase to hear it spoken. To see other occurrences of the word from the same text, the reader can double-click a word and produce a concordance such as the one for *lambeaux* in the figure. In this case the concordance shows that this word will appear several times in the remainder of the text, which is a good reason for giving attention to the word, and also shows that the normal collocation of this word is *des lambeaux de*+ NOUN. To confirm the meaning of the word, or see other forms of the word, a link within the concordance ouput takes the reader to a bilingual French-English learner dictionary (Coffey, 2000) entry for the same word. This will be precisely the same word, or in the case of a word form such as a plural that does not have its own entry, it will be the base form of the word. This dictionary, like all the dictionaries used in this project, is capable of taking a plural word such as *lambeaux* and tracing it back to its singular form *lambeau* so that different forms of words are grouped according to a common head word or family. To record a word or phrase, a leaner can click on the LEXIQUE UTILISATEUR (user

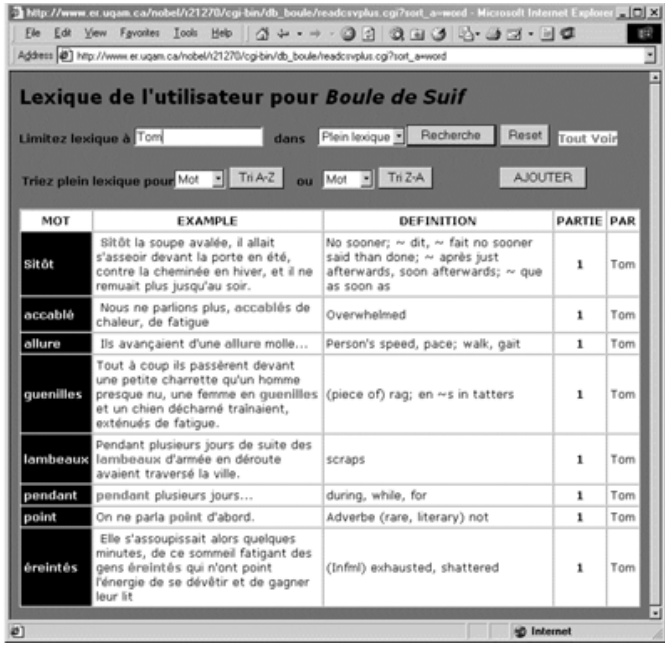
Figure 1 □ The main interactions proposed by resource-assisted reading (RA-Read).



lexicon) button to create an easy paste-in record of the word or phrase along with its meaning and definition (shown in. Figure 2). These entries were created by the single user Tom, but if several readers were working together then the TOUT VOIR (see all) button would show the word collections of all readers. All these resources are free, and together add up to much of what a human reading assistant would provide for a learning reader.

Measures. It is common in vocabulary-from-reading studies to test only a small number of words from a text of a just a few paragraphs or pages. For example, Chun and Plass (1996b) used a text of 762 words and tested 36 words in their Cyberbuch experiment. Although such a modest task may be experimentally convenient, it hardly represents the scale of reading that is expected of students reading at an advanced level in an academic subject. In the present study, as already noted, much longer texts were used, and also many more potentially unknown words tested before and after reading. A way of determining which words might be unknown was to run both texts through a frequency program (available at www.lextutor.ca/tools), pull out all the singletons or words that occur only once in the text, and pretest the participants for all of these well in advance of reading. In Unassisted's German text,

Figure 2 □ Electronic vocabulary notebook, version 1.



300 words were thus identified, and in Assisted's French text 400 were identified. Pretesting would identify which of these were in fact unknown prior to reading, but it was anticipated that at least half would be unknown in either case, providing a large space for any potential learning to occur in.

The large number of words to be tested was one reason for choosing a case study. The motivation was to create a manageable experiment by limiting the number of participants rather than the realism of the task. The role and place of case or single-subject studies in vocabulary research is well set out in Meara (1995). One role for such studies is to iron out methodological wrinkles where these exist, as will be attempted below, and to establish cases in principle before involving larger numbers of participants. A positive result from the present study will justify a future study with larger numbers of both test words and participants. Any results from the present study should be seen as making a case in principle, and laying the basis for further large-scale study.

The large number of words (in two languages) needing to be tested also necessitated an automatic form of testing that could be achieved in a reasonably short space of time. A computer-based test was developed, adapted from Wesche and Paribakht's (1996) vocabulary knowledge scale wherein learners

evaluated target self-assess target words as either *definitely known, possibly known,* or *not known* (adapted by Horst & Meara, 1999). The computer screen presented words in random sequence one at a time, and each was categorized as already described. Using this method, a reasonably fine measure of knowledge could be achieved (i.e., the distinction between possibly known and certainly known), and several hundred words in any language could be tested or retested in a single sitting. Any problems of guessing created by the self-assessment format could be countered by asking for a definition of a sample of the words judged known. In terms of comparability with the studies mentioned in the literature review (e.g., Knight, 1994, or Chun and Plass, 1996a) the judgment *possibly known* is comparable to recognition knowledge (in previous studies, subjects who had judged a word as possibly known were almost invariably able to select an appropriate definition for the word); definitely known plus a confirming definition is comparable to productive knowledge. The aim was to provide comparable measures but for a far larger number of words and in two languages.

Research questions. The main question is whether free, reusable reading resources can in principle match the expensive, dedicated resources reported in much of the research. A subsidiary question is whether any effects can simply be attributed to time on task, or whether assisted and unassisted reading will occupy roughly the same amount of time.

Procedure. Six weeks before the start of the experiment, Unassisted and Assisted were pretested on the singletons in their respective texts. Conveniently, each of them had rated 45% of their singletons unknown ($400 \times 45\% = 180$ words for Assisted, $300 \times 45\% = 135$ words for Unassisted). These were learning goals comparable to those a second language academic learner might actually be faced with. Further, although the texts were of unequal sizes, the learning tasks were almost identical (Unassisted had 135 words to learn in a text of 9,500 words, or a density of about 1 new word in 70, compared to Assisted's 180 words from a total of 13,418, or 1 new word per 74).

Two days before the start of the experiment, Assisted was given training in the use of the various resources integrated with her text. Training was terminated when Assisted was at ease with all of the interactions needed to access the resources integrated into her text. When the experiment began, the two readers read their texts three times each, and were tested for vocabulary growth one day after each reading. The purpose of reading the text three times was to determine the exact number of encounters the participants had with each word (each of the words was a singleton, appearing once in the text, and hence was encountered three times over three readings. By contrast, in many

vocabulary-acquisition-from-reading studies, the number of occurrences of each word in the stimulus text is either unknown or unreported. In Chun and Plass's text (1996b), which is Heinrich Boll's (1981) *Anekdote zur Senkung der Arbeitsmoral,* the test word *flut* (flood) appears once in the text, *hummer* (lobster) twice, and *kutter* (cutter) three times, that is, with a randomness that raises the question whether it is the resource or the number of encounters that is the source of any learning. Three days following the third reading and test, definitely known words were checked through the provision of a definition that was confirmed by a native speaker of each language. Reading times were recorded. Assisted's pattern of resource use was checked with each reading to see whether she was employing the full range.

Results. Unassisted read his text from beginning to end, with occasional lookups in a bilingual paper dictionary and occasional backtracking or rereading but no marginalia or annotations. Assisted read her text on the screen, normally reading the entire text with the sound file running, pausing it regularly to examine a word or phrase. A typical sequence was to pause the recording and double-click a word, which produced its text-to-speech rendition and a concordance, and from there to single-click the word again for a repeat of the pronunciation, and more than half the time to click the concordance's dictionary link to see a definition. A few recurrent words were pasted with an example and definition into the lexical database. Despite the vast difference in resource use, there was no significant difference, reading times for each condition being roughly proportional to the different lengths of the two texts: 3 hr for Unassisted, 9,500 words (3,167 per hr), 4 hr for Assisted, 13,418 words (3,355 per hr) with minor variations. In other words, Assisted's use of resources had not built up time on task as a confounding account of any difference in learning outcomes.

The rate of word learning for the two readers and conditions is shown in Table 1. Unassisted's progress was the typical slow but normal progress reported above in the literature review. After three readings he had no more definitely known words than before reading the text at all (no gain in productive knowledge). The number of possibly known words had advanced from 84 to 99, or a gain of 15 words out of a learnable 135, for an 11% gain at the recognition level. This is very much in line with the typical finding of natural vocabulary acquisition from reading, namely 5% likelihood of learning at recognition level only from a single encounter (Unassisted had three encounters).

Assisted's progress was somewhat greater. Her number of definitely known words advanced from 80 at pretest to 204 at third posttest, for a gain of 124 words out of a learnable 180, or a gain of 68%. On a subsequent check on

words reported known, she was able to produce acceptable definitions for 94% of these, so it is reasonable to say that she had achieved productive control of 94% of her 124 words, or 116 words from a learnable 180 (64%). Adding the possibly known and known gains gives an estimate of total recognition ability (production includes recognition), which in this case is a gain of 124 + 28 = 152 words from an original learnable pool of 180 words, or 84% of learnable target words learned at this level.

Discussion. On the first question, whether cheap resources are as effective as dear: Chun and Plass (1996b) reported a 77% gain at recognition level and 25% at production level. In the present experiment, Assisted's gain at recognition level was 84% and at productive level 64%. The higher rate is possibly because words were encountered a precise three times in this experiment, compared to one, two, or three times in the Chun and Plass (1996b) experiment. Or it could be related to the participants' knowledge that vocabulary growth was one of the interests of the study. In any case, it appears that the high rate of learning produced by an expensive, dedicated system can in principle be replicated by a simpler and more usable system dependent only on properly chosen publicly available resources. Also, the comparison does not include any adjustment for Chun and Plass's possible biasing of their results by overweighting their test items with picturable words in accordance with their wish to employ picture resources.

On the second question, whether effects can be attributed to time on task: With three readings of roughly 3 hr each, these two participants clearly spent more time reading that Chun and Plass's (1996b) participants could have done in two consecutive class periods (roughly 9 hr in this experiment compared to 2 in Chun & Plass, 1996b). On the other hand, tackling 36 unknown words in 2 hr (18 words/hr) is comparable to tackling 180 words in 9 hr (20 words/hr). In any case, the time question was not about comparing experiments as much as comparing normal reading and assisted reading, and in this case the reading time of Assisted and Unassisted was equal, discounting for the slightly larger French text, despite the amount of resource use the latter entailed. The whole point of integrated resources is their ease of access, and hence minimal distraction from the reading task, which time comparability indeed suggests to be the case.

It seems clear that the approach to resource-assisted reading described in this study is only one or two experiments away from readiness for wide implementation in zones of education where it is both needed and suitable. Where is it needed? It is largely needed in places where human-peer reading tutors and teachers are not available and computing is needed to replace human resources to the extent that they can. This of course is exactly the situation in

much or most of the developing world. The special suitability of computer-assisted learning in the developing world is a case made by many. Banerjee et al. (2005, p. 10), discussing some negative findings from computer-assisted learning experiments in developed countries, specifically in Israel and the United States (and coincidentally involving a vocabulary expansion software package), made a distinction between the context of computer-assisted learning in the developed and developing worlds:

> It is not clear, however, that these results apply to the use of computers in schools in developing countries: in Israel and in the US, computer-assisted learning replaces time spent in well equipped classrooms with high quality instructors. It is easy to imagine that computers can make a significant improvement in schools in developing countries even if they are not useful in the developed world. (p. 10)

Whether the computer has no role to play in the developed world is a moot point, but it seems clear that it has a strong role to play in the developing world.

For whom is resource-assisted reading suitable? The participants in this experiment were language learners with basic competence in a second language, but who could read a full-length, noninstructional text only with moderate difficulty. A measure of this difficulty is that only 81 and 80 of the single-appearance words were definitely known out of 300 and 400 respectively, or 27% and 20%, along no doubt with many others that appeared more than once. The position of these two readers is thus comparable to that of many, perhaps most, learners in the developing world who have basic competence in the language of instruction but face a heavy vocabulary burden when reading in an advanced subject. My own experience teaching ESL in a number of developing countries suggests that such a learner is the typical entrant to a program of higher learning or advanced training. (A caveat, however, on the concept *developing country*: in 2006, TutorVista, a Bangalore, India, based company will begin donating free "online tutoring to U.S. students in everything from grammar to geometry . . . to kids in the 10 poorest counties in the U.S." under provisions of the No Child Left Behind Act (Cole, 2006). In other words, the developing world has no specific north-south, or east-west geographic coordinates in other than the most general terms, and the resource-assisted reading approach advocated here is applicable anywhere that text difficulty exceeds reading ability.

Limitations. These findings clearly require further confirmation with larger groups. A methodology and rationale are now in place to do this.

Further Development & Dissemination

Most of the resources integrated into Assisted's reading task are available on www.lextutor.ca for use with readers' or course designers' own texts. Various interfaces and resource mixes are under experimentation and are already being widely used (several dozen resourced texts are created on this Web site daily, worldwide).

The dictionaries available for this project are under constant development. Accessibility, lemmatisation, and ever increasing numbers of language pairs in the case of bilingual dictionaries, have all increased dramatically in just the past few years. A limitation in this area is of course that none of the dictionaries available provide definitions for European language words in local African or other developing-area languages. On the other hand, the monolingual learners' English dictionaries, such as the *Cambridge Advanced Learners Dictionary* or the *Longman Dictionary of Contemporary English* online version, are increasingly able to offer good use to learners from any first language who has basic knowledge of English. That is because the definitions in these learner dictionaries are constructed from common words only, and because all words in the definitions are themselves clickable for further information. Learners who know the 2,000 most common words of English can make use of these resources.

The problem remains that these dictionaries present words in several senses, so that a fairly high degree of comprehension of the text is required to choose the correct sense. This problem can in principle be solved through further developments to the click-on approach to definition access. The dictionary can in principle "know" which words lie to the right and left of the clicked word, and can use these in a quasi-intelligent fashion to constrain the choice of senses for presentation. Experiments in this technology are under way with Oxford's new *Genie* learner dictionary (although to a limited extent as yet; reviewed by Horst & Cobb, 2006).

The dictionary is possibly the main resource in the resource-assisted approach, but the subsidiary resources are also under progressive development. Text-to-speech increases in quality of rendition year by year. The concordancer (a program that provides other contextualizations of the same word from the story or elsewhere) used in these experiments is being developed to be an ever better simulation of the human reading tutor functions described above. A full version of London's *Call of the Wild* (www.lextutor.ca/callwild) experiments with a "Story Concordancer" that connects clicked words to the chapters of the book where they occur, on the one hand, and to other works by the same author, on the other. Sets of texts, as against single texts, will soon be available to users of the authoring or "Builder" routines. The lexical database has been temporarily unlinked from the resource-assisted reading project for

separate development (www.lextutor.ca/group_lex/demo/), but will be reconnected in coming months with several new facilities.

Learning research continues to provide the major inspiration for developments in the resource-assisted reading project. One experimental routine has recently integrated an interesting finding by Wesche and Paribakht (2000) whereby superior word learning results from meeting a word in reading and then doing various activities involving the word, as opposed to simply meeting it more times in reading. Accordingly, a new version of Hypertext Builder (http://www.lextutor.ca/hypertext/eng_2) gives learners the option of clicking novel words into a box, so that when reading is finished they can send these words to one or all of three exercises. One focuses on form (spelling), one on meaning (fitting the word to a set of new contexts), and one on word recognition (distinguishing words from nonwords with millisecond-timed feedback).

Conclusion

Cheap, shared, nonproprietary online resources make it fairly straightforward to integrate both literacy and self-study training into a distance or other online training project in Africa or any other wired or wireless location in the developing world. This integration can be initiated in a bottom-up fashion close to the point of delivery by a small number of designers or instructors for any number of learners. Early indications are that these resources can be used to strong advantage by learners with only basic competence in the language of instruction. □

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