CHAPTER III
RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research methodology of the study. The description begins with research design, population and sample, and stages of research. After that, the pilot study is briefly described with results and suggestions for improving the main study. The description of the materials and instruments are divided into three main topics: the method of corpus compilation and word selection, classroom materials and research instruments. Regarding the corpus compilation, two main components i.e. the Engineering Corpus and two concordancers, are described. Then, the frequency-based method of word selection is explained on how to construct a target wordlist and weekly wordlists used in designing classroom materials and assessing instruments. The description of the classroom materials is concerned with the designs and validation of a lesson plan, handouts and activities in two version, and review tasks. That of the research instrument involves the design and validation of the tests, students' logs, teacher's field notes, questionnaires and interviews. Finally, the methods of data collection and analyses are presented.

3.2 Research Design

The study was conducted in the form of '*a matching-only pretest-posttest comparison group design*' (Fraenkel and Wallen, 2000). In this design, an experimental group was compared with a comparison group by matching students in pairs in terms of their proficiency levels of vocabulary. The design was represented as in Figure 3.1.

Figure 3.1: Representation of a research design

Experimental group	O_1	M	X_1	O_2	O_3
Comparison group	O_1	M	X_2	O_2	O_3

In this case, the Xs were independent variables referring to the teaching methods used in the study. The X_1 represented the concordance-based method whereas the X_2 referred to the conventional teaching method, in which vocabulary were taught through reading and vocabulary exercises without concordances. The M referred to the fact that the participants in each group had been matched according to certain variables i.e. their levels of vocabulary proficiency. The Os meant an observation whereby the O_1 represented the pretest, the O_2 referred to the posttest, and the O_3 meant the delayed test. The students' scores on these measures were dependent variables of the study. In the experiment, most learning conditions were similar in both groups. The difference was due to the demands of the different teaching methods used in the study. Table 3.1 summarizes the similarities and differences between them.

Table 3.1: Similarities and differences between the two sample groups

Similar Conditions
1. Teacher
2. Syllabus and lessons
3. Target wordlist
4. Period of time
5. Review tasks
6. Pretest/Posttest & delayed test

Different Conditions		
	Experimental group	**Comparison group**
Method	Concordance-based	Conventional
Classroom	Language laboratory	Normal classroom
Materials	Handouts with concordance information	Handouts without concordances
Activities	Hands-on & paper-based	Paper-based only
Teacher's roles	Supporter and facilitator	Knower

On the one hand, most learning conditions of both groups were the same. The researcher was the teacher teaching both groups using the RMUTL syllabus of Technical English Reading in one academic semester i.e. four months. The course description focused on reading articles, journals and textbooks related to the students' specialized fields. The vocabulary component was integrated, which was aimed at increasing vocabulary knowledge for academic reading. The same target wordlist was set as a learning goal for both groups and each weekly lesson focused on the same set of target words. In addition, each set of the review tasks and the tests were administered to both groups.

On the other hand, the differences between both groups were due to the demands of the used methods. The experimental group was exposed to '*a concordance-based method*' whereas the comparison group was taught with '*a conventional method of teaching vocabulary through reading*'. The differences included classroom settings, learning materials and activities. The experimental group

studied in a multimedia language laboratory equipped with sufficient computers for facilitating hands-on activities. However, the comparison group studied in a normal classroom using a whiteboard and an overhead projector. Another difference was the formats of learning materials. The handouts used in the experimental group consisted of linguistic items mostly in a concordance format including instructions used as guidelines for students to accomplish the given tasks while dealing with corpus information. In the comparison group, the handouts were in a traditional paper-based format without concordances. These handouts included reading passages with reading and vocabulary exercises. The lessons for both groups were parallel in content but the presentation and practice stage was designed in different versions. The experimental group was trained through paper-based and hands-on activities to deal with corpus information with guidance from the teacher and the handouts. However, the comparison group was taught by the teacher in presenting, explaining, clarifying, illustrating and providing practice on language items. Both groups were assigned to do exercises or tasks outside class.

3.3 Population and Sample

3.3.1 Population

The population of the study consisted of about 1,000 engineering undergraduate students at Rajamangala University of Technology Lanna (RMUTL), Tak Campus. The population was students who studied in two main disciplines, namely, Engineering and Industrial Education. Students in both disciplines shared a lot of interests in their specialized fields since the students studied the same foundation courses, differing only in regard to their specialized subjects. In this paper, the students from both disciplines are referred to as engineering students. RMUTL engineering students were typically homogeneous in terms of age, gender, first language, level of present education and previous English study. All students were Thai between the ages of 18-25. Nearly all of them were males with very few females. These students were assigned to different classes according to their specialized fields of study, namely Electrical Power Engineering, Mechanical Engineering, Industrial Engineering, Civil Engineering, Computer Science and Telecommunication

Technology. In four-year undergraduate programs, the students studied the same English courses: two Foundation Courses, Technical Reading, and either Conversation or Technical Writing. Before entering the universities, most students graduated from local secondary schools or technical colleges whereas the others were from nearby provinces in the northern areas of Thailand. In general, their previous English study was not much different. English classes were the main source of their English exposure with little chance of using English outside classrooms.

3.3.2 Samples

The samples of the study consisted of 52 RMUTL engineering students who were studying in the third year of their undergraduate programs in the academic year of 2005. All students were studying the same course of Technical English Reading for one academic semester or four months. The participants were selected with a purposive sampling method, not randomly selected, since they had already been allocated into classes. The two intact groups were obtained according to the availability of the classes. One group was randomly assigned to be an experimental group while the other represented a comparison or control group. To equate both groups, the students were matched in pairs according to their English vocabulary proficiency based on the pretest scores. Then, group equality was statistically verified by comparing the pretest mean scores using the *independent-sample t-test* of the SPSS program at the significance level of 0.05.

In the study, the experimental group consisted of 28 students in Electrical Power Engineering whereas the comparison group included 26 students in Industrial Engineering. Since the students were matched in pairs between groups, there were a total of 26 pairs i.e. 52 students in the study. As the number of the students in each group was nearly the same, only two students were excluded from the study. However, the pretest scores of both groups were not significantly different at the beginning of the study. When the students were matched in pairs, the difference in each pair was not more or less than three scores. It was found from mean comparison that both groups were somewhat comparable on their vocabulary proficiency with the mean difference at 0.31, $t = 0.809$, and $p > 0.05$ as illustrated in Table 3.2.

Table 3.2: Mean comparison of pretest scores in the main study

	t-test for Equality of Means				
	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Pretest: Equal variances assumed	.243	50	.809	.31	1.267

$p > 0.05$

Specific information of the samples was obtained from the questionnaire (see Appendix B) administered at the beginning of the study. The questionnaire was aimed at eliciting the details of all participants in four main aspects: students' personal information, previous English study, reading background, and computer skills. The details of the samples are described as follows.

3.3.2.1 Personal information

In general, the participants had a lot in common. They were of an average age of about 20. More than half of them graduated from local schools or colleges whereas the others were from nearby provinces in the northern parts of Thailand. Their overall academic performance was average, according to their last Cumulative Grade Point Averages (GPAs) which were mostly clustered around 2.50 – 3.00 out of 4 points. Only one participant in the experimental group was female but she was excluded from the study because of her much higher scores on the pretest than the others. Therefore, all participants in the study were male students.

3.3.2.2 Previous English study

Most students i.e. 83.3% started learning English at primary schools whereas 13% started at kindergartens and about 3.7% started at secondary schools. The average length of previous English study ranged from 10 to 13 years. Only six students occasionally studied with English-native teachers whereas the others had never done so. Before the experiment, they had studied two English Foundation Courses, in which only three students got grade A whereas the others got grades B, C and D at 32%, 36% and 30% respectively. In terms of their attitudes, the students on average liked studying English. Their main motivation for studying was for studying in higher education and for improving their job prospects. Their past learning habits were fairly good. They usually attended English classes, somewhat actively joined class activities and could usually complete assignments in time and

were rarely absent or late. However, they seldom had any chance to practise using English outside the classroom. The students rated their own English proficiency as good in reading and writing skills but poor in speaking and listening skills.

3.3.2.3 Reading background

About 70% of the students liked reading. They often read Thai newspapers, textbooks, advertisements, comics and cartoons. As for English texts, however, most students read at a sentence level and only 15 % of them read English texts longer than one page at a time and mostly with texts assigned in their specialized subjects. They indicated that the causes of their difficulties in reading were in the area of vocabulary and text organization.

3.3.2.4 Computer skills

In the experimental group, except for one student, all of them liked using computers and often used them in their daily lives. About 70% of the students had their own computers at home whereas the others usually accessed the computers at the university or computer-service shops. The students could use computers fairly well. The programs they mostly used were computer games, Microsoft Word, Power Point, Internet Explorer, Excel and CAD programs. These programs were often used for playing games, typing assignments, accessing websites and using technical programs. They sometimes used computers for e-mailing, chatting online or using self-study programs. Although all students had experience in applying computers to study different subjects in the forms of CD-ROMs and Internet webpages, not many of them used computers for studying English. None of them knew about language corpora.

3.4 Stages of Research

The Technical English Reading course used in the experiment was typically available only in the first semester of each academic year. Therefore, the procedure of the study was planned accordingly. The pilot study was implemented in the first semester in the academic year of 2004 whereas the main study was in that of 2005.

The main study was conducted within four months or one semester. After that, the data were analyzed and interpreted and the findings were reported.

3.5 Pilot Study

Before the main study was conducted, a pilot study was implemented to try out some concordance materials as well as to assess problems or difficulties which might arise during the experiment. The trial of materials was necessary because the concordance-based method was completely new in the experimental setting. Therefore, the implementation of the pilot study was expected to obtain insights and guidelines of how to design and improve the lessons including all necessary materials for the main study. In addition, problems concerning the use of them could be identified and tackled before the implementation of the main study. In this topic, the implementation of the pilot study is briefly described (see further details in Appendix C) with results and suggestions made for the main study.

The samples in the pilot study consisted of 21 pairs of RMUTL undergraduate engineering students similar to those in the main study. Before the pilot study, a small corpus of around 100,000 running words was compiled from academic texts in engineering. In text selection, the texts were randomly selected without grading or balancing in terms of text types and topics. After the corpus was compiled, 840 target words were selected on the criteria that they were words included in the GSL or the AWL (see these wordlists in Appendix D) which were also high frequency words in the corpus with at least 8 occurrences. Then, the resulting target wordlist was divided into 12 weekly wordlists, i.e. 70 words per list, used for designing weekly lessons and related materials. Four parallel lessons were designed in two versions: one with concordance information and the other without concordances. The lessons were planned with a strategies-based plan. The target words were presented in language input, activities and exercises.

A number of difficulties occurred in designing and implementing these lessons and materials. Firstly, the process of corpus compilation did not facilitate the designing practices and the corpus texts were very difficult for the students to read. Secondly, the number of target words was too large to cope with in each weekly

lesson. Thirdly, language presentation in classes are not motivating, especially in the concordance-based group since the materials did not facilitate learning by linking various aspects of words to be learned together. Fourthly, the students were not properly prepared for the concordance-based method before the lessons started.

It was found that the students could not properly deal with the concordance outputs which seemed overwhelming and confusing for them due to the absence of learner training before the study. The students reported that the difficulty was on dealing with the linguistic information in the corpus. Unfamiliar words in contexts were so many that they were not helpful in interpreting the focused text. They thought that the main cause was their insufficient proficiency in English. However, their attitudes towards the method were fairly positive. They realized that the method was useful for studying English but they needed longer training before they could deal with it adequately.

According to these problems, suggestions were provided for the main study on corpus compilation, the number of target words, lesson plan, and the provision of learner training. Firstly, a corpus had to be carefully re-compiled with grading and balancing on text types and topics. To reduce the difficulty and facilitate reading comprehension in concordances, text topics should be concerned with fundamental knowledge and clustered in a few particular topics. Secondly, the number of target words had to be reduced in order to obtain more time for sufficient practice. Thirdly, the lessons should be planned according to particular themes in order that various aspects of target words could be learned together. Finally, learner training should be provided step by step.

3.6 The methods of a corpus compilation and word selection

Based on the framework and guidelines suggested in the pilot study, a new corpus was specifically compiled for the main study as an important linguistic resource for selecting words and designing lessons, classroom materials, and research instruments. After that, words were selected to establish a new target wordlist used as a goal for designing all lessons, materials, tests and tasks. This topic describes the

corpus compilation of the Engineering corpus, freeware downloadable concordancers – *WCONCORD* and *AntConc*, and the frequency-based method of word selection.

3.6.1 The Engineering Corpus

The corpus used in the main study was entitled the '*Engineering Corpus*'. It was specifically compiled from academic texts in engineering fields. This corpus was used as a main linguistic resource for word selection as well as for designing all lessons, materials, activities, tasks and tests. In compiling the corpus, main considerations were on text selection as well as on a corpus size in order to make the corpus somewhat balanced and representative. In text selection, text topics and types were determined in order to obtain homogenous data clustered with typical recurrent features of a target language while the size of the corpus was kept small for making the corpus information manageable for the students, but still sufficient for particular recurrent features to be noticeable (cf. Aston, 2001).

3.6.1.1 Text selection

Text selection was based on sources recommended by RMUTL engineering instructors by using the questionnaire illustrated in Appendix E. Most texts in the corpus were from web-based resources (Aston, 2002). Only texts with topics concerning the fundamental knowledge of engineering such as *energy, technical drawing, engineering materials* etc. were selected in order to reduce a number of technical terms in the texts as well as to make the corpus information more readable for the students. Moreover, to obtain homogenous data in particular fields, Aston (2001) suggest that text topics should be clustered in particular areas. Accordingly, text topics in the present study were divided into four main areas which are common to the students. These topics included common interests in engineering, electrical power and electronics, mechanics and automotives, and computers and IT.

Topics concerning '*common interests in engineering*' were also restricted to five issues i.e. engineering fields, physics, materials, drawing and general matters. Topics such as '*electrical power and electronics*' and '*mechanics and automotives*' involved fundamental knowledge in the fields. The last topic, '*computers and IT*', involved the issues of using computers and IT in general. Apart

from the text topics, only five text types were used: textbooks and handouts, manuals and handbooks, articles and news, advertisements, and abstracts of articles and research. Balance of text topics and text types were taken into consideration. Details about text topics and text types in the Engineering Corpus are illustrated in Appendix E.

3.6.1.2 Corpus size

In the Engineering Corpus, the length of each selected text ranged from half a page to three pages. However, most texts were kept not more than one page long. All texts were saved in the main corpus called '*Total*'. To reduce the overwhelming amount of data for students, Aston (2002) suggests that dividing a corpus into sub-corpora is a good strategy because a small size of each sub-corpus is more manageable and available to be selected according to the focus of the study. In the present study, all information in this main corpus was divided and kept in five sub-corpora, namely: Textbooks, Manuals, Articles, Advertisements and Abstracts. The sub-corpus '*Textbooks*' included texts from textbooks and handouts used for studying fundamental subjects in engineering. As this type of texts was more frequently used in academic study, the sub-corpus '*Textbooks*' was bigger than the other four sub-corpora. It consisted of 200 computer files with 50 files concerning topics in each of four specified areas i.e. common interests, electrical power and electronics, mechanics and automotives, and computers and IT.

The other sub-corpora were '*Manuals*', '*Articles*', '*Advertisements*' and '*Abstracts*'. These sub-corpora included text types as signified by their names. The sub-corpus '*Manuals*' consisted of texts from manuals and handbooks to give instructions or suggestions on how to do something. The sub-corpus '*Articles*' contained news and articles in engineering journals, magazines and newspapers. The sub-corpus '*Advertisements*' included advertisements of engineering products. The last sub-corpus '*Abstracts*' contained abstracts of articles and research published in online journals or webpages. Each of these sub-corpora contained 140 computer files with 35 files concerning topics in each specified area. As a result, the main corpus '*Total*' or '*The Engineering Corpus*' consisted of 760 files in grand total, containing around 500,000 running words with about 24,000 word types. Statistical information of the Corpus is shown in Table 3.3.

Table 3.3: Statistical information of the Engineering Corpus

Subcorpora	Text Types	Topic Areas	Files	Words	Word Types
Textbooks (39.56%)	Textbooks & Handouts	Common Interests	50	39462	4830
		Electrical Power & Electronics	50	59248	5826
		Mechanics & Automotives	50	48307	5717
		Computers & IT	50	53167	6626
		Total	**200**	**200184**	**12975**
Manuals (16.43%)	Manuals & Handbooks	Common Interests	35	22044	3773
		Electrical Power & Electronics	35	24540	3366
		Mechanics & Automotives	35	20104	3007
		Computers & IT	35	16457	2498
		Total	**140**	**83145**	**7482**
Articles (28.13%)	Articles & News	Common Interests	35	47678	6324
		Electrical Power & Electronics	35	35378	5517
		Mechanics & Automotives	35	41186	5512
		Computers & IT	35	18121	4059
		Total	**140**	**142363**	**12480**
Advertisements (9.4%)	Advertisements	Common Interests	35	10669	3080
		Electrical Power & Electronics	35	12093	3166
		Mechanics & Automotives	35	13362	3390
		Computers & IT	35	11455	2850
		Total	**140**	**47579**	**8111**
Abstracts (6.47%)	Abstracts of articles & research	Common Interests	35	11704	3137
		Electrical Power & Electronics	35	6572	1934
		Mechanics & Automotives	35	7388	2045
		Computers & IT	35	7096	2105
		Total	**140**	**32760**	**6066**
The whole Engineering Corpus		**Grand Total**	**760**	**506031**	**24725**

3.6.2 Concordancers

Two concordancers were used in the study i.e. '*WCONCORD 2.0*' and '*Antconc 3.0.1*'. Both programs were freeware which could be downloaded from the Internet. *WCONCORD* was available at http://www.linlit.tu-darmstadt.de/downloads/wconcord.zip whereas *Antconc* could be downloaded from http://www.antlab.sci.waseda.ac.jp/software/antconc3.0.1.exe. *WCONCORD* was developed in 1996 by Zdenek Martinek from West Bohemia University in Pilsen (Czech Repulbic) and Les Siegrist from the Technische Hochschule Darmstadt in Germany. *Antconc* was released in 2005 with the development of Laurence Anthony from the Center for English Language Education in Science and Engineering (CELESE), School of Science and Engineering at Waseda University in Japan.

Both programs were very user-friendly and suitable for beginners with little or no experience with this type of program. They could operate basic functions of general concordancers very well in building word frequency lists, displaying statistical information, searching words and collocations, sorting outputs, displaying *KWIC* concordances, displaying source texts, and manipulating outputs. Nevertheless,

one limitation of *WCONCORD* was in its counting ability. The program would stop counting after around 16,000 lexical items. This made statistical information of a corpus that has more than 16,000 lexemes inaccurate, and not all concordances of the searched words could be displayed. Unlike *WCONCORD*, *Antconc* was more accurate in counting word frequency and more capable of displaying all concordances of the searched words. However, the concordance display of *WCONCORD* looked much simpler for beginners in observing word contexts than that of *Antconc* as seen in Figures 3.2 and 3.3 respectively.

Figure 3.2: A concordance display of *WCONCORD*

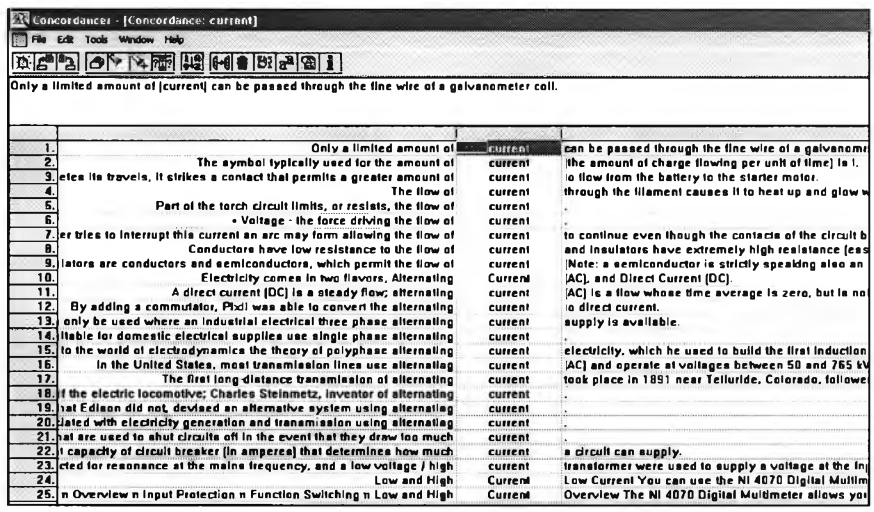
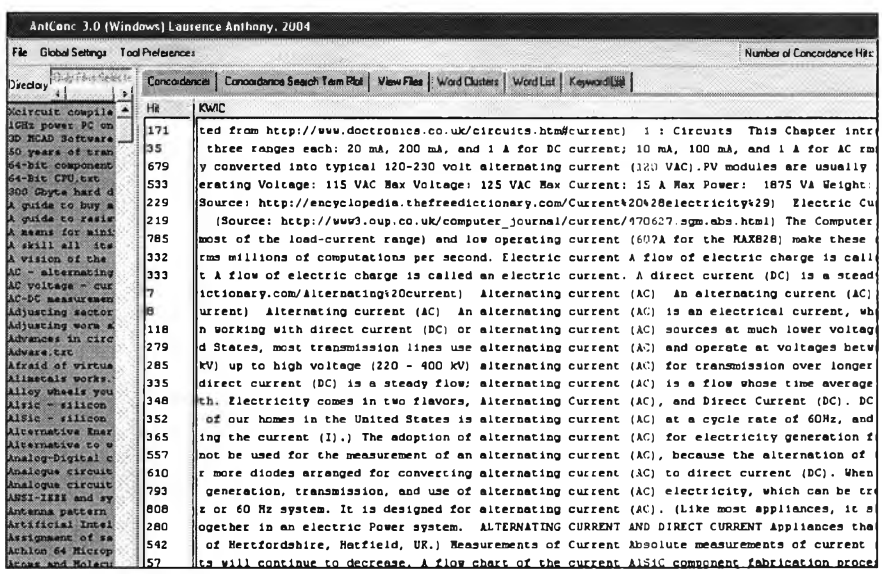


Figure 3.3: A concordance display of *Antconc*



In the study, therefore, *Antconc* was used by the teacher in selecting target words, designing lessons and preparing materials whereas *WCONCORD* was mostly used in classroom activities for training students to deal with corpus information. When students became more familiar with the operation of *WCONCORD*, they were encouraged to try using *Antconc*.

3.6.3 Word Selection

In the study, target words were identified to meet the goal of teaching academic vocabulary. These target words were aimed at words necessary for coping with academic texts as well as words frequently occurring in engineering academic texts. Thus the target words were selected on a frequency basis according to the following criteria: words in the lists of the GSL and the AWL, and words with high frequency i.e. at least 15 times in the Engineering Corpus. Two wordlists of the GSL and the AWL were set as '*reference lists*' since both lists together were regarded as lexical thresholds for academic reading as discussed in 2.2.2 in Chapter 2. These lists were used as criteria for selecting target words in a more manageable size (see Appendix D). In word selection, a word frequency list was built from the Engineering Corpus to check against the reference lists of the GSL and the AWL. The focus was more on the lexical words whereas most function words such as articles, pronouns, auxiliaries, prepositions and conjunctions were omitted. However, some function words which might pose problems to students such as '*despite, furthermore, regarding, except*' were also included in the target wordlist.

To select target words, words in the top ranks in a word frequency list of the Engineering Corpus were checked as to whether they were also words in the reference lists. If they were, the next consideration would be on whether they were words unknown by the students. Words predicted as students' known words were excluded whereas words predicted as unknown and useful would be included in the target wordlist. At this stage, teacher's discretion was important for determining students' known or unknown words by relying on her experience of teaching students at a similar level. The lexical word '*power*', for example, was a word in the GSL and appeared at a high rank on the frequency list with 1,694 occurrences. However, this word was known well by the students as referring to '*electricity or energy*' and this was the only meaning found in the corpus. Therefore, it was excluded from the target

wordlist. On the other hand, the word '*current*' was also known well by the engineering students as referring to '*movement of electricity*'. However, its other sense of '*at present or now*' was also found surprisingly in the Engineering Corpus and it was uncertain that students knew this sense of the word. Therefore, the word '*current*' with 812 occurrences in the Engineering Corpus was included in the target wordlist although it occurred less frequently than the word '*power*'.

3.6.3.1 Target wordlist

The resulting wordlist formed a '*target wordlist*' for vocabulary study in one semester. Therefore, the number of target words in the main study included 480 headwords, all of which were words in the GSL or the AWL with high frequency in the Engineering Corpus i.e. not less than 15 times (see Appendix G). With a frequency basis in word selection, the target wordlist was justified on the grounds that the words to be studied were necessary for academic reading and found often in engineering academic texts. This was one way to ensure that learners would get the best return for their vocabulary learning efforts

After the target wordlist was created, target words were used in designing weekly lessons, pretest/posttest and delayed test, and review tasks. The distribution of the target words in each practice is summarized in Table 3.4 whereas these distributed wordlists are illustrated in Appendix G.

Table 3.4: Distribution of target words

Items	No. of items	No. of words in each item	Total No. of words in each type of items	No. of occurrences of each word in the Engineering Corpus
Target wordlist	1	480	480	At least 15 times
Weekly Wordlists	12	40	480	At least 15 times
Pretest/posttest/delayed test 1. Definition part	1	51	101	At least 80 times
2. Cloze part		50		Depend
Review Tasks 1. Definition part	4	15	30 per task 120 in all four tasks	At least 50 times
2. Cloze part		15		Depend

To design weekly lessons, all 480 target words were distributed into 12 '*weekly wordlists*', each of which consisted of 40 words. Each weekly wordlist was a target of each weekly lesson. To design the pretest/posttest and delayed

test, 8-9 words were selected from each of the 12 weekly wordlists. There were 101 tested words in total: 51 words for assessing definitional knowledge and 50 words for assessing the ability to transfer lexical knowledge in the form of cloze passages. Words tested in the definition part were words occurring in the Engineering Corpus not less than 80 times. However, words tested in the cloze part were words naturally co-occurring with a set of other tested words in particular passages used in the test. To design four review tasks, ten words were selected from each list of three-related weekly wordlists. There were 30 reviewed words in each task and a total of 120 reviewed words in all four tasks. The format of the task was similar to the test. However, words reviewed in the definitional part were words occurring in the corpus not less than 50 times whereas words reviewed in the cloze part were words naturally co-occurring with a set of other reviewed words in particular passages.

3.6.3.2 Weekly wordlists

After the target wordlist was created, the list was divided into twelve '*weekly wordlists*'. Each weekly wordlist consisted of 40 target words to be studied in each weekly lesson and there were a total of 480 target words in all lists (see Appendix G). Words from the target list were grouped in each weekly list depending on their similarities in meaning or grammatical functions.

For example:

- Words referring to things in engineering e.g. *object, component, element, device, instrument, equipment* etc.
- Words referring to engineering workplaces e.g. *site, firm, plant, manufacturer, factory, organization* etc.
- Words used for giving definitions and examples e.g. *mean, define, refer, represent, such as, for instance* etc.
- Words often used in mathematics e.g. *amount, quantity, symbol, divide, multiply, equal* etc.
- Words with similar endings or suffixes e.g. *definition, description, preparation, expression* etc.

Each weekly wordlist was intended for students to work on. Therefore, words in each list were used in designing a lesson, class activities and tasks in the related week.

3.7 Classroom Materials

Classroom materials consisted of lesson plans, handouts and task sheets, and review tasks, all of which were used for conducting classroom activities.

3.7.1 Lesson plan

The whole lesson plan was divided into 12 lessons taught in 12 weeks. The class was held once a week in three consecutive periods i.e. 150 minutes in total altogether. The content in each lesson was based on a particular theme with the main focus on 40 target words in a given weekly wordlist. The outline in Table 3.5 illustrates an overview of the whole lesson plan in one semester.

Table 3.5: Outline of the whole lesson plan in the main study

Weeks	Lessons	Themes	Weekly Wordlist
1	Introduction of course description Administration of the questionnaire and pretest		
2	Introduction	Introduction to the concordance-based method for the experimental group Introduction to reading in general for the comparison group	
3	1	Engineering Fields	Weekly wordlist 1
4	2	Engineering Drawing	Weekly wordlist 2
5	3	Computers in Engineering	Weekly wordlist 3
6	4	Machines & Engines	Weekly wordlist 4
7	5	Energy and Electricity	Weekly wordlist 5
8	6	Electrical Systems in Automobiles	Weekly wordlist 6
9	Midterm Exam: Review Tasks 1 and 2		
10	7	Engineering Products	Weekly wordlist 7
11	8	Power Transmission	Weekly wordlist 8
12	9	How to Build an Electric Motor	Weekly wordlist 9
13	Revision and Review Task 3		
14	10	Latest Technology	Weekly wordlist 10
15	11	Causes of Failure	Weekly wordlist 11
16	12	Electric Vehicles	Weekly wordlist 12
17	Revision and Review Task 4		
18	Final Examination: Posttest		

These lessons were planned by using text types in the corpus as contexts with a theme-based plan. In addition, the preparation for concordance-based activities was also planned for learner training in the form of paper-based activities. These details are in the following three sub-topics: text types used as contexts, a theme-based plan and preparation for concordance-based activities as follows.

3.7.1.1 Text type used as contexts

The twelve lessons were based on twelve themes i.e. engineering fields, engineering drawing, computers in engineering, machines and engines, energy and electricity, electrical systems in automobiles, engineering products, power transmission, how to build an electric motor, latest technology, causes of failure, and electric vehicles. These themes, which were familiar to RMUTL students who were studying electrical and industrial engineering, were primarily chosen to motivate students to study in their familiar contexts. It was planned the themes would be presented in various text types in order to make students aware of different writing styles of texts. The language used in presentation and examples was extracted from the text types as illustrated in Table 3.6.

Table 3.6: Themes relating to text types used as contexts in lessons

Lessons	Themes	Genre / Text Types
1	Engineering Fields	Textbooks and Handouts
2	Engineering Drawing	Textbooks and Handouts
3	Computers in Engineering	Textbooks and Handouts
4	Machines and Engines	Textbooks and Handouts
5	Energy and Electricity	Textbooks and Handouts
6	Electrical System in Automobiles	Textbooks and Handouts
7	Engineering Products	Advertisements
8	Power Transmission	Articles
9	How to build an electric motor	Manuals and Handbooks
10	Latest Technology	News and Articles
11	Causes of Failure	Articles
12	Electric Vehicles	Abstracts of articles or research

The majority of texts were texts extracted from textbooks and handouts since they were used more often in fundamental subjects in engineering. The other text types were sometimes used for completing assignments in engineering courses but less often than textbooks and handouts. All texts which were planned to be presented in English classes had already been saved in the Engineering Corpus and had also been classified into its sub-corpora as described in 3.6.1.2. This made each type of text convenient for references when needed. In the comparison group, such types of language were prepared by the teachers to be presented in the classroom handouts. In the experimental group, however, texts might be presented either in the handouts or in hands-on activity while accessing the sub-corpus of each text type.

3.7.1.2 Theme-based plan

As the lessons were organized on particular themes, the target words were grouped in terms of the related themes as much as possible. The details of word groups in each lesson are illustrated in Table 3.7.

Table 3.7: Words grouped according to themes in the lessons

Lessons	Themes	Vocabulary
1	Engineering Fields	Words referring to engineering contexts, objects, workplaces, studies and practices
2	Engineering Drawing	Words concerned with technical drawing
3	Computers in Engineering	Words concerned with computers, their ability and features
4	Machines and Engines	Words used for giving definitions and examples
5	Energy and Electricity	Words concerned with calculation and ways of grouping things
6	Electrical Systems in Automobiles	Words used for describing equipment's parts, components, position, material property and ways of putting things together
7	Engineering Products	Common words in advertisements for describing good features of products
8	Power Transmission	Words used for describing processes
9	How to build an Electric Motor	Words used for giving instructions, suggestions and warning as well as for emphasizing instructions
10	Latest Technology	Words used for comparison and contrast
11	Causes of Failure	Words used for describing causes and effects, concerning damage and malfunction
12	Electric Vehicles	Words concerned with estimation and publication

The theme '*Engineering Fields*', for example, consisted of words concerned with tools, workplace or study which was often found in engineering contexts. Regarding the theme '*Engineering Drawing*', words often found in such contexts e.g. '*dimension*', '*measurement*', '*distance*', '*angle*' etc. were grouped together. Words unable to be grouped by their meaning might be categorized by their functions or uses which were useful for reading, for example, the use of the past participle which might cause problems for Thai students in interpreting reading texts. In addition, words used as discourse markers might be grouped together since they were useful for training students how to guess unknown words from contexts. Another example was one lesson based on the theme of '*Causes of Failures*'. The focus of the lesson was on studying vocabulary concerned with causes and effects e.g. '*cause*', '*lead*', '*due to*', '*result*', '*therefore*' etc. as well as words concerned with damage e.g. '*failure*', '*damage*', '*faulty*', '*injury*' etc.. At the same time, students would learn how to use cause and effect clues to infer the meaning of texts.

Grouping words by themes and their functions made it possible for word meanings to be studied simultaneously with some language points necessary to learn various aspects of words, rendering more meaningful learning activities (see Appendix H for more details). One example activity in which more than one aspect of words was studied was a lesson based on the theme '*Engineering Fields*'. In this unit, the target words were concerned with engineering contexts including the words '*condition*', '*situation*' and '*context*'. When the word '*context*' was introduced in some sample sentences or concordances, students were trained to deduce its meaning from the immediate contexts which were highlighted. Then, the concept of using context clues for guessing the meaning of unknown words was pointed out as an important strategy in reading. After that, students practised deducing the word meanings of the other two words '*condition*' and '*situation*' and then comparing the meanings and usage of these words. In some cases, words were grouped according to their similar grammatical function or word parts in order to teach word-attack skills by recognizing word parts. Thus, words with similar suffixes such as '*definition*', '*description*', '*demonstration*', '*preparation*' etc. were grouped together.

3.7.1.3 Preparation for concordance-based activities

To properly prepare students for concordance-based activities, before the first lesson began, an introduction lesson was planned for fully training students to deal with computer concordancing skills. At this stage, attention was entirely paid to the application and usefulness of the method rather than language study. In the same week, the other group was introduced to general concepts in reading academic texts. After the introduction lesson, the first two lessons were planned for gradually moving the students forward in dealing with the observation of concordances. These lessons were aimed at training them to observe the contexts of the keywords. In both lessons, paper-based concordances were mostly used since they were suitable for preparing students in observation skills for two main reasons. Firstly, some concordances could be graded and only the ones containing full sentences would be selected to prevent confusion or the students being overwhelmed. Also, it usually appears in fragmented data. Secondly, contexts of the keywords could be highlighted in bold or italic in order to draw students' attention to the language

point focused on at that time. In training students to deduce word meaning from contexts, for example, the context clues useful for the guesses were highlighted as in the sample activity in Figure 3.4.

Figure 3.4: Sample of a paper-based concordance activity

Activity: Guess the meaning of the keywords in the following concordances by using the bold words to help your guesses. Then match the keywords with their definitions.

Keywords	Definitions
..... 1. object	a. a thing
.....2. device	b. a part of something
..... 3. component	c. an electrical or mechanical tool

1	An	object	**is something** which can be seen or touched.
2	A falling	object	is a **thing** moving downwards.
3	A fast-moving	object	has a high speed.
4	A slow-moving	object	has a low speed.
5	A **switch** is a	device	**for** making or braking an electric circuit.
6	A **voltage regulator** is a	device	**to** keep the power stabilized.
7	An **electric motor** is a	device	**to** convert energy into mechanical power.
8	A **dynamometer** is a	device	**to** measure an engine's torque.
9	A **bearing** is one of a machine	component	used **to** reduce friction.
10	A **battery** is a major	component	**of** an electrical system in automobiles.
11	A **screen** is a displaying	component	**of** a computer.
12	A **capacitor** is a reactive	component	**of** an electric circuit.

In such activity, both language and concordancing skills were learned simultaneously. On the one hand, they were trained in a reading strategy for deducing word meaning from contexts. Thus, word meaning and the reading strategy were learnt together. On the other hand, they were trained to make use of a concordance format in observing the contexts for language study. With paper-based activities, context observation could be facilitated by highlighting key context clues as well as by selecting short concordances with simple language. Therefore, paper-based activities were proper for preparing students for hands-on activities by making them gradually familiar with the concordances step by step (see the sample plan in Appendix I).

3.7.2 Handouts and activities

Classroom materials used in each lesson included a single set comprising a handout and a task sheet. The handout was used during class activities whereas the task sheet was used as an assignment outside classes. Language items used for presentation and exercises were extracted and adapted from the Engineering Corpus. An individual lesson was designed in two versions: one with concordances used in the

experimental group whereas the one without concordances was used in the comparison group. The lessons of both versions were parallel in terms of target words from the beginning to the end of the semester. Accordingly, the same weekly wordlist of each lesson was given at the beginning of each handout to call students' attention to the target words when they found or revised them during or after the lesson. Despite focusing on the same set of target words, the presentation of them is not necessarily in the same order, depending on the contexts of each version. It was planned that most words in a given weekly wordlist were to be studied during class activities whereas some words were assigned for extra practice outside classes.

Activities in one lesson of both versions were divided into three main parts: *Warm Up, Presentation and Practice,* and *Application.* Only in the part of *Presentation and Practice*, were the activities in each version different whereas those of the *Warm Up* and *Application* were the same because these two parts had the same focuses for both groups on activating students' ideas at the beginning of the lesson, and on practising the transfer of lexical knowledge to new contexts at the end. Firstly, the part of *Warm Up* activities usually begins with class discussion to elicit students' participation as well as to raise their awareness on some points of language. This part is similar in both versions, except that one version uses concordance items but the other uses sentences.

The part of *Presentation and Practice* was aimed at practising some language points. In both versions, this part was typically divided into 5-6 activities in each lesson and each activity might include a few sub-activities. In the handouts, when new key concepts were introduced, written explanation and examples were also provided. However, the differences between them were the different formats of language presentation and activity types. The experimental group was trained to deal with concordance information in the corpus both in paper-based and hands-on activities using the guidelines and support from the teacher and the handouts. On the other hand, the comparison group studied vocabulary through reading together with the teacher's teaching and explanations. Nevertheless, in a concordance version, the presentation of language and examples was increasingly reduced in the subsequent lessons in order for students to complete tasks more independently from the teacher. The concordance handouts at the later lessons were used for assigning tasks, rather than providing guidelines and explanation as in the earlier lessons.

The last part of Application was similarly designed for students in both groups to practise transferring their newly learnt lexical knowledge in a particular lesson to new reading contexts. The activities were in the form of cloze passages with dense clusters of missing target words at a length of about 100-250 words per passage. In one lesson, there were about 1-2 passages with the topics corresponding to the theme of the lesson. The students' task was to fix the newly learnt words in the gaps of the passages. More details and examples of each part in both versions are presented below, starting from a concordance version in the experimental group and then followed by a non-concordance version in the comparison group. To highlight the different types of activities in both versions, these samples are extracted from the same lesson i.e. '*Lesson 4: Machines and Engines*' (see Appendices J and K) for illustrating the parallel lessons of both groups.

3.7.2.1 A sample concordance version

Despite the same focus in each lesson, the students in the experimental group were trained both in language and concordancing skills. They were assigned to explore language information from the corpus rather than obtaining language input from the teacher. The handouts were used as guidelines for the students to study from the corpus information. To complete the assigned tasks, they were encouraged to observe contexts in concordances and find information, examples and answers from the corpus. During classroom activities, the teacher acted as a facilitator and supporter to facilitate the activities and to provide help, if needed.

There were two main types of activities: paper-based and hands-on activities. In paper-based activities, target words were contextualized and prepared by the teacher. As discussed in 3.7.1.3, these paper-based activities was used in the first two lessons in order to prepare students for hands-on activities by making them gradually familiar with observation and concordancing skills. In the later lessons, paper-based concordances were used only when some language points needed to be clarified or when on-screen concordances of particular keywords would be too overwhelming for the students. To prevent students' confusion, concordances with full sentences and simple structures were selected to be presented in the handouts rather than those with fragments. However, fragmented concordances were

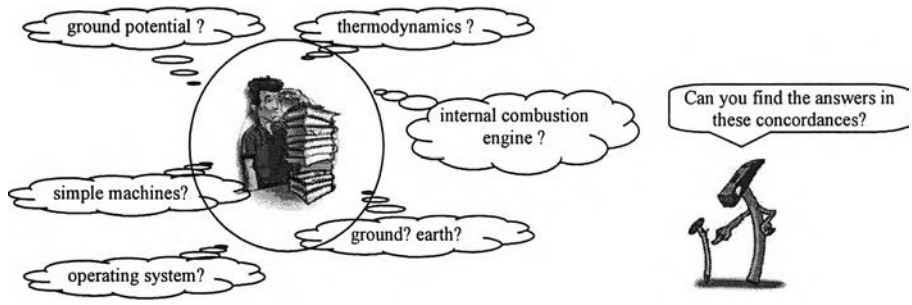
increasingly included in the later lessons when students became more familiar with them in order to make them aware of the nature of the corpus output.

The hands-on activities were introduced in Lesson 3 and then their application was gradually increased in the later lessons whereas the paper-based concordance was proportionally decreased. The sample handout of paper-based activities has already been illustrated and described in 3.7.1.3. Here, the description is on the lesson with hands-on activities (see a sample handout of the whole lesson in Appendix J). The sample lesson was based on the theme '*Machines and Engines*' with the focus on training reading strategies of guessing the meaning of unknown words from definition, description and example clues as well as from word parts. Generally, the *Warm up* activity in each lesson was aimed at eliciting students' existing knowledge for discussion in order to lead to new language points. A sample of this activity is illustrated in Figure 3.5.

Figure 3.5: Sample of a warm up activity in a concordance version

Warm Up

What do these words mean?



The	**term**	"*thermodynamics*" usually **refers to** the physical study of the state of a system.
The	**term**	"*internal combustion engine*" normally **refers to** any engine operating by burning fuel inside.
The	**term**	"*operating system*" **means** a computer software used for the direct control of basic system.
The	**term**	"*ground* (**or** *earth*)" usually **means** a common return in circuits.
The	**term**	"*ground potential*" **means** there is no difference in potential between a circuit point and earth.
The	**term**	"*simple machines*" **means** any devices required only a single force to work.

In this sample lesson, the technical terms were used to activate students' ideas and to draw their attention to the target words used as definition clues of the given technical terms. The concordance format made it easy to observe the contexts of the target word '*term*' and deduce its meaning. The other two target words i.e. '*refer*' and '*mean*' were highlighted in bold. In deducing word meaning and uses, the whole class discussed them together with some hints from the teacher. Then, the

concept of using context clues to guess the meaning of unknown words was introduced as an important strategy in reading. A written explanation and examples of such concept were also provided in the handout for students to review later, if needed.

Figure 3.6: Sample of learning activities in a concordance version

Activity 1: Studying context clues of definitions

Activity 1.1: Search the words '*refer**', '*define**', and '*mean**' to find the answers to the following questions.

1. Which form of each searched word, active or passive, is mostly used?
2. Which keyword is often followed by '*to*'?
3. Which keywords are often followed by '*as*'?
4. When is '*as*' used after these searched words?
5. What are typical collocations of these searched words?

Activity 1.2: Complete the definitions of the given words in the following concordances, using the information from the corpus. Then guess the meaning of the technical terms highlighted in ***italics***.

1	***Microfarad***	means	millionths of a Farad.
2	***Kinetic energy***	means	movement .....
3	In RF circuits, ***Fo***	means	.....
4	***AutoCAD*** is	defined	as interactive drawing .....
5	***Power*** is	defined	formerly as ..... per unit time.
6	***Energy*** is	defined	as '.....'.
7	***Currents***	refer	to .....
8	***Primary storages***	refer	to .....
9	***Engineering drawing***	refer	to .....
10	***The flow of electrons*** is	referred	to as ..... .
11	A ***CPU design*** is often	referred	to as ..... .
12	A ***semiconductor*** is	referred	to as a ..... that may act as a conductor or insulator.

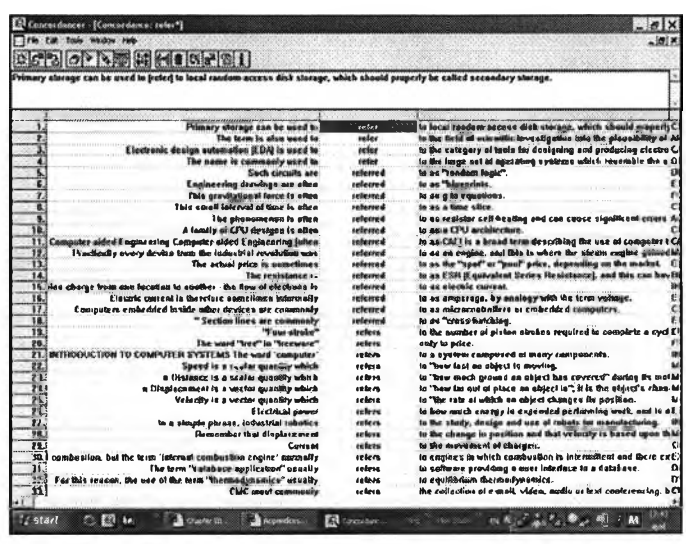
Activity 1.3: Each set of the given concordances has the same keywords which are missing from the lines. Read the concordances and determine which given keyword is missing from each set.

	means	defined	referred
Set	Q is	.....	as the frequency divided by the bandwidth, measured
1	One horsepower was	.....	as the amount of power needed to lift 33,000 pounds
	The volt was	.....	as the potential difference across a conductor when a
	The potential difference is	.....	as the amount of work per change.
Set	"Q = 0.5 C"	.....	the quantity of electric charge is 0.
2	An intangible thing	.....	a thing you can't grab it and throw it against the wall.
	Work	.....	moving something, lifting something, warming something,
	The term 'ground potential'	.....	there is no difference in potential (voltage) between a circuit
Set	Historically, 'memory'	.....	to "magnetic core memory" in the 1950s.
3	Engineering drawing are	.....	to as "blue prints'.
	Such circuits are	.....	to as 'conventional' current as opposed to electron flow.
	A family of CPU designs is	.....	to as a CPU architecture

The next activity was Activity 1 with three sub-activities. The students were assigned to explore the information from the Engineering Corpus used as their linguistic input rather than being presented with a reading passage. The handout as illustrated in Figure 3.6 was used to provide guidelines to do these activities. According to the handout, Activity 1.1 directed the students to study the target words '*refer*', '*define*' and '*mean*' by accessing the corpus to answer the given questions. The questions were provided to guide them step by step in observing the contexts of each keyword. As this lesson was at the beginning of applying hands-on activities, the teacher demonstrated how to operate the method and asked the whole class to follow the practice immediately after each step of the demonstration. At this stage, clarification and class discussion were often used. However, in the later lessons, a number of guided questions and the demonstration were reduced as students became more familiar with the method.

With the use of the concordancer, the information needed to answer the questions in Activity 1.1 could be searched and obtained quickly. After sorting the concordances by their left and right contexts, the typical patterns and collocations of the keywords were noticeable. With a wildcard search of '*refer**', for example, all word types of *refer* such as *reference*, *references*, *referred*, *refers* in the corpus would firstly appear on the screen. As the focus at this time was on a verb, two unfocused types i.e. '*reference*' and '*references*' were suggested to be deleted in order to make the language in focus more distinct. To answer the first question of whether an active or passive form of '*refer*' was mostly used, students were advised to sort the left contexts to get the output as in Figure 3.7.

Figure 3.7: Concordance output of '*refer**' with the left sort.



The sorted concordances made it convenient for students to identify language components of active and passive form of the keywords before inferring which form was mostly used. In addition, the comparison of the number of uses of each word type was also easy when using the number of concordance lines indicated at the left side of the screen and the scroll bar. Next, to answer the other given questions, the right sort would allow students to see which words often came after the keywords. In this case, even with the left sort, the preposition '*to*' was clearly seen as always coming after '*refer'* whereas '*to as*' usually comes only after its passive form. In such an activity, students were expected to quickly observe recurrent patterns of '*refer*', compare which form was mostly used, and infer its typical collocations i.e. '*refer(s) to*' and '*be referred to as*'. After obtaining all answers concerned with '*refer*', students repeated the same practice by themselves to find the answers concerned with '*define*' and '*mean*'. The answers from all given questions would make them aware of the different collocations among these target words.

In Activity 1.2, students further practised finding the definitions of the given technical terms by accessing the corpus. With the facility of a computer, it did not take long for students to complete the tasks. Then, they were asked to practice interpreting the completed concordances containing definitions of the given terms. In the last activity i.e. Activity 1.3, students were encouraged to retrieve this new lexical knowledge by finding the missing keywords from the given sets of the concordances. If students could remember that the typical collocations of '*refer'* were '*refer to*' and '*be referred to as*', it would not be difficult for them to fix the word '*referred*' in the gaps of concordances in set 3. This would happen similarly with the cases of '*mean*' and '*define*'.

The last part was Application, which was aimed at encouraging students to apply new lexical knowledge in reading. In other words, they practised retrieving word knowledge learned in the lesson and using the words in different contexts. The Application part was in the form of rational-deletion cloze passages where target words studied in the lesson were omitted from the passage. Words learned in previous lessons were highlighted in *italics* to remind the students. Some sentences found in earlier activities might be repeatedly found in cloze passages in order to recycle encounters of words and sentences, reduce difficulties in reading, and facilitate their understanding of the reading texts. Most weekly target words were studied during classes but if all activities could not be finished in time, students would be assigned to do them outside classes.

3.7.2.2 A sample non-concordance version

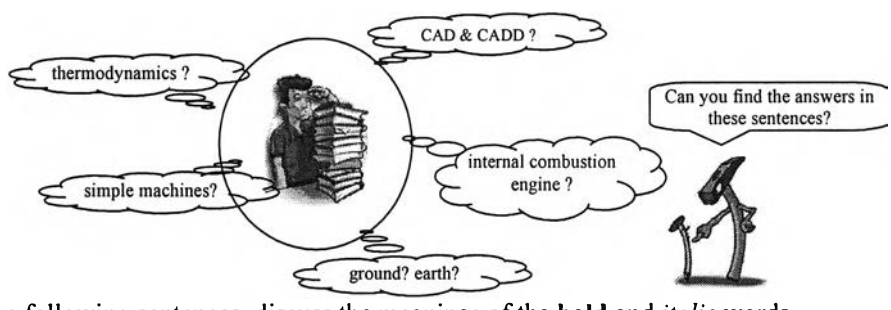
The materials for the comparison group were paper-based only and aimed at teaching various aspects of words through the contexts of short reading passages. Therefore, after the Warm Up activities, the lessons usually started with a short reading passage with a dense cluster of target words in that lesson. The questions following the passages were used to guide students on some new concepts concerning vocabulary learning, rather than to check reading comprehension. The tasks in each activity were concerned with strategies to guess the meaning of unknown words by using word-attack skills (e.g., breaking down word parts to guess word meaning) or using context clues (e.g., definitional clues and example clues). Target words might be either presented in the reading passage or vocabulary exercises. All of them were pre-selected and contextualized by the teacher. The teaching method is like many other conventional methods which include the teacher presenting, explaining, clarifying, illustrating, and the students practicing language items.

To highlight the different types of activities in two parallel lessons, the whole sample non-concordance version in Appendix K was extracted from the same lesson i.e. '*Lesson 4: Machines and Engines*' as illustrated in a sample concordance version. The sample *Warm Up* activity of a non-concordance version is shown in Figure 3.8.

Figure 3.8: Sample of a warm up activity in the handout of the comparison group

Warm Up

What do these words mean?



From the following sentences, discuss the meanings of the **bold** and *italic* words.

- The ***term*** "*thermodynamics*" usually **refers to** the physical study of the state of a system.
- The ***term*** "*internal combustion engine*" **refers to** any engine operating by burning fuel inside.
- All these ***terms*** , "*CAD and CADD*", **refer to** the designing and technical drawing.
- The ***term*** "*ground* (**or** *earth*)" usually **means** a common return in circuits.
- The ***term*** "*simple machines*" **means** any devices or mechanical components required only a single force to work.

As mentioned earlier, in this version the activity was not much different from that in the other group, except that the linguistic examples were not in a concordance format. Students' existing knowledge was elicited for discussion in order to draw their attention to new target words: '*term*', '*refer*' and '*mean*' highlighted in **bold** and a strategy to use these words as definition clues to guess the meaning of some technical terms highlighted in *italics*. During this activity, it was pointed out to students that most technical terms frequently occurring in academic texts were defined and they could find the meaning of the words without referring to a dictionary if they knew how to use the definition clues. Written explanation on the concept of context clues and some examples were provided in the handout for the students to review, when needed.

The following activities were included in the part of *Presentation and Practice*. This part consisted of six activities in this lesson. Activity 1 was selected for discussion here with the related handout illustrated in Figure 3.9. This activity was divided into three sub-activities focusing on teaching a set of target words '*mean*', '*define*' and '*refer*' in terms of their meanings, collocations and uses for giving definitions to other words. In addition, skills of getting information and using definition clues were integrated.

In Activity 1.1, a short reading passage entitled '*Machine*' was presented with the target words highlighted in *italics*. Pre-&post-questions were used for drawing attention to the language in focus as well as for checking reading comprehension. Class discussion was used to introduce the concept of definition clues as well as to compare the answers. Then, Activity 1.2 was aimed at drawing attention to different collocations of the target words. Students studied typical collocations of each word in three given sentences which were nearly the same and then identified the differences among them i.e. '*means*', '*be defined as*', and '*be referred to as*'. After that, they matched the given technical terms with their definitions and practised using these collocations in constructing sentences. In Activity 1.3, the practice was on observing collocations of the target words before completing the given sentences. At this stage, students were told to pay attention to the immediate contexts of the omitted words and then use their new knowledge of the word collocations to complete the gaps with the given words.

Figure 3.9: Sample of learning activities in a non-concordance version

Activity 1: Studying context clues of definitions

Activity 1.1: Read the following passage and answer the questions.

1. How many words are defined in the following passage?
2. What are they?

Machines

The *term* 'machine' *means* an assembly of parts operating together to perform work. A machine *is* generally *referred to as* any mechanical or electrical device that transmits or modifies energy to perform or assist in the performance of tasks.

A simple machine is *defined as* a mechanical component *such as* bearing, gear, lever, screw whereas a machine tool *is defined as* a powered mechanical device *such as* lathe, mill, drill etc. The term 'machine tool' *is* usually *referred to as* tools that used a power source.

A computer-controlled machine *is known as* a computer-numerical-controlled (CNC) machine. A CNC machine *refers* specifically *to* the machine tools which are controlled by computers in manufacturing work. It *is* sometimes *called* machine intelligence or artificial intelligence. In one sense, CNC machines may be said to *represent* special industrial robot systems.

Answer the following questions.

1. What is a machine?
2. What is a simple machine?
3. What are examples of a simple machine?
4. What is a machine tool?
5. What are examples of a machine tool?
6. What is a CNC machine?
7. What is another name for a CNC machine?
8. What may a CNC machine stand for?

Activity 1.2: Study the following sentences.

- A machine **means** an assembly of parts operating together to perform work.
- A machine **is defined as** an assembly of parts operating together to perform work.
- A machine **is referred to as** an assembly of parts operating together to perform work.

Match the words in column A with their definitions in column B. Then make up sentences as in the above sentences.

A	B
..... Power	a. movement energy
..... Energy	b. an electric current.
..... Kinetic energy	c. an ability to do work.
..... A semiconductor	d. units of energy per unit time
..... The flow of electron	e. a material that may act as a conductor or as an insulator.

Activity 1.3: Complete the following sentences with the given words.

means *defined* *referred*

1. 'Binary', coming from the Latin, ... twice or two.
2. In this context, data is ..... as a collection of numbers or characters.
3. A device from the industrial revolution was ..... to as an engine.
4. Technology ..... the study and science of techniques.
5. Random Access Memory (RAM) ..... that the memory cells can be accessed in any order.
6. Artificial intelligence is .....as intelligence shown by anything manufactured by humans.
7. One AMP is .....as 625,000,000,000,000,000,000 electrons moving across a circuit every second!

The other activities in this lesson were on studying other sets of target words i.e. sets of words used for giving descriptions and examples and words

with similar suffixes. Some words presented in the previous activities might be studied again but with a different focus. For example, the words '*define*', '*describe*', '*express*', and '*represent*' had already been introduced as markers of definition and description clues in Activity 1 but they were also grouped with another set of target words for studying word parts or similar suffixes of '*-ion*' i.e. '*definition*', '*description*', '*expression*', '*representation*' etc. Similarly, the word '*refer*' had been grouped with the words ending with '*-ce*' or '*-ence/-ance*' e.g. '*reference*', '*acceptance*' and '*existence*'. The last part of the lesson, i.e. Application, was similar to that of the experimental group since the objective of the activity was to encourage students to apply or transfer new knowledge just learnt in the lesson to reading contexts.

3.7.2.3 Validation of classroom materials

The validity of the lesson plan, handouts and task sheets was established by consulting three experts in the fields of EFL teaching and classroom concordancing. The assessment focused on content selection, activity design, the consistency of lessons in the two groups, and the justification of the content selection and the activity design in serving the objectives of the study (see the checklist in Appendix L). The results from the checklist revealed that there was no controversy among the experts' opinions although their suggestions were different in the details. Overall, all experts agreed that content selection and activity design were justified in nearly all areas and could well serve the objectives of the study. Regarding the difficulty level of the content, however, one expert rated this issue as unsure and gave comments on an activity concerned with the skill of deducing word meaning with limited citations as well as suggested ways for improving it. On the other hand, all of them were much concerned about the length of time available. Regarding the assessment of an individual activity in each lesson, about 90% of opinions agreed that the activity design was justified and could cover the necessary issues which should be learnt.

Useful suggestions were given for improving the materials on four issues: to simplify written instructions and explanations, include more variety in language presentation and practice, reduce the difficulty level of the content in some activities, and reduce the amount of content in each lesson to obtain sufficient time for

all activities. Based on these suggestions, the lesson plan and classroom materials were modified accordingly. The main problem was the lessons did not match the time provided. With such available time, each lesson was crammed with a lot of activities due to the attempts to contextualize and cover all given weekly target words. Although the number of the weekly target words was reduced from 70 words a week in the pilot study to 50 words a week in the materials being assessed, the problem of crammed lessons could not be solved. Therefore, in the main study, the number of the weekly target words was reduced further to 40 words a week.

3.7.3 Review tasks

Four review tasks designed by the teacher were used as on-going assessments (see Appendix M) to track learning development at different stages of the study. An individual review task was initially planned to be assigned to both groups for reviewing words in three related lessons. However, due to the time limitation, the first two tasks had to be used together as the mid-term exam whereas the other two tasks were assigned separately in the subsequent three weeks respectively. Like the tests, an individual task was divided into two parts: one for reviewing definitional knowledge and the other for reviewing transferable knowledge. The definitional part was designed in the form of matching words to the right definitions whereas the other part concerned with knowledge transfer was in the form of rational-deletion cloze passages.

All four review tasks consisted of 120 reviewed words in total i.e. 30 words per task. In the word selection for designing each task, 30 words were selected from three related weekly wordlists i.e. 10 words from each. Then, half of the selected words were used in each part of the task. Fifteen words reviewed in the definition part were words occurring in the Engineering Corpus not less than 50 times whereas words used in the transferable knowledge part were words naturally co-occurring with a set of other reviewed words in particular passages. The details on word selection for designing the tasks were summarized in Table 3.8 (see all 120 reviewed words in Appendix G).

Table 3.8: Details on word selection for designing the tasks

Weekly Wordlist (40 words per list)	Number of Selected Words Per Review Task	Total Number of Words Per Review Task	Number of Words in Each Part of the Task	Number of Each Word's Occurrences in the Corpus
Weekly wordlist 1	10	30 words in Review Task 1	Part I = 15	At least 50 times
Weekly wordlist 2	10			
Weekly wordlist 3	10		Part II = 15	Depend
Weekly wordlist 4	10	30 words in Review Task 2	Part I = 15	At least 50 times
Weekly wordlist 5	10			
Weekly wordlist 6	10		Part II = 15	Depend
Weekly wordlist 7	10	30 words in Review Task 3	Part I = 15	At least 50 times
Weekly wordlist 8	10			
Weekly wordlist 9	10		Part II = 15	Depend
Weekly wordlist 10	10	30 words in Review Task 4	Part I = 15	At least 50 times
Weekly wordlist 11	10			
Weekly wordlist 12	10		Part II = 15	Depend
	Grand Total	**120 words from all target words of 480 words**		

3.7.3.1 Definition Part

The definition part was designed to include 15 items making up 5 sets of 3 definitions and 6 words as options. In other words, 3 definitions were provided in each set whereas the three target words were given as options together with the other three distractors. The students had to match the given definitions to the right words in order to get a score on each item as in the following sample set of three items.

Example:

	Definitions	Words	
....c...1	a thing	a. fact	d. task
...a...2	Information	b. edge	e. condition
...d...3	a piece of work	c. object	f. organization

The given definitions were mainly based on two online dictionaries i.e. the *Cambridge Dictionary Online* and the *Newbury House Dictionary of American English*. The definitions given were short and simple in order not to overload students with reading. The optional words in the same set were words with the same grammatical function but with clear-cut meanings to eliminate ambiguity.

3.7.3.2 Cloze Part

The second part which was in a cloze format consisted of 3 short rational-deletion cloze passages with 3 reviewed words in each. In each passage, 5 reviewed words were deleted and were given as choices plus three other distractors,

making up 8 options in total. The following sample is extracted from one cloze passage from Review Task 1.

Example:

I. Electric Current

(Source: Adapted from a passage available at http://encyclopedia.thefreedictionary.com)

advantage as conduction corrected defined internal means original

Electric current is any flow of charge, usually through some electrical conductors. In the past, current was (1)..... in the history of electrical science (2)..... a flow of positive charge. However, in the case of metallic (3)....., current is caused by a flow of negatively charged electrons in the opposite direction. Despite this misunderstanding, the (4)..... definition of current still stands.

The symbol *'I'* is typically used for the amount of current or charge flowing per unit of time. Historically, the symbol for current, *I*, came from the German word *Intensität*, which (5)..... *'intensity'*. The SI unit of electrical current is called the *ampere*.

In total, there were 3 cloze passages in each task and 12 passages in all four review tasks. The used passages were semi-authentic with a length of around 100-170 words. The readability of each passage was calculated for *The Flesch-Kincaid Grade Level* and *The Flesch Reading Ease Scores* by using the calculating program of '*Flesh 1.5*' developed by Jack Frink (2005). According to Frink (2005), *The Grade Level* indicates an index that gives the years of education required to comprehend a document whereas *The Reading Ease Scores* rates text on a 100-point scale; the higher the score, the easier it is to understand the document. These two indices of scores are often found in comparison with each other, which can be summarized for convenient interpretation as shown in Table 3.9.

Table 3.9: Interpretation of readability value

Reading Ease Scores	Reading Grade Level	Reading Difficulty
90-100	5^{th} grade	Very easy
80-90	6^{th} grade	Easy
70-80	7^{th} grade	Fairly easy
60-70	8^{th} – 9^{th} grade	Standard
50-60	10^{th} -12^{th} grade (High school)	Fairly difficult
30-50	13^{th} -16^{th} (Some college)	Difficult
0-30	Graduate level	Very difficult

The average readability values of twelve passages used in the Review Tasks were calculated and illustrated in Table 3.10. The Reading Ease Scores

ranged from 35.59 to 70.34 with the mean score at 48.27. The passages with the scores nearly reaching the cutting points of 50 were interpreted as suitable for students at a college level and perhaps at high schools as well. The average Grade Level of 9.84 confirmed that the passages were suitable for students in the 9^{th} – 10^{th} grades in the US high school level system. Therefore, the texts were considered as being suitable for the present study dealing with undergraduate students.

Table 3.10: The average readability values of the passages in the review tasks

	N	Minimum	Maximum	Mean	Std. Deviation
Reading Grade Level	12	7.11	11.55	9.8483	1.37644
Reading Ease Scores	12	35.59	70.34	48.2717	9.58689

In scoring, each correct item in the tests was marked and given a score of 1 score whereas a wrong item was marked as 0. Then, all the correct items of an individual student were totaled to determine his gained scores: A total score of 15 on the Definition Part and 15 on the Cloze Part. All review tasks were validated together with the pretest/posttest and delayed test. The validation of these instruments is described later in 3.8.1.3.

3.8 Research Instruments

There were five main types of instruments for collecting data in this study: pretest/posttest and delayed posttest, students' logs, teacher's field notes, questionnaires, and interviews.

3.8.1 Pretest, immediate posttest and delayed posttest

The pretest, immediate posttest and delayed posttest (see Appendix N) were teacher-designed in the same paper used as achievement tests for assessing definitional and transferable knowledge at different stages of the study. The pretest was administered at the beginning of the study, the immediate posttest was at the end, and the delayed posttest was a month after the study. In administering the delayed posttest, the students were not told in advance in order to prevent any effects of students behaving differently from normal such as reviewing the lessons more than

usual or memorizing some points from the previous posttest. The pretest was used to assess students' vocabulary knowledge before the experiment. After finishing the study, the results from the immediate posttest of both groups were compared to assess the differences in learning effects on definitional knowledge and transferable knowledge. In addition, the comparisons between the average scores of the immediate and delayed posttests were used to determine the retention percentages of the two teaching methods as well as the difference in retention rates between groups.

The test format was similar to that of the review tasks i.e. divided into two parts: the Definition Part for measuring the definitional knowledge and the Cloze Part for measuring transferable knowledge. The Definition Part was in a matching format, slightly adapted from the Vocabulary Level Tests of Schmitt et al. (2000) whereas the Cloze Part included rational-deletion cloze passages, similar to those used in Cobb's studies (1999a and b; and 1997a and b). Regarding the tested words, 8-9 words from each weekly wordlist were selected to make up 101 tested words in total. Then, 51 words were used in the Definition Part whereas the other 50 words were used in the Cloze Part. Words already used in the review tasks were excluded from the test. The words tested in the Definition Part were target words with high frequency in the Engineering Corpus i.e. at least 80 occurrences whereas words in the Cloze Part were words naturally occurring together with other target words in the same set. The details on word selection for designing the test were summarized in Table 3.11 (see all 101 tested words in Appendix G).

Table 3.11: Details on word selection for designing the test

Weekly Wordlist (40 words per list)	**Number of Selected Words**	**Total Number of Tested Words**	**Number of Words in Each Part of the Test**	**Number of Each Word's Occurrences in the Corpus**
Weekly wordlist 1	9	101 words in total	Part I = 51 (17 sets of 3 words)	At least 80 times
Weekly wordlist 2	8			
Weekly wordlist 3	9			
Weekly wordlist 4	8			
Weekly wordlist 5	9			
Weekly wordlist 6	8			
Weekly wordlist 7	9		Part II = 50 (5 words / passage)	Depend
Weekly wordlist 8	8			
Weekly wordlist 9	9			
Weekly wordlist 10	8			
Weekly wordlist 11	8			
Weekly wordlist 12	8			

3.8.1.1 Definition Part

In designing the Definition Part, 51 test items were made up of 17 sets of 3 definitions and 6 words as options. The given definitions in the test were based on online dictionaries i.e. the *Cambridge Dictionary Online* and the *Newbury House Dictionary of American English.* A set of 6 options consisted of 3 tested words and 3 distractors. The options in the same set were words with similar grammatical functions and clear-cut meanings to prevent ambiguity. The test-takers' task was to match the given definitions with the right target words as in the following two sets of examples.

Example:

	Definitions		Words
....f...1	Give	a. improve	d. press
...e...2	Receive	b. bend	e. obtain
...a...3	make better	c. detect	f. provide
...a....4	Look for	a. search	d. decrease
...f....5	tell about	b. permit	e. shift
...e....6	make change	c. satisfy	f. describe

3.8.1.2 Cloze Part

The last part was for testing the ability to transfer lexical knowledge to reading contexts in the form of the rational-deletion cloze passages. This part consisted of 10 short cloze passages, in each of which five tested words were omitted. Therefore, there were 50 tested words in total in this part. The omitted words were among the choices provided. The test-taker's task was to reconstruct the text by putting the tested words in the right gaps of the passage. One sample cloze passage of the test was illustrated below.

Example:

II. Energy

(Source: Adapted from a passage available at http://www.energyquest.ca.gov/story/chapter01.html)

amount different element equal integral invented measured medium

Energy causes things to happen around us. It can be found in several (6)..... forms. It can be chemical energy, electrical energy, heat (thermal) energy, light (radiant) energy, mechanical energy, and nuclear energy.

Energy is measured in many ways. One of the basic measuring units is called a Btu. Btu stands for 'British thermal unit', and was (7)..... by the English scientist. Btu is the (8)..... of heat energy used to raise the temperature of one pound of water by one degree Fahrenheit, at sea level.

Energy also can be (9)..... in joules. A thousand joules is (10)..... to a British thermal unit (i.e. 1,000 joules = 1 Btu).

The Cloze Part of the test consisted of 10 passages in total. These passages were semi-authentic and were about 100 – 223 words in length. The average readability values of the passages as illustrated in Table 3.12 was 9.42 in Reading Grade Level and 52.06 in Reading Ease Scores. These values were approximately similar to those of the review tasks which meant that the ease/difficulty level of the passage was considered suitable for students at 9th Grade of the US high school level. Although the reading ease scores of 52.06 indicated that the texts were fairly difficult, they were justified in the study as all of them are authentic academic texts appropriate for undergraduate students.

Table 3.12: The average readability values of the passages used in the test

	N	Minimum	Maximum	Mean	Std. Deviation
Reading Grade Level	10	6.33	11.95	9.42	1.52631
Reading Ease Scores	10	40.14	66.96	52.06	7.74173

In scoring, each correct item in the tests was marked and given a score of 1 whereas a wrong item was marked as 0. Then, all the correct items of an individual student were totaled to determine his gained scores: a total score of 51 on the Definition Part and 50 on the Cloze Part.

3.8.1.3 Validation of the test and the review tasks

After the test and all review tasks were constructed, they were assessed for their validity and reliability. To validate the contents, two experts in the fields of testing and assessment were consulted. For item validation, three English instructors at RMUTL were also requested to validate these measures (see validation checklists and results in Appendix O). Regarding the content validation, the experts gave their opinions on the checklists on the issues of word selection, format and design, and consistency to the objectives of the study. To calculate the data from the checklists, the items marked indicating agreement on justification are rated 1, those indicating disagreement are -1, and those indicating unsure are 0. Then, these results were calculated for their means and the overall results are shown in Table 3.13. The issues were considered justified if the mean values were not less than 0.5.

Table 3.13: Results from the content validation of the test and review tasks

	Minimum	Maximum	Mean	Std. Deviation
1. Word Selection: Criteria	1	1	1.00	.000
Representativeness	0	1	.50	.707
2. Part I: Instructions	-1	0	-.50	.707
Test format	0	1	.50	.707
Definitions	0	1	.50	.707
Distractors	0	0	.00	.000
3. Part II: Instructions	-1	0	-.50	.707
Test format	0	1	.50	.707
Length of passage	1	1	1.00	.000
Enough contexts	1	1	1.00	.000
Variety of text types	1	1	1.00	.000
Topics of passage	1	1	1.00	.000
Contents	0	1	.50	.707
4. Overall: Conform to objectives	1	1	1.00	.000
Time	0	0	.00	.000

(N = 2)

According to the results in Table 3.13, all issues were justified because their means were not less than 0.5, except the issues of the instructions in Part I and II. The criteria for word selection were considered appropriate. Regarding representativeness, however, different ratings were received. One expert agreed that the number of tested and reviewed words i.e. over 30% of all target words was statistically enough to represent the entire target words whereas the other expert rated this issue as '*unsure*'. He mentioned that although such a number seemed justified, there was no rule of thumb to ensure such representativeness. In fact, after the validation of classroom materials, the number of target words was reduced from 600 to 480 words. As a result, the total number of tested and reviewed words i.e. 101 and 120 words respectively formed 221 words which were about 46% of the target words. Such number was nearly half of the target words and all these words were also balanced in terms of word presentation at different stages of the study. Therefore, this number may be claimed to represent the target words.

In Part I of the measure, nearly all issues obtained different ratings, except for the appropriateness of distractors which were similarly rated as '*unsure*'. In cases of distractors, it was suggested that options in each set should be grouped according to similar grammatical functions to prevent confusion. Based on their suggestions, distractors in Part I were modified as suggested. The remaining three aspects being assessed were instructions, test format and given definitions. Firstly, it was suggested that the instructions should be made simpler and clearer both

in Part I and II. Secondly, the format of the test, as suggested by one expert, should be improved in terms of a typing format, not a design format. Finally, some definitions given in the measures were considered ambiguous and had to be modified to make them clearer. Based on these comments and suggestions, Part I in all measures was modified accordingly.

In Part II, nearly all issues were similarly rated as being justified, except for three issues on instructions, test format and contents selection. The instructions and the test format received the same comments and suggestions as those in Part I whereas finding reliability value of the contents in gapped passages was suggested to ensure that they matched students' proficiency level. In addition, it was suggested that more distractors be included in each passage in order to reduce the chance of guessing. All the remaining issues i.e. length of the passage, contexts of each gap in the cloze, variety of text types and topics of the passages were agreed upon as being justified. According to these suggestions, the cloze passages were calculated for their readability values and then were slightly simplified in order to make them more suitable for the students in the study while maintaining as much authenticity appropriate for academic texts as possible. Moreover, one more distractor was included for each cloze passage.

Regarding the overall design, both experts agreed that these measures met the objectives of the study. However, the length of test-taking time was considered insufficient since many items as well as cloze passages were included in these measures. Therefore, the time set for the test was changed from 2 hours to 3 hours and that of the tasks was changed from 40 minutes to 1 hour. Apart from all the suggestions mentioned above, various details from other suggestions were also taken into consideration in modifying the test and all review tasks.

After such modification, test and task items were validated by three RMUTL English instructors. These instructors tried to do the test and tasks to assess whether each item of these measures was clear or ambiguous in test taking. The checklist for item validation in Appendix O was used for these instructors to give comments. Similar to the calculation of content validation, the items indicating agreement on justification are rated 1, those indicating disagreement are -1, and those indicating unsure are 0. The results were calculated for their means and the test items were considered justified if the mean values were not less than 0.5. These results are

shown in Appendix O. It was evident that the means of all items were justified because they were over 0.5 although a few items were marked as ambiguous by one of these experts. The ambiguous items were modified accordingly in order to ensure the clarity of the measures although each of them was rated as '*unsure*' by only one expert from three.

3.8.1.4 Reliability of the pretest/posttest and delayed test

After the contents and items were validated, the reliability of the test was also established. The measure was piloted with a sampling group of 34 engineering students who were of a similar level to the participants in the main study. The review tasks were not piloted because they were used as classroom materials rather than research instruments and their data were mainly supplementary. After the piloted test was administered, the test scores were calculated with a statistical method called an *alpha coefficient* or *Cronbach's Alpha* to find out the reliability value in terms of the test internal consistency. As a result, the obtained Alpha value was 0.7254. Despite being slightly lower than the expected value of 0.75, the derived value was acceptable in the study for two reasons. Firstly, in many published research papers, the reliability values between 0.7-0.8 were typically acceptable for Cronbach's Alpha, according to Field (2005). In addition, Santos (1999) cites that 'Nunnaly (1978) had indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used in the literature'.

Secondly, it was assumed that the low reliability value was due to the lack of heterogeneity of RMUTL students' vocabulary proficiency. Ary et al. (2002, p.261) mentioned, 'The reliability coefficient increases as the spread, or heterogeneity, of the subjects who take the test increases. Conversely, the more homogeneous the group is with respect to the trait being measured, the lower will be the reliability coefficient'. RMUTL students' vocabulary size was limited, as evidenced from the study for assessing their vocabulary size described in 1.1 in Chapter I. Therefore, their performance resulted in the low reliability value of the piloted test. With these assumptions, the test reliability value which was slightly lower than the estimation was considered acceptable.

In the study, the overall reliability value of the test was calculated without discriminating individual items. It was assumed that students'

performance on the piloted test might not be a good index for discriminating the test items. On the one hand, the test was aimed at assessing achievement on specific lexical knowledge which most RMUTL students did not possess. Although the test contents were strongly considered by the researcher as something necessary to be learned, the students had not yet had any chance to learn them. On the other hand, with limited vocabulary size, students would not put their full effort into doing the test since most of the tested words were unknown to them and the gain in scores did not have any effects on them in any way. However, the test had to be piloted with these students since they were the sampling group which was similar to the participants of the study in many important aspects. As a result, their average derived scores were very low and some scores were due to guessing rather than true performance. Accordingly, the indices of the test items could not precisely indicate whether the items were proper or not. Therefore, the test items which had already been validated were not discriminated against or omitted.

3.8.2 Students' logs

Students' logs were used only by students in the experimental group to reflect their opinions, comments and suggestions while dealing with the concordance-based method. After every lesson, about 10 students were requested to record the data. These students were randomly selected but some students might volunteer later to write their information in the logs. Some students might write the logs immediately after the classes but some might ask to do it at home and returned the completed logs on the next day. There were 12 logs in total as there were 12 lessons. Each log included a set of questions and some examples used as guidelines for recalling and recording data, and students were advised to write and reflect upon their opinions and comments in Thai. This was to ensure that students' records would cover the needed information (see Appendix P).

3.8.3 Teacher's field notes

Teacher's field notes were detailed notes with a checklist of observation. A checklist was used as a set of guidelines and supplementary data for the observation on students' processes and attitudes while dealing with the concordance-based method. This was to ensure that as much information as needed would be obtained

from the observation as possible. In the observation checklist, five main points were listed i.e. students' participation in general, dealing with a concordancer, dealing with corpus information, feelings and problems. These points were observed according to some questions used as guidelines for the observation (see Appendix Q). The data from the teacher's records were useful in describing and interpreting students' processes and attitudes in dealing with the concordance-based method. These data were triangulated with students' logs and interviews as well as their performance on the tests and tasks in order to find out whether there was any controversy or congruence among them.

3.8.4 Questionnaires

Two sets of questionnaires were administered in the present study. The first questionnaire was administered with both groups of students at the beginning of the study to collect the participants' information before the study. The second questionnaire was used only with the experimental group at the end of the study in order to obtain information about their processes and attitudes while dealing with the concordance-based method. The description of both questionnaires is as follows.

3.8.4.1 Questionnaire I

The first set of the questionnaire was aimed at eliciting students' data on areas of general information, previous English study, reading background, and computer skills (see Appendix B). These initial data were necessary for identifying students' background enough for determining whether some factors might relate to the effects of the treatment or not. For example, if they were unfamiliar with computers, they might not like using a concordancer to study English; or if they did not like reading in general, it was likely that they would not attempt to read a lot of corpus information while dealing with the method. With knowledge of students' background on such data, the outcome of the study could be interpreted more precisely.

Questionnaire I was designed in the form of a checklist combined with a rating scale and an open-ended section for comments and suggestions. It was divided into five main parts: general information, previous English study, reading background, computer skills, and comments and suggestions. The part

of general information consisted of four items concerned with students' bio-data: name, age, field of study, previous schools/institution, and last GPAs. The second part of previous English study involved students' previous background in studying English. This part included nine items. The first six items were checklists for students to give information on their initial introduction to English study, length of studying time, possible exemption from studying English, previous native-English teachers, two previous English Grades, attitude towards English study, and motivation to learn English. In the last two items, students were requested to rate their previous participation in English classes in terms of frequency as well as to rate their four skills of English on a 5-point rating scale.

The third part of Questionnaire I was concerned with students' reading background to elicit their habits and attitude on reading in general. There were ten items of checklists to seek information on their attitudes towards reading; experience in reading texts in Thai in terms of frequency and text types; and experience in reading texts in English in terms of frequency, length of texts, English texts in engineering courses, difficulty, and strategies used to solve problems. The fourth part included checklist items on students' computer skills. There were twelve items to elicit information on students' attitude towards using computers, frequency of access, possession of computers, places for access, basic computer skills, types of used programs, types of activities, experience in using computers to learn other subjects and types of materials used, experience in using computers to learn English and types of materials used, and experience with a corpus or a concordancer. The last part was open-ended for students to freely give comments and suggestions concerning English study.

3.8.4.2 Questionnaire II

Questionnaire II was administered at the end of the study in order to elicit students' information about their processes and attitudes while dealing with the concordance-based method (see Appendix R). This questionnaire was divided into five main parts: students' studying performance, computer skills, concordancing skills, attitudes towards the method, and comments and suggestions. Regarding studying performance, students were requested to rate their performance in terms of their class attendance, participation in activities, understanding of the

lessons, ways to deal with problems, frequency of revision and assignment completion. The second part was concerned with computer skills. It consisted of 8 items in a 5-point rating scale, except item 3 which included 11 sub-items in the form of a checklist. The issues involved students' skills in dealing with computers in general, a concordancer, concordance-based activities, frequency of using concordancing skills, skills in dealing with concordancing activities, frequency of accessing the corpus, confidence and the preference in using the concordancer.

The third part dealt with concordancing skills in terms of context observation in the form of a checklist and a 5-point rating scale. The questions dealt with students' strategies in reading a concordance format, making use of the concordance information, performance in dealing with the concordance activities, problems in dealing with concordance information, ways to solve such problems, and opinions on the use of the concordance format. The fourth part involved students' attitudes towards the concordance-based method. In the first three items, students were asked to rate their opinions on usefulness, ease/difficulty, and their preference in using the concordance-based method. The last question was a checklist asking whether the students would continue using the method for their own study in English. The last part was open-ended for students to freely give comments and suggestions for improving the concordance-based method.

3.8.4.3 Validation of the questionnaires

The questionnaires were validated together with the lesson plans and the classroom materials by the same group of three experts in the fields of EFL teaching and classroom concordancing. Checklists (in Appendix S) were used for validating both questionnaires and it was divided into three main parts: assessment of each questionnaire item, overall aspect, and comments and suggestions. According to the results, all items in Questionnaire I and II were rated as justified by all three experts.

3.8.4.4 Reliability of the questionnaires

The reliability of both Questionnaires I and II was established by piloting them with 21 students who had been the participants in the experimental group in the pilot study. Despite being small in number, this group of students was

considered to be the best option for piloting the questionnaires, especially Questionnaire II as they had experience in dealing with the concordance-based method. After these questionnaires were tried out, only the items in the form of a 5-point rating scale were calculated for the reliability value by using the method of an *alpha coefficient* or *Cronbach's Alpha* at the set point of 0.75 (see the results in Appendix S).

In Questionnaire I, there were 8 scaled items and two of them included 7 sub-items. Thus, there were 23 items altogether to be calculated. Questionnaire I appeared to have good internal consistency with the Alpha value at 0.8593, which was much higher than the set point. No items were deleted although the deletion of some items might have slightly increased the reliability value of the questionnaire. Such deletion was considered as not being worthwhile since the possible increase in Alpha value would be slightly higher whereas data derived from such items were still considered as being useful. Questionnaire II had 18 items and three of them had 29 sub-items so there were 44 items altogether for calculation. It appeared that Questionnaire II had better internal consistency i.e. Alpha value at 0.9117. The results were illustrated in Appendix S and no items in this questionnaire were deleted for the same reasons as for Questionnaire I.

3.8.5 Interview

The semi-structured interview was carried out with audiotape recordings on a one-to-one discussion basis. The interview was conducted in Thai in order to obtain as much information as possible. Nearly half of the students i.e. 11 students in the experimental group were interviewed by appointment within one week after the completion of the study. The interviewees were randomly selected so some of them might or might not be the same students who wrote the students' logs. A set of questions was designed as an interview framework and these questions were aimed at eliciting students' information in four main areas: computer concordancing skills, observing skills in concordances, and attitudes and opinions (see Appendix T). At the beginning of the interview, they were asked about their computer concordancing skills. During this stage, students were asked to recall their performance while operating the concordancer and specify which activities they performed in operating the programs in order to assess how well they could use it. To facilitate students in

recalling and giving examples of their performance, either or both illustrations of on-screen concordances as in Figure 3.10 and 3.11 were provided.

Figure 3.10: The on-screen concordance of '*depend**' used in the interview

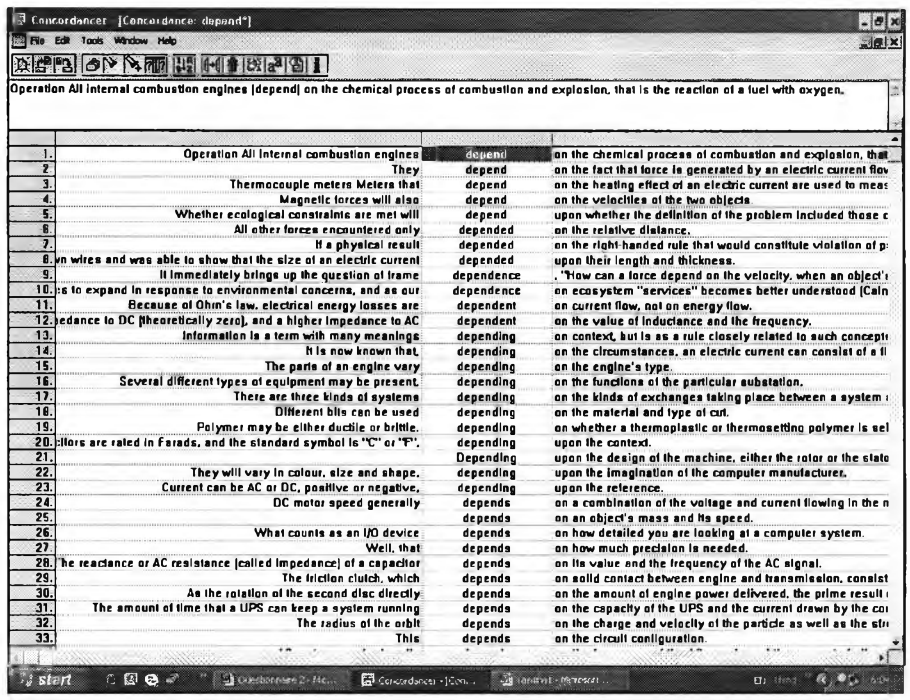
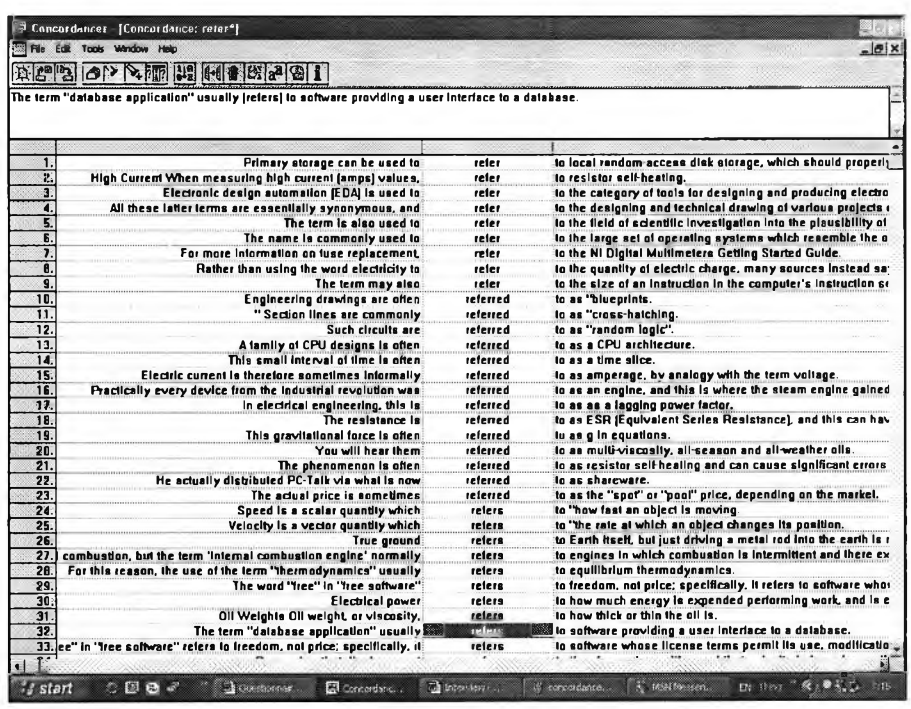


Figure 3.11: The on-screen concordance of '*refer**' used in the interview



After sufficiently discussing students' computer concordancing skills, the interview moved on to elicit details about students' observing skills in regard to concordances. One or two illustrations of '*refer**' and '*depend**' concordances were used to help them specify how they observed the contexts of the keywords in order to assess in what ways as well as how well they could make use of the context observation in studying vocabulary for reading. Then, the students were asked about their feelings and opinions towards the method in terms of usefulness and ease/difficulty of the method, preference and problems in dealing with the method, and the probability of them in continuing to use the method for their own study. Finally, they were requested to give comments and suggestions about how to improve the concordance-based lessons.

3.6.4 Data Collection

As mentioned earlier, the duration of the experiment was one academic semester or 18 weeks. The English class met once a week for a 150-minute session. The stages of data collection can be seen in Table 3.14.

Table 3.14: Stages of data collection

Weeks	Lessons	Themes	The experimental group only
1	Introduction of course description Administration of the questionnaire and pretest		
2	Introduction	Introduction to the concordance-based method for the experimental group Introduction to reading in general for the comparison group	
3	1	Engineering Fields	Field note and log 1
4	2	Engineering Drawing	Field note and log 2
5	3	Computers in Engineering	Field note and log 3
6	4	Machines and Engines	Field note and log 4
7	5	Energy and Electricity	Field note and log 5
8	6	Electrical Systems in Automobiles	Field note and log 6
9	Midterm Exam: Review Tasks 1 and 2		
10	7	Engineering Products	Field note and log 7
11	8	Power Transmission	Field note and log 8
12	9	How to Build an Electric Motor	Field note and log 9
13	Revision and Review Task 3		
14	10	Latest Technology	Field note and log 10
15	11	Causes of Failure	Field note and log 11
16	12	Electric Vehicles	Field note and log 12
17	Revision and Review Task 4		
18	Final Examination: Immediate Posttest		
Interview within a week after the study Delayed Posttest one month after the study			

At the beginning of the study, the pretest and the first set of the questionnaire were administered for obtaining students' information on their existing vocabulary proficiency as well as on their personal information before the study. Then, during the study, twelve sets of teacher's field notes and students' logs were recorded after each lesson with the concordance-based method. Four review tasks were administered: the first two tasks were used together as the midterm exam whereas the other two tasks were used as quizzes after three later lessons. Next, the immediate posttest was used as a final exam and the interview was conducted within a week after the final exam. Finally, the delayed posttest was administered within a month after the study i.e. the beginning of the following semester.

3.10 Data Analysis

The data analysis is described according to five research questions proposed in the study (see 1.3, Chapter 1). Since the first three questions dealt with a quantitative study on the learning effects of vocabulary learning, the method of data analyses for these questions are described together under the same sub-topic. On the other hand, the analyses for the last two questions are explained separately on exploring students' learning processes and attitudes in dealing with the concordance-based method.

3.10.1 Data analysis for Research Questions 1 – 3

The first three research questions were concerned with learning effects of two teaching methods on vocabulary learning in the areas of definitional knowledge, transferable knowledge and retention rates of both knowledge types. These three questions had one independent variable (IV) with two levels of teaching methods: the concordance-based method used in the experimental group and the conventional teaching method used in the comparison group. In addition, four dependent variables (DVs) included the learning effects of these methods on the measures of definitional knowledge, transferable knowledge and retention rates of both knowledge types. The definitional and transferable knowledge were represented by the average scores on the Definition Part and the Cloze Part in the immediate posttest respectively. The retention rates of both knowledge types were from the

average scores on their corresponding parts of the delayed posttest. These variables are summarized in Table 3.15.

Table 3.15: Independent and dependent variables in Research Questions 1-3

1 IV with 2 levels	**A Concordance-based Method** (An experimental group)				**A Conventional Teaching Method** (A comparison group)			
4 DVs	**DV1**	**DV2**	**DV3**	**DV4**	**DV1**	**DV2**	**DV3**	**DV4**
	Scores on Definition Part in the immediate posttest	Scores on Cloze Part in the immediate posttest	Scores on Definition Part in the delayed posttest	Scores on Cloze Part in the delayed posttest	Scores on Definition Part in the immediate posttest	Scores on Cloze Part in the immediate posttest	Scores on Definition Part in the delayed posttest	Scores on Cloze Part in the delayed posttest

Note: DV1 = measure of definitional knowledge on the immediate posttest
DV2 = measure of transferable knowledge on the immediate posttest
DV3 = measure of definitional knowledge on the delayed posttest
DV4 = measure of transferable knowledge on the delayed posttest

Because there were multiple DVs, to analyze the data, a multivariate analysis of variance (MANOVA) was conducted to determine the differences between the learning effects of the two teaching methods on definitional knowledge, transferable knowledge and retention rates of both knowledge types. The focus of each analysis of variance was on the extent to which these teaching methods affected each of the knowledge types, regardless of the interaction effects among them. In running the SPSS program, the teaching methods were defined as the fixed factors whereas the average scores on four measures were dependent variables. To control the overall error rate, the Bonferroni method was used to adjust the selected significance level (0.05). To interpret the results of MANOVA, the basic assumptions on the equality of covariance matrices were tested before the learning effects of both methods on each measure were considered separately from the tests of between-subjects effects. If significant differences in learning effects were found on any measures, these differences would be calculated to find the magnitudes of their effect sizes and the relative non-overlap indexes between groups. Regarding the retention effects, apart from conducting MANOVA and calculating effect sizes, the retention percentages of both methods on both measures of knowledge types were also calculated. Details about this procedure are as follows.

Firstly, the basic assumption of MANOVA was tested on the equality of covariance matrices, using the *p*-value of the Box' *M* test. Its insignificance *p*-value ($p(M) > 0.05$) indexed the support of this assumption that the covariances in the matrices were equal whereas its significance *p*-value ($p(M) < 0.05$) indexed the violation of this assumption. With the equality of the sample sizes in the present study, however, Tabachnick and Fidell (2001) point out that MANOVA is fairly robust because the interpretation of MANOVA results usually rests on the interpretation of significant univariate effects after the overall test is significant. Regarding a multivariate test, the Wilk's Lambda method was used in the present study to test whether the means of both methods were equal across all of the measures. This method was selected because of its popular use and robustness to the violation of assumption (Lewicki and Hill, 2006; Tabachnick and Fidell, 2001; and Hinto, Brownlow, McMurray and Cozens, 2004). The significant *p*-value of Wilk's Lambda (Λ) indicated that there would be the effects of the teaching methods on the measures in general. However, it would not indicate exactly where the effects lied in which measures.

Therefore, learning effects of both teaching methods on each measure were considered separately, based on the obtained *F*-value and *p*-value from the tests of between-subjects effects. Each difference was significant if the *p*-value was less than 0.05 ($p < 0.05$). When a significant difference was found, its magnitude was determined in terms of *effect sizes*. The SPSS program also provides the MANOVA effect size values in *Partial Eta Squared* (η_p^2) i.e. 0.01 = small effect, 0.06 = medium effect, and 0.14 = large effect, according to Cohen's effect sizes (cited in Coetzee, 2005). However, the values of η_p^2 do not index the description of additional measures on non-overlap or percentile standing between groups. Therefore, in the present study, the Cohen's *effect sizes* (*d*) were calculated instead, by using the following formula proposed by Cohen (1988, cited on the webpage http://web.uccs.edu/lbecker/Psy590/es.htm).

$$d = M_1 - M_2 / \sigma$$

Where $\sigma = \sqrt{[\Sigma(X - M)^2 / N]}$

Where X is the raw score, M is the mean, and N is the number of cases.

Accordingly, the difference between the means, M_1 - M_2, was divided by standard deviations, σ, of both groups. The interpretation of Cohen's *d* and the relative percentile standing values are shown in Table 3.16.

Table 3.16: Interpretation of Cohen's *d* effect size and the relative percentile standing

Cohen's Standard	Effect Size	Percentile Standing	Percent of Non-overlap
	2.0	97.7	81.1%
	1.9	97.1	79.4%
	1.8	96.4	77.4%
	1.7	95.5	75.4%
	1.6	94.5	73.1%
	1.5	93.3	70.7%
	1.4	91.9	68.1%
	1.3	90	65.3%
	1.2	88	62.2%
	1.1	86	58.9%
	1.0	84	55.4%
	0.9	82	51.6%
LARGE	0.8	79	47.4%
	0.7	76	43.0%
	0.6	73	38.2%
MEDIUM	0.5	69	33.0%
	0.4	66	27.4%
	0.3	62	21.3%
SMALL	0.2	58	14.7%
	0.1	54	7.7%
	0.0	50	0%

To interpret the result, the values of 0.2, 0.5 and 0.8 are generally regarded as small, medium and large effect sizes, based on Cohen's description. Moreover, the percentile standing provides more information on the relative difference between both groups. For example, the effect size of 0.0 indicates that the distribution of scores for the group with higher scores overlap completely with the other group i.e. 0% of non-overlap. The mean score of the former is at the 50^{th} percentile of the latter. Another example effect size of 0.8 indicates that the magnitude difference between both groups is large and its relative percentile standing of 79 means that the mean of the group with higher scores is at 79^{th} percentile of the other group.

Finally, to answer the first three research questions, the results of the between-groups effects on the following DVs or measures were used as indicated in Table 3.17.

Table 3.17: Data for answering the first three research questions

Research Questions	Data for providing the answers to the questions
Question 1	DV1 (measure on definitional knowledge in the immediate posttest)
Question 2	DV2 (measure on transferable knowledge in the immediate posttest)
Question 3	DV 3 (measure on retention rates of definitional knowledge in the delayed posttest)
	DV 4 (measure on retention rates of transferable knowledge in the delayed posttest)

Regarding retention rates, apart from conducting MANOVA and estimating the effect size, the retention percentage of each knowledge type was also calculated from the mean scores of each group on the corresponding part of the immediate posttest and the delayed posttest.

3.10.2 Data analysis for Research Question 4

Question 4 was aimed at exploring students' learning processes in dealing with the concordance inputs. Students' learning processes in the present study were operationally defined as students' performances in dealing with dealing with a computer concordancer and that in dealing with concordance information. Dealing with a computer concordancer refers to students' abilities to operate a concordancer to find corpus information, display and manipulate concordance output for facilitating the observation of word behaviours in various concordance contexts. On the other hand, dealing with concordance information is concerned with students' abilities to utilize the concordance facilities and the observation of word contexts to enhance their vocabulary learning by identifying various aspects of words to interpret texts and deduce word meaning. Learning processes were assessed by the relevant data from Questionnaire II, teacher's field notes, students' logs and interview. In addition, the average total scores from all measures were also used as supplementary data to reveal students' overall learning development.

To analyze the data, the descriptive data from the open-ended sections of the questionnaire, teacher's field notes, students' logs and interview were grouped according to the students' performances in dealing with a computer concordancer and those in dealing with concordance information. On the other hand, all items in the questionnaire were summarized in percentages according to students' rating the frequency and quality of their performances in dealing with a computer concordancer

and concordance information. In addition, the scaled items were labeled 1 to 5 points respectively from negative to positive aspects or less to most frequency. Only item 4 in Part 3 was labeled in the reverse order since it carried negative connotations concerning how many problems the students faced. Then, each scaled item was calculated for the mean and interpreted with the given point closet to the mean as in Table 3.18.

Table 3.18: Interpretation of the results from scaled items

Means of Scaled items	**Interpretation**				
Between 4.5 and 5	Always	Very Quick	Very Much	Very Well	Very Easy
Between 3.5 and 4.4	Often	Quick	Much	Well	Easy
Between 2.5 and 3.4	Sometimes	Moderately Quick	Average	Fairly	Average
Between 1.5 and 2.4	Rarely	Slow	A Little	Poorly	Difficult
Between 1 and 1.4	Never	Very Slow	Very Little	Very Poorly	Very Difficult

All these data were grouped together for being interpreted respectively on students' performances in dealing with the computer concordancer and the concordance information in acquiring skills for vocabulary learning. In addition, to reveal the overall learning development, the average total scores from all measures were also used as supplementary data. To analyze the data, the average total scores on all measures of both groups from the beginning through the end of the study were compared, using the MANOVA similarly to that described in 3.10.1. In this analysis, there were 7 DVs: the average total scores of the pretest, review tasks 1 to 4, the immediate posttest and the delayed posttest. The results from the MANOVA were used to reveal the students' overall learning development as well as to identify when the significant difference between groups occurred.

3.10.3 Data analysis for Research Question 5

Question 5 was aimed at exploring students' attitudes towards the application of the concordance-based method. In the present study, students' attitudes refer to their opinions in terms of the method's usefulness for vocabulary learning and level of difficulty as well as the students' degree of preferences in dealing with the

method. The investigation on students' attitudes was based on students' opinions found in students' logs, Questionnaire II and the interview.

The data from all items of the questionnaire were summarized in percentages to reveal the frequency of students' opinions towards the concordance-based method. The scaled items were labeled 1 to 5 points respectively from negative to positive aspects. Then, each scaled item was calculated for the mean and interpreted with the given point closet to the mean as in Table 3.18. The students' attitudes were considered positive if each mean was not less than the middle point of 3 on the 5-point rating scales. Then, the descriptive data from the open-ended sections of the questionnaire and from the interview were grouped together according to the students' opinions in terms of the method's usefulness for vocabulary learning and level of difficulty as well as the students' degree of preference in dealing with the method.

3.11 Summary

This chapter describes the research methodology of the study. The research was designed in the form of '*a matching-only pretest-posttest comparison group design*'. The population consisted of around 1,000 RMUTL engineering students at undergraduate level and the samples were two intact groups in the academic year of 2005. One group was randomly assigned to the experimental group studying with the concordance-based method whereas the other group represented the comparison group studying with the conventional teaching method. The students were matched in 26 pairs according to their vocabulary proficiency in the pretest. A pilot study was conducted in order to try out classroom materials. The results were used to provide guidelines for the implementation of the main study.

In the main study, the Engineering Corpus of around 500,000 running words was compiled from academic texts in engineering. Then, 480 target words belonging to the GSL or AWL wordlists were selected from high frequency words in the corpus. The resulting target wordlist was divided into 12 weekly wordlists i.e. 40 words per week. Then, these target wordlists were used to design all classroom materials and research instruments. Regarding classroom materials, the lesson plans and class

handouts were designed in two versions: one for the experimental group and the other for the comparison group. Four review tasks were developed for ongoing assessments whereas the pretest, the immediate posttest and the delayed posttest were designed in the same paper for assessing the overall learning effects on definitional knowledge, transferable knowledge and retention rates. The other instruments were the teacher's field notes and students' logs to be recorded after each concordance-based lesson whereas the questionnaire and the interview were used to collect data at the end of the study.

In data collection, Questionnaire I and the pretest were administered at the beginning of the study. During the experiment, the teacher's field notes and the students' logs were recorded after every concordance-based lesson. The first two review tasks were used as the midterm exam whereas the other two tasks were separately administered after every three lessons. At the end of the study, the immediate posttest was administered with both groups whereas Questionnaire II and the Interview were arranged only with the experimental group. Finally, both groups took the delayed posttest about one month after the study.

For data analysis, the data for answering Research Questions 1-3 were based on the average scores on the Definition Part and the Cloze Part in the immediate posttest and the delayed posttest. The multivariate analysis of variance (MANOVA) was used to compare learning effects of the concordance-based method and the conventional teaching method in the areas of definitional knowledge, transferable knowledge and retention rates of both knowledge types. Research Question 4 was concerned with exploring students' learning processes in dealing with concordance input to acquire concordancing skills and vocabulary knowledge. The processes were examined in two areas: students' performances in dealing with a computer concordancer and those in dealing with concordance information. The analysis of the learning processes was based on the data collected from teacher's field notes, students' logs, Questionnaire II and interview. In addition, averages total scores from all measures administered from the beginning to the end of the study were also used as supplementary data to reveal students' overall learning development as well as to identify the stage in which the significant difference occurred between both groups. The last Research Question 5 was dealt with students' attitudes towards the application of the concordance-based method. The analysis was based on the

descriptive data from the students' logs, questionnaire and interview. These data were grouped according to students' opinions in terms of the method's usefulness and level of difficulty as well as their degree of preference to deal with the concordance-based method.