รหัสโครงการ SUT 2-203-43-12-20

รายงานการวิจัย

SUT Students' Proficiency in Reading Subject-Specialist Textbooks in English

ได้รับทุนอุดหนุนการวิจัยจาก
มหาวิทยาลัยเทคโนโลยีสุรนารี

ผลงานวิจัยเป็นความรับผิดชอบของหัวหน้าโครงการวิจัยแต่เพียงผู้เดียว

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หัวหน้าโครงการวิจัย

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สาขาวิชาภาษาอังกฤษ

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ได้รับทุนอุดหนุนการวิจัยจากมหาวิทยาลัยเทคโนโลยีสุรนารี ปีงบประมาณ พ.ศ. 2543

ผลงานวิจัยเป็นความรับผิดชอบของหัวหน้าโครงการวิจัยแต่เพียงผู้เดียว

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บทคัดย่อ

จุดประสงค์ของการวิจัยเพื่อวัดความสามารถด้านการอ่านตำราภาษาอังกฤษของนักศึกษาวิศวกรรมศาสตร์ มหาวิทยาลัยเทคโนโลยีสุรนารี เนื่องจากว่าความสามารถในการอ่านและความรู้คำศัพท์ภาษาอังกฤษมีสหสัมพันธ์สูง ผู้วิจัยจึงให้นักศึกษาจำนวน 250 คน สอบข้อทดสอบคำศัพท์ ภาษาอังกฤษที่จำเป็นทางด้านวิศวกรรมศาสตร์ จำนวน 2000 คำ

ผลการสอบพบว่าโดยเฉลี่ยนักศึกษารู้ความหมายของศัพท์ที่จำเป็นน้อยกว่าครึ่งหนึ่ง แต่การสอบนี้แยกนักศึกษาได้เป็น 2 ระดับ และระดับสูงมีความสามารถรู้ความหมายของศัพท์ใกล้เคียงกับจำนวนที่ตั้งไว้

ABSTRACT

The purpose of this project was to assess SUT engineering students' ability to read their subject-specific textbooks in English. Given the well-attested correlation between reading ability and vocabulary knowledge, a yes-no checklist test of engineering vocabulary knowledge was administered to about 250 SUT students about to embark on their engineering studies. Subjects were tested on their knowledge of the most common 2000 foundation engineering words. The scores indicated that students knew only slightly less than half the 2000 necessary words. However bimodality in the scores indicated that a sizeable minority of students were fairly close to reaching 95% lexical coverage needed for successful reading.

Table of Content

List of Tables

1. Introduction

SUT engineering students are supposed to read engineering textbooks in English, in order to flesh out the knowledge they gain from their lectures. As Ward (2001) showed, this goal is important for a wide range of reasons. These relate to the individual student -who needs the knowledge that is often available only in these textbooks, and who cannot pursue more advanced studies without gaining access to academic materials in English. They also relate to national economic objectives, since the purpose of the engineering programme is to help create technological self-sufficiency for Thailand. Ward (2001) gave some indication that they had great difficulty in reading textbooks in English.

2. Objectives

The aim of this project is to estimate the ability of SUT 2nd-year engineering students to read English language textbooks.

3. Methodology

The method used will be a vocabulary test. This raises three questions: first, what reason is there to think that a vocabulary test will measure reading ability ? Second, which words will be tested? Third, what type of vocabulary test is appropriate? These are discussed in sections 3.1, 3.2 and 3.3 below.

3.1 Vocabulary and reading

There has been a great deal of research to indicate that vocabulary knowledge and reading ability are closely connected and that the latter can largely be predicted from the former. The arguments are presented here in sections 3.1.1, 3.1.2 and 3.1.3 below.

There are three arguments for thinking that this project will enable us to assess students' reading ability from a vocabulary test.

3.1.1 The argument from common sense

Nobody to my knowledge has ever tried to dispute the usefulness of knowing at least some words in a language that one is attempting to read. People (including researchers) would I believe generally assume that the more words one knows, the better. For example, vocabulary was a major factor in the nearly all the numerous readability indices cited by Klare in his 1974 study (Klare 1974), the clear implication being that the shorter or more common the words in a text, the easier (other things being equal) it was. More recently, four taxonomies of reading skills cited as "fairly typical" in Urquhart & Weir (1998:90) all mention vocabulary knowledge in some form or another. Student behaviour also appears to support this; most teachers will have noticed (with Ghadessy 1979 and Lynn 1973, who are most commonly cited as having written about it first) students' tendency to write translations above unknown words in texts that they are reading. In my own reading of Thai I (and my fellow learners) all do this too. The word is the basic unit of meaning and we read to get meaning.

This suggests that the burden of proof might be on those who would deny a connection between vocabulary knowledge and reading.

3.1.2 Evidence from psycholinguistics

The main point of the psycholinguistic evidence is that skilled readers focus on about 80% of individual content words (see e.g. Carpenter & Just 1981). This focusing involves two types of process: recognition of the visual input and what Perfetti (1985:13) called semantic activation, i.e. making the connection between the visual input and the item in the reader's mental lexicon. Perfetti made the two observations (p.14) that "Very little information is obtained from the visual periphery", and (ibid.), and that "...little information is obtained between fixations". Words at the end of a sentence receive longer focus, lasting about half a second, than other words, a phenomenon that has been referred to as "sentence wrap-up" time (Carpenter & Just 1981); the reader assembles the lexical elements into some form of proposition. Propositions (p.37) "...represent the meaning information that a reader assembles from a sentence" and this assembly depends on lower-level processes.

Verbal efficiency theory relates this focus to successful reading by talking about the allocation of limited resources in short-term memory ("the quality of a verbal processing outcome relative to its cost in processing resources" - Perfetti 1985:102). Verbal efficiency theory states that "...reading becomes easier the the more that processes which *can* be at high efficiency *are* in fact at high efficiency." (author's italics). If efficiency is high, i.e. if the word level processes are accomplished quickly, then lexical access is fast and requires little or nothing in the way of processing resources or attention. Attention is thus freed for higher-level processes of understanding propositions, inferences and larger segments of text. Similar conclusions are reached by Britton et al. (1982), and Britton et al. (1985:229):

> "...if the load imposed by the lower level component processes...can be reduced, and if this additional capacity can be reallocated to the higher level processes of text integration, then the text integration process can proceed more effectively.".

The less time is spent on visually identifying words and in "remembering" what they mean (lower level component processes), the more quickly higher level processing can proceed. Similarly Stanovich (1986) lists research showing that good reading ability correlates with quicker eye movements (i.e. the fovea, the point of focus in the retina, moves more quickly, processing letters and individual words more quickly and using less capacity). Grabe (1991:378), writing for an applied linguistics readership, summarises the research from psychology thus:

> "..many cognitive psychologists now see the development of automaticity in reading, particularly in word identification skills, as critical to fluent reading".

Many other ESL writers, citing similar sources, echo the same thoughts on how "efficient" word processing comes with good reading (e.g. Grabe 1988, Grabe & Stoller 1997, Mezynski 1983, Paran 1996, Nation & Coady 1988, Walcyzk 2000).

Given the correlational evidence that "...(knowledge of word meanings and comprehension) are distributed in a similar manner in the population" (Urquhart & Weir 1999:196), this study should give a good indication of students' reading ability.

3.1.3 The threshold argument

Laufer's (1985) argument was that students need to attain a certain level of L2 proficiency before they could read the L2 successfully. She further claimed that the most important element in this proficiency was vocabulary knowledge. The psycholinguistic evidence above shows us why this is may be true: low-level processing constraints prevent the lexically-challenged L2 reader from behaving in the way he does when reading L1, from being verbally efficient. Laufer's own work is really an attempt to quantify the relationship between word knowledge and reading ability, but both of the pillars of her threshold (95% tokens and 3000 words) are suspect. The percentage of "known tokens" necessary for reading undoubtedly varies from reader to reader, text to text, subject to subject, word type to word type and quite possibly day to day. 95% is no more than a rough estimate which we have adopted here for purposes of argument. The 3000-word figure must similarly depend on a number of circumstances. All this suggests that it is one thing to posit a threshold but quite another to say where it is. This study, however, in making the strong assertion that the 2000-word EL will provide 95% coverage of the words our students need for the purpose they have in mind, at least quantifies two important variables in the threshold equation. Therefore any claim to predict SUT students' reading ability from vocabulary knowledge will have that much more validity.

3.2 Which words?

The words necessary for reading foundation engineering textbooks were established by Ward (2000). This work produced a list of 2000 words which gave adequate coverage of the engineering textbooks they are required to read, based on five recommended textbooks. "Adequate coverage" is defined in the following way: that 95% of the running words in the text are known by someone who knows the 2000-word list. The list is called EL (engineering list) and is divided into two parts – EL1 (the first 1000 words) and EL2 (the second 1000 words). EL1 consists of the most common 1000 words.

3.3 Which test?

The test used here is the yes-no checklist test, where the subject checks the words he knows in a list. The yn test (as it will be referred to hereafter) is extremely simple as all the subject is required to do is indicate whether he knows a word or not. In order to guard against subjects claiming to know words which they in fact do not, a number of non-words (words which do not exist in English and therefore cannot possibly be known) are normally inserted in the list. The subject's score (calculated according to how many real words he has checked) is then adjusted downwards according to the number of non-words he has falsely claimed to know, this number being taken to represent his tendency to overestimate his own knowledge.

Perhaps the best-known modern proponent of yn tests is Paul Meara. Meara (1990:107) explains the advantages of the test:

3.3.2 Nonwords

The problem of subjects over-estimating their scores is normally dealt with by including various non-existent words and adjusting the subject's score (based how many words he claims to know) downwards according to the number of non-words he claims to know (explained in Meara & Buxton 1987). The formula for adjusting scores according to nonwords checked ("false alarms") is as follows:

$$\frac{A-B}{1-B}$$

where A = fraction of correctly checked real words
B = fraction of incorrectly checked non-words ("false alarms").

Thus if on a test of 100 items (50 real words and 50 nonwords) a testee checks 25 of the real words and no nonwords, he is taken to be answering factually and gets a score of

$$\frac{1/2 - 0}{1 - 0}$$

i.e. 50%. He is then assumed to know 50% of the words from which the sample is taken.

If on the other hand he checked 25 real words and 5 nonwords the result would be

$$\frac{1/2 - 1/10}{1 - 1/10}$$

i.e. 44%.

Nagy et al. (1985) identified three types of nonword: words with "decoding"-type errors like *robbit* (apparently spelling mistakes); "pseudo-derivatives" like *usal*; and English-like nonwords like *felinder*.

The question of the proportion of words to nonwords has no conclusive answer. I will follow the Eurocentres tests ratio of 2:1 (real/nonwords).

4. Pilot studies

Two pilot studies were undertaken, one at the Rajabhat Institute, Korat, and the other at Burapha University, Bang Saen. Since it was obviously impossible to test all the 1000 words in any of the lists, I wanted to know how big a sample to use. It was established that 60 per list was the minimum. This was the first result of the pilot tests. Secondly, it was established that there was no effect for the different sets of nonwords used, and that they could thus be used interchangeably in the SUT study proper. A third concern was whether or not subjects would perform to the best of their ability. The first pilot was inconclusive in this respect so with the second pilot special care was taken to supervise strictly and students were given as much encouragement as possible. This resulted in a much more "businesslike" atmosphere and more reliable scores.

5. The SUT study: results and discussion

The test was administered in a differential equations class near the end of their first year at SUT. This ensured that only engineering students (actually, engineering students-to-be) were present and that there would be a large number of subjects. 600 students were registered for the course, but only about 250 actually attended. According to the class teacher, this was a relatively good turnout. Students were not compelled to provide any information about themselves: it was felt anonymity might increase cooperation. There was however a space on the test form where they could write their year of study, and their i/d number if they wanted to know their results. 106 subjects volunteered the former information, 80 the latter. Of the 106, 97 were first year, 8 second, and one third. The teacher confirmed the impression that the great majority of the class were first year students, who were yet to begin their engineering courses proper.

The teacher pointed out that in order to enter this differential equations course all the first year students had passed Calculus 1 and 2 at their first attempt in the previous two terms[1]. This might indicate a better-than-average general academic ability, since many students fail these two courses. Also the fact that they attended at all indicated some degree of motivation, especially since the class was at 8 a.m. But it is impossible to draw any definite conclusions about the sample from these points.

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[1] The small number of second-year students had previously failed them.

I had come to believe that the presence of a foreign and perhaps intimidating teacher (myself) might lead some subjects to behave uncooperatively, so the administration of the test was put in the hands of two reliable and respected Thai teachers. It was explained carefully to students that the purpose of the test was to improve the English curriculum for them and their peers, and they were encouraged to do their best. They were also reminded to check only words that they knew the meaning of. Subjects took between 15 and 20 minutes to complete the test. I came in at the end: my impression that students were cooperating and taking the process at least fairly seriously was confirmed by the administrators.

There were three test forms:

1. A 60-item test of *EL1* (with 30 non-words), and a similar test of *EL2*. As before, these tests (and tests 2-4 below) divided the 60-word samples into 2 x 30 words. 50% of subjects took this test form.

3. A 60-item test of *EL1* (with 30 non-words), and a similar test of *g2*. 25% of subjects took this test form.

4. A 60-item test of *g1* (with 30 non-words), and a similar test of *EL2*. 25% of subjects took this test form.

In this way 75% of students would be tested on *EL1*, 75% on *EL2*, 25% on *g1* and 25% on *g2*: all students would be tested on at least one engineering list. This reflected the importance of the engineering lists for this study. All students were tested on one "most-frequent" list and one "less-frequent" list, to balance out the difficulty of the different versions

In practice the expected percentages given above did not turn out quite exactly.

Table 1 overleaf shows the scores. The left hand column shows the wordlist tested. The 6th column (in bold) shows the average score on the wordlist. For example, .565 indicates that subjects know 565 of the 1000 words in *EL1*.

bothered to do it properly. For these reasons students were given a positive purpose for the test (helping them and their peers read textbooks), they were granted anonymity, and the test was administered by teachers who were known to be well-liked and respected. But were they really doing their best?

A point about the yn test is that the task is so simple that great efforts of concentration are not required, so doing one's best is relatively easy. The almost uncanny similarity between the *EL1* results in pilot 2 and those at SUT also suggest that the scores are valid; surely it is much more likely that both sets of subjects were performing to the best of their ability rather than both being equally lazy! In fact one might have expected that the Burapha students, being second year as opposed to first, would have outperformed the SUT students. But they did not.

However the scores showed one worrying feature in that subjects scored consistently higher on the *a* versions (the first group of 30 real/15nonwords for each list) than on the *b* versions. Table 2 below shows the figures.

Table 2: Scores on a and *b* versions of all four lists

	mean	std. deviation
*EL1*a	.621	.127
*EL1*b	.505	.145
*EL2*a	.417	.130
*EL2*b	.352	.191
*g1*a	.743	.174
*g1*b	.679	.166
*g2*a	.553	.164
*g2*b	.484	.194

The *a* versions were not more "technical" than the *b* versions: *EL1* version a, for example, had 16 words from *es* and 14 from *gs*, while *EL1* version *b* had 17 *es* words and 13 from *gs*. This reflects the fact that there are 542 words in es which are not in gs (i.e. the slight predominance of *EL1*-specific words over *g1*-also words in *EL1*).

All the differences were significant at @=.05.

The scores on the *a* and *b* versions did correlate well, suggesting that the two versions were testing the same thing:

Table 3: Correlations between a and *b* versions of the yn test

	n	Correlation	Significance
EL1 a/b versions	177	.711	.000
EL2	175	.645	.000
g1	70	.672	.000
g2	70	.838	.000

but the difference in the *a/b* means is difficult to explain unless we accept that students did in fact get progressively fed up with the test. Since all subjects did the "easy" test (*EL1* or *g1*) before the "difficult" one (*EL2* or *g2*), it is quite possible that they did *EL1a* with more application than *EL1b*; *EL1b* with more application than *EL2a*; and *EL2a* with more application than *EL2b*. It is a failure of the test design that this possibility was not taken into account.

There is thus some evidence that the test scores may be inflated; some also that they may be deflated; and some that they accurately reflect students' vocabulary knowledge. What if these scores are an accurate reflection?

EL1 is the crucial list here, since it gives very high (over 93%) coverage of some typical basic engineering text. On the EL1 test, the mean, mode (.57) and median (.57) are virtually identical. There is a strong central tendency (a somewhat peaked curve) but the main departure from normality is in the trough around the 60% mark, hinting at two somewhat different populations. I will return to this point later.

The *EL1*/*EL2* means of .57 and .39 indicate that average students know only 570 of the 1000 words in *EL1* and only 390 of those in *EL2*. At first glance this looks as though the possibilities of them attaining sufficient vocabulary knowledge are remote, but in fact the figures are not quite as discouraging as they might seem. It is very likely that the 570 words they know tend to be towards the more frequent end of *EL1*. I assumed for purposes of argument that they knew exactly the most frequent 570 words of *EL1*, and the most frequent 390 words in *EL2*. In fact these truncated lists give surprisingly good coverage of a 60000-word engineering text.

Table 4: Coverage by shortened lists of a 60000-word engineering text

Word list	Coverage
EL1 (570 words)	90.1 (cf. 95.4% for all EL1)
EL2 (390 words)	1.7 (cf. 2.7% for all EL1)
Total	91.8

This vocabulary of under 1000 words (570 + 390) in fact gives 10% better coverage than the 2000 words of the GSL!

This 90% figure explains why it is very difficult for students to read textbooks (to my knowledge no researcher has claimed that successful reading can take place with one word in ten unknown) but also suggests that the average student is not that far from the "magic" 95% at all. It seems on the face of it feasible to expect students to learn, in their first year of university study, the 400 words necessary to bring them near 95%. The objection that this would expose them to large amounts of technical vocabulary for which they were not academically prepared does not really stand up to examination. Such technical vocabulary would consist of words in *EL1* which were not in *g1*, but consider the following random 50-word selection of these words:

stress / shear / volume / specific / axis / require / diameter / ratio / parameter / friction / horizontal / respective / bend / substitute / drag / block / depth / approach / principle / exert / reject / truss / radius / static / interact / accelerate / negative / proportion / triangle / mole / physical / interpret / investigate / path / convert / triangle / suffice / transverse / obvious / assign / concrete / dam / criterion / establish / assemble / excess / factorial / weld / throughout / stationary /

There is little technical difficulty involved in this list. As someone who stopped studying science or mathematics 35 years ago, the only words here that I would feel doubtful about explaining are *shear, truss, mole, transverse* and perhaps *factorial*. There may be some traps here where seemingly general words are used with technical meanings - *stress, specific* (specific gravity), *drag, path* - but in general the *EL1*-specific words do not present a heavy technical learning load.

However in their first year SUT students only have 108 hours of English instruction. In view of the improvement in general reading ability that would have to accompany this lexical improvement, which could only occur with large amounts of reading practice, it would be asking quite a lot in terms of motivation to do work outside class.

6. Conclusions

The syllabus guidelines issued by the Thai ministry of Education for the teaching of English in secondary schools are very vague in terms of words and structures. The latest relevant document (Ministry of Education 2002) states that students should improve their skills in "speaking, listening, reading and writing in connection with the following topics: personal information, family, school, the environment, food, drinks, personal relationships, hobbies and general welfare, buying and selling, the weather, studying and working in the tourism industry, management, places of interest, language, and science and technology, using a vocabulary of about 3600-3750 words." (p.5). Such categories might make some sense in a task-based learning environment with well-trained teachers but neither of these conditions obtains in Thailand. The majority of students study a book called "Blueprint", which is a general coursebook with a standard mixture of grammatical, functional and situational syllabuses.

In the face of this lack of direction teachers and pupils are more interested in the university entrance examination. This is in a multiple choice format and is largely based on short reading passages. These passages are based on the topics listed in the previous paragraph, but a sceptic might say it would be difficult to find passages that were not based on these topics. Of course as the examination approaches much class time is spent doing multiple choice sample papers above (Nawm[2], personal communication), but this does not seem to be successful either.

The point is that no special provision is made for students who have chosen the science/math option, who subsequently make up the engineering undergraduate population. This of course is reflected in the higher mean scores on *g1* and *g2* than on *EL1* and *EL2*.

If the *g1/g2* scores reflect reality, then the average subject knows about 1200 words of the 2000 most common words in the Brown corpus. Of course this does not show their total vocabulary, but it is highly unlikely

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[2] Head of Supervisory Unit of the Ministry of Education on Secondary English Teaching for Northeastern Thailand

that they are anywhere near the 3600 word target set by the Ministry. In any case they have had no special training for the task facing them when they reach university - reading academic material in English. This is reflected in the fact that their scores on the general vocabulary are considerably higher than on the engineering vocabulary. Textbook reading is thus rendered very difficult.

It is not the only thing that makes it difficult, but it is a basic problem that needs to be solved. It is, if you like, a necessary but not a sufficient condition for a solution.

What Nation (2001) calls "rich instruction" would be necessary in order for students to learn the necessary vocabulary. The words have to be seen many times, over an extended period of time, in a number of contexts. This could be accomplished by a reading programme centred around texts based on *EL1* - preferably in high school, but (given the bureaucratic difficulties of accomplishing change in the Ministry of Education) more likely in first-year university course. One would hope that by virtue of being reading-based the programme would also develop the other non-lexical aspects of reading. Such a programme would have to be content-based to some extent but probably not at any great level of difficulty. It might be possible to find commercial texts that provide the necessary reading material. EL would be a useful tool in deciding this, since it could function as a checklist to compare with the vocabulary syllabus in the commercial material. If commercial materials are not available, then universities have the task of adapting or rewriting authentic materials or writing their own texts. This in turn would involve cooperation between university engineering and English departments, a phenomenon not widely noted so far.

This study indicates that the learning task would be formidable for many students. There is also clearly a motivation problem; the more Thai engineering materials that become available (whatever the quality), the less students generally will be willing to make the effort to improve their English.

My tentative conclusion here is that there is a substantial minority of students who are near the lexical target for reading English textbooks and who might thus merit special treatment designed to help them read textbooks in English. The tests given here, which all show bimodal distributions, can identify these students. If we took the top 25% *EL1* and *EL2* scores, for example, then their mean knowledge of *EL1* is 650, and of *EL2* 480. This (assuming again that they knew the most frequent items in each list) gives us the following coverage of the 60000-word engineering text:

Table 5: Coverage by shortened lists(2) of a 60000-word engineering text

Word list	Coverage
EL1 (650 words)	91.4
EL2 (480 words)	1.9
Total	93.3

The final piece of evidence for the bimodality which justifies my (tentative) conclusion can also be seen from comparing the results of those students who identified themselves with those of students who did not. The former group outperformed those who preferred anonymity, with higher mean scores on all four tests.

Table 6: Comparison of means of identified and unidentified students

	N (identified)	Mean (identified)	N (unidentified)	Mean (unidentified)	
EL1	56	.6107	122	.5392	
EL2	51	.4454	123	.3637	
g1	22	.7591	47	.6959	
g2	26	.5576	45	.4860	

A one-way ANOVA test (Table 7 below) showed an effect for self-identification in all the tests except *g1* and *g2* (though Table 6 above seems to show a noticeably better performance on the latter two also):

Table 7: ANOVA test of effect for self-identification in 4 tests

	n	F	Sig.
EL1	175	5.812	.004
EL2	172	6.351	.002
G1	67	2.090	.132
G2	68	1.303	.278

There are several ways of interpreting this: it might be that the better students were less shy about having their knowledge revealed, or that they performed better because they were interested in the results. I would like to suggest tentatively that the self-identification might indicate various positive attitudinal traits - interest, desire to show knowledge, desire to succeed - and that the correlation between self-identification and scores supports the idea of bimodality in the population.

This study suggests that for a substantial minority of SUT students, there may not be that far to go to achieve the goal of being able to read textbooks, and that EL, an especially an *EL1*-based reading programme, might be a very useful tool in trying to achieve it. There would be difficulties involved, but something like this has to be done if there is any serious intention of enabling Thai engineering undergraduates to do what politicians, civil servants, businessmen and lecturers all agree they should do - gain access to academic material in English.

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