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THE VOCABULARY COURSE SYLLABUS FOR SPORTS SCIENCE GRADUATE STUDENTS

Ratchanee Singkhachan

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in English Language Studies

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THE VOCABULARY COURSE SYLLABUS FOR SPORTS SCIENCE GRADUATE STUDENTS

Suranaree University of Technology has approved this thesis submitted in partial fulfillment of the requirements for the Degree of Doctor of Philosophy.

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รัชนี สิงคะจันทร์ : คำศัพท์สำหรับนักศึกษาระดับบัณฑิตศึกษาหลักสูตรวิทยาศาสตร์การกีฬา (THE VOCABULARY COURSE SYLLABUS FOR SPORTS SCIENCE GRADUATE STUDENTS) อาจารย์ที่ปรึกษา : รองศาสตราจารย์ ดร.เจเรมี วอร์ด, 246 หน้า

งานวิจัยนี้มีวัตถุประสงค์เพื่อ 1) เปรียบเทียบประโยชน์ของคำศัพท์ระหว่างรายการคำศัพท์ตามแนวคิดเนชั่น รายการคำศัพท์ที่มีความถี่สูงจากคลังคำศัพท์แห่งชาติอังกฤษ และรายการคำศัพท์สรีรวิทยาการออกกำลังกาย 2) สร้างรายการคำศัพท์จากคลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกาย และรายการคำศัพท์จากคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกาย 3) เปรียบเทียบการใช้คำศัพท์จากคลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกาย และคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกาย

ขั้นตอนการวิจัยดังนี้ 1) สร้างคลังคำศัพท์ 2 คลังคำศัพท์ซึ่งประกอบไปด้วยคลังคำศัพท์หนังสือสรีรวิทยาการออกกำลัยกายและคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกาย 2)หาสัดส่วนของคำศัพท์จากคลังคำศัพท์ทั้งสอง เปรียบเทียบกับคำศัพท์ตามแนวคิดเนชั่น และรายการคำศัพท์ที่มีความถี่สูงจากคลังคำศัพท์แห่งชาติอังกฤษโดยใช้โปรแกรมเรนจ์ 3) เรียงรายการคำศัพท์ที่เกิดขึ้นในคลังคำศัพท์ตามลำดับความถี่โดยใช้โปรแกรมเวิร์ดสมิธ คำศัพท์ที่มีความถี่ในการใช้ 3 ครั้งขึ้นไปจะถูกนำมาแยกกลุ่มตามมาตราส่วนประมาณค่าประยุกต์ แล้วนำมาแยกกลุ่มอีกครั้งเป็นคำศัพท์ทั่วไปหรือคำศัพท์เทคนิคสรีรวิทยาการออกกำลังกาย รายการคำศัพท์เทคนิคที่ได้จากคลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกายนำมารวมกับรายการคำศัพท์เทคนิคที่ได้จากคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกาย เรียกว่า รายการคำศัพท์สรีรวิทยาการออกกำลังกาย 4) นำคำศัพท์ที่มีความถี่ในการเกิดขึ้น 3 ครั้งขึ้นไปในแต่ละคลังคำศัพท์ มาหาคำนาม แล้วนำคำนามที่ได้ไปหาคำนามผสม แล้วนำคำนามผสมมาแยกกลุ่มโดยใช้มาตราส่วนประมาณค่าประยุกต์ หลังจากนั้นนำมาแยกกลุ่มอีกครั้งเป็นคำนามผสมทั่วไปและคำนามผสมเทคนิคสรีรวิทยาการออกกำลังกาย 5) นำรายการคำศัพท์สรีรวิทยาการออกกำลังกายมาเปรียบเทียบกับรายการคำศัพท์ของเนชั่น และรายการคำศัพท์ที่มีความถี่สูงจากคลังคำศัพท์แห่งชาติอังกฤษ โดยใช้เกณฑ์คือ การเป็นตัวแทนที่ดี การครอบคลุมของคำศัพท์ ความมีประสิทธิภาพ และความเป็นไปได้ที่จะเรียน 6) เปรียบเทียบความแตกต่างในการใช้คำศัพท์ระหว่างสองคลังคำศัพท์ในด้านคำศัพท์เทคนิค การครอบคลุมของคำ และคำนามผสม

ผลการศึกษาพบว่า 1) คำศัพท์เทคนิคจากคลังคำศัพท์หนังสือและบทความวิจัยสรีรวิทยาการออกกำลังกาย สัดส่วนคำศัพท์สูงกว่า สัดส่วนคำศัพท์ตามกรอบแนวคิดเนชั่น คำศัพท์เทคนิคใน

คลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกายมีสัดส่วนร้อยละ 23.70 และในคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกายมีสัดส่วนร้อยละ21.11 2) สัดส่วนของคำศัพท์เทคนิคที่ได้จากมาตราประมาณค่าประยุกต์มีสัดส่วนที่มากกว่าสัดส่วนคำศัพท์เทคนิคตามแนวคิดของเนชั่นเช่นกัน โดยในคลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกายมีสัดส่วนร้อยละ 35.72 และในคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกายมีสัดส่วนร้อยละ 29.34 3) คลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกายมีคำศัพท์เทคนิคมากกว่าคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกาย 4) คำนามผสมเกิดขึ้นในสองคลังคำศัพท์ในสัดส่วนที่สูง คลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกายมีคำนามผสมจำนวน 3,410 คำและในคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกายมีคำนามผสมจำนวน 2,010 คำ และในจำนวนนี้มีคำนามผสมที่เป็นคำนามผสมเทคนิคในสัดส่วนที่สูง ในคลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกายคิดเป็นร้อยละ 86.24 และในคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกายคิดเป็นร้อยละ 75.77 แสดงว่ามีการใช้คำนามผสมที่เป็นคำนามผสมเทคนิคในคลังคำศัพท์หนังสือสรีรวิทยาการออกกำลังกายมากกว่าคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกาย 5) รายการคำศัพท์สรีรวิทยาการออกกำลังกายมีจำนวน 2,208 คำ รายการคำนามผสมมีจำนวน 4,059 คำ รายการคำศัพท์สรีรวิทยาการออกกำลังกายถูกนำมาเปรียบเทียบกับรายการคำศัพท์ของเนชั่นและรายการคำศัพท์ที่มีความถี่สูงจากคลังคำศัพท์แห่งชาติอังกฤษ ผลปรากฏว่า รายการคำศัพท์สรีรวิทยาการออกกำลังกาย เป็นตัวแทนที่ดี ครอบคลุม มีประสิทธิภาพ และมีความเหมาะสม สำหรับการสอนศัพท์ภาษาอังกฤษสำหรับผู้เรียนวิทยาศาสตร์การกีฬา 6) ความแตกต่างในการใช้คำศัพท์ระหว่างสองคลังคำศัพท์คลังคำศัพท์หนังสือมีคำเทคนิคและคำนามผสมมากกว่าในคลังคำศัพท์บทความวิจัยสรีรวิทยาการออกกำลังกาย

สาขาวิชาภาษาต่างประเทศ ลายมือชื่อนักศึกษา_____

ปีการศึกษา 2558 ลายมือชื่ออาจารย์ที่ปรึกษา_____

RATCHANEE SINGKHACHAN : THE VOCABULARY COURSE SYLLABUS FOR SPORTS SCIENCE GRADUATE STUDENTS. THESIS ADVISOR : ASSOC. PROF. JEREMY WARD, Ph.D. 246 PP.

VOCABULARY/TECHNICAL VOCABULARY/EXERCISE PHYSIOLOGY

This study aimed to: 1) compare the usefulness of Nation's Paradigm (NP), British National Corpus High Frequency Word List (BNC HFWL), and Exercise Physiology List for creating a vocabulary syllabus suitable for exercise physiology graduate students, 2) create vocabulary syllabi from the Exercise Physiology Textbook Corpus (EPTC) and Exercise Physiology Research Article Corpus (EPRAC), and 3) compare vocabulary use in the EPTC with the EPRAC.

The investigation started with the creation of the EPTC and the EPRAC. Second, the text coverage by these lists of the two corpora was compared with the baseword lists of NP and BNC HFWL. Third, words in each corpus were listed and words occurring at least three times were selected for word classification. Words were classified by using the rating scale approach, then, they were classified into technical and non-technical words. Then, technical words from the two corpora were used to form the Exercise Physiology List (EPL). Fourth, Noun Noun Combinations (NNCs) were identified manually from the two corpora; then they all were classified by the adapted rating scale and then into technical and non technical NNCs list groups. The technical NNCs from the two corpora were used to form the Exercise Physiology Noun Noun Combination List (EPNNL). Fifth, the EPL was compared with words in NP and BNC HFWL by using the criteria set which are being representative, comprehensive,

efficient, and practical. Sixth, vocabulary used in the two corpora was compared to see the distinctions of the two genres in terms of technicality, text coverage, and NNCs.

The findings are: 1) technical words classified by running against the baseword lists in both EPTC and EPRAC give higher text coverage than NP's claim which is 23.70% in EPTC and 21.11% in EPRAC. 2) The proportion of technical word types classified by the rating scale is also higher than that given by NP. It covers 35.72% of all word types in EPTC and 29.34% of all word types in EPRAC. 3) EPTC contains more technical word types than in EPRAC. 4) There are high proportions of NNCs in the two corpora. There are 3,410 NNCs in EPTC and 86.24% of them are technical NNCs. There are 2,010 NNCs in EPRAC and 75.77% of them are technical NNCs. NNCs are employed more in EPTC than in EPRAC. 5) The newly created list (EPL) contains 2,208 word types and the EPNNL contains 4,059 NNCs .The EPL seems to be more useful than NP and the BNC HFWL in terms of being representative, comprehensive, efficient, and practical. The EPL can be suitable not only for sports science graduate students but also teachers, course designers, and other people in the field. 6) More technical words and NNCs occur in EPTC than in EPRAC.

School of Foreign Languages Student's Signature_____

Academic Year 2015 Advisor's Signature_____

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Ratchanee Singkhachan

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CHAPTER 1

INTRODUCTION

This current chapter presents the background, the rationale, the significance, the purposes, and the research questions for the study, and also definitions of the terms used in this study.

1.1 Background of the study

Some information about the discipline, which is sports science, selected for this investigation and its place in education is provided, as follows:

1.1.1 Sports science discipline

Sports science is the scientific knowledge of sports. It aims to optimize performance of sport players in competition. Another name for it with a relatively similar meaning, and which is used interchangeably with sports science, is exercise science. Originally, there were three key sub-disciplines: sports and /or exercise psychology; sports and/or exercise biomechanics; and sports and/or exercise physiology. Exercise science is the study of how to develop people's movement and change their life span (Wuest & Bucher, 2009). It aims to optimise the physical activity levels, experiences, and benefits of the general population (Thatcher et al, 2009). Sports science is aimed at athletes. However, there is a great deal of overlapping. Sometimes these two disciplines are combined together as sports and exercise science, and sometimes either sports science or exercise science is used. Therefore, sports science

and exercise science are used interchangeably in this study. Nowadays, there are many sports competitions held at different levels. Whenever a sport competition is held, sports science is used to prepare athletes both physically and mentally for effective sport performance. In the modern world where people would hope to live longer and be healthier, exercise science is employed for use with the general public to improve their health.

Because of sports and/or exercise science's role in society, and in lives of both athletes and people generally, it is studied at many educational levels.

1.1.2 Sports Science in Thai Education

Many institutes and universities in Thailand provide a sports science program at bachelor's and master's degree levels. Nevertheless, only a few universities provide this program at the doctoral level because of the high requirements for admission to the program and the difficulties of studying at this advanced level.

One of the institutes which have opened sports science program for a bachelor's degree is the Institute of Physical Education (IPE), where the researcher works. The IPE is a new higher education institute established in 2005 with 17 campuses all over Thailand. The IPE aims to produce and develop people in physical education, sports, sports science, health science, recreation, and related fields (Institute of Physical Education, 2011). Because it is a new institute, its lecturers are supported in the pursuit of their education for both a master's degree and a doctoral degree. One of the most popular majors receiving support is sports science which is a central focus of the IPE and forms one of the IPE's faculties; therefore, its lecturers have an incentive to master this discipline. From preliminary informal interviews that the researcher had with her colleagues who have furthered their education in sports science, it was found that they

had encountered some academic difficulties in their studies. One of the difficulties is English text reading. This difficulty has led the researcher to look through the factors related to English text reading.

1.2 Rationale of the study

Students who study a sports science program encounter some difficulties which will be mentioned in the following section.

1.2.1 Some difficulties facing graduate students of sports science

English plays a major role in science, technology, medicine, and science (Phillipson, 1992), which all originated from western countries. Sports science, an applied science, consists of sports and science and cannot avoid English as a medium of communication. Consequently, when graduate sports science students study the content of the discipline; they have to study in English. Moreover, as advanced learners who need new knowledge and ideas and who study autonomously most of the time when doing their coursework and conducting research, reading English texts is a necessity. However, students still encounter difficulty in reading. Nation (2001) pointed out that the factors related to reading comprehension are vocabulary, grammar, and background knowledge. Vocabulary seems to be the most important factor which will help students to overcome reading difficulty (Grabe, 2009; Laufer, 1992).

As mentioned before, a main aspect of the difficulty of studying in English is that sports science graduate students need vocabulary for their academic material reading.

1.2.2 Vocabulary

Vocabulary is a potential factor related to effective communication (McCarthy, 1990; Nation, 2001, 2008; Schmitt & McCarthy, 1997). It is a basis of language, and plays an overall role; Wilkins (1972, p. 111) stated that "without grammar, little can be conveyed, without vocabulary, nothing can be conveyed". People who know more vocabulary can communicate more effectively and successfully in every skill and at all levels. If graduate sports science students do not have adequate vocabulary, undoubtedly they will encounter difficulty in reading.

Vocabulary relates to reading skill and, crucially, affects reading comprehension. Reading comprehension depends significantly on the vocabulary size (Hsu, 2011; Laufer, 1992) which is the number of words known. The bigger the vocabulary size is, the more words that are understood. Laufer (2010) suggested that to comprehend well in academic reading, 95% text coverage is required. Text coverage is the percentage of running words in the text that are covered by the baseword lists that the researcher uses. It means that academic text readers should know 95 out of 100 running words in a text to understand the text well. The vocabulary size needed to reach 95% is around 4,000 word families, consisting of 2,000 word families from high frequency words, about 570 word families from the Academic Word List (AWL) and 1,000 or more from technical words, proper nouns and low frequency words (Nation, 2001). However, reading different kinds of texts requires different text coverage and this will be discussed in detail in Chapter 2.

The vocabulary size to reach 95% in sports science and which words should be included are considered. If this information is known, it would benefit the design and teaching of a vocabulary course syllabus for sports science.

1.2.3 Vocabulary syllabus

A vocabulary syllabus comprises a vocabulary list selected for learning a particular subject. It shows syllabus designers, teachers, and learners what vocabulary learners need, and how much has to be learned. The creation of vocabulary syllabi prepares English for Academic Purposes (EAP) learners before studying, and facilitates them while studying the content in order to help them learn effectively and efficiently.

To teach vocabulary effectively, words and word combinations should be taught. Their patterns and characteristics are also worth teaching. Lexical patterning or a lexical pattern is the repetition of words or group of words (Scott & Thompson, 2001). It is used to set the summaries of words and word combinations of texts (Hoey, 1991). Consequently, lexical patterning is used in this study to find out repeated words or combinations. Words or combinations which occur repeatedly or frequently mean they play roles in the texts.

Vocabulary syllabi for EAP learners, such as Nation's four types of words or Nation's Paradigm (NP) and the British National Corpus High Frequency Word List (BNC HFWL) have been created and studied in various academic disciplines and have shown their usefulness (Chung & Nation, 2003; Clark & Ishida, 2005; Nation, 2004; Nation & Kyongho, 1995).

1.2.3.1 Nation's Paradigm (NP)

Nation's Paradigm (NP) consists of high frequency word type or general word type or words in the GSL, academic word type or semi-technical word type or words in the AWL, technical word type, and low frequency word type. Details will be reviewed in Chapter 2.

The usefulness of Nation's Paradigm's (NP) is presented as follows:

- it is comprehensive because

- it covers a lot of words in the language using at least 2,570 word families from the list of general words. These are from the GSL (2,000 word families), the list of academic words from the AWL (570 word families), and some more technical words which are necessary in specialized fields; and

- the vocabulary in NP has high text coverage: about 80% of the tokens in an academic text are from the GSL, about 10% from the AWL, and about 5% or more from technical words. This is the original proportion proposed by Paul Nation (2001).Therefore, all the words together form more than 95% of the text coverage which can help readers comprehend academic texts well. For the later proportion of vocabulary in NP proposed, the technical vocabulary solely covers around 30% in specialized areas from rating scale identification (Chung & Nation, 2003; Wasuntarasophit, 2008) which is very high. The high proportions of NP in texts from previous studies are discussed in Chapter 2;

- it is efficient because

- each type of the vocabulary in NP was created based on certain purposes (general, academic, specialized purposes). Therefore, learners can supposedly learn only necessary words in any of the types according to their learning purposes to make their learning easier and faster

without unnecessary words. However, it depends on the reliability of the classification.

Nevertheless, there are some weaknesses in NP as presented below that make it difficult to identify technical vocabulary because

- there are some overlapping words. Some words in the GSL can be classified as technical words, or some words in the AWL can be classified as technical words if the meanings in that particular discipline are considered. For example, *wave* which is a word in the GSL is classified as a technical word in engineering corpus (Wasuntarasophit, 20008) when the context is taken into consideration;

and,

- different approaches used for technical vocabulary classification bring out different results.

- it is not representative of the corpus for the list building because

- the corpus created the GSL is sixty years old which may be considered to be too old. The text disciplines created the AWL were from only four broad academic disciplines and based on only written texts without spoken discourse. Hence, the GSL and the AWL cannot be representative of particular specialized areas.

Besides NP, one list created recently by Nation and widely employed is British National Corpus High Frequency Word List (BNC HFWL).

1.2.3.2 British National Corpus High Frequency Word List (BNC HFWL)

The British National Corpus High Frequency Word List (BNC HFWL) comes from British National Corpus (BNC). BNC HFWL consists of 14 one thousand word family lists, details of which will be presented in Chapter 2. Words in the BNC HFWL are common in British English, and are proposed on the basis of usefulness as follows:

- there are no overlapping words because

  - a word is classified into a list explicitly, and cannot change from one list to another, even though forms and meanings or both are considered.

- the list is comprehensive because

  - it contains a lot of words. There are 14,000 word families from list 1-14; and

  - the first three baseword lists of BNC HFWL give higher text coverage than the GSL plus the AWL. The studies of Hancioglu et al (2008), and Nation (2004) found that the vocabulary from the first three lists of BNC HFWL covered higher text coverage than GSL plus AWL. The previous studies related to this topic are reviewed in Chapter 2.

Nevertheless, there is an argument about the BNC HFWL that

- it is inefficient because

- the BNC HFWL was not built based on specific purposes; hence, learners have to spend time to study a lot of unnecessary words from all the lists without the specific ones.

The above paradigm and lists were created for EAP in general, hence they cannot suit all EAP learners. Therefore, it may plausibly be practical to have specialized vocabulary lists specific to a particular discipline.

1.2.3.3 Specialized vocabulary list

Besides the vocabulary lists for EAP learners in general, there are vocabulary lists which are specific to particular fields, e.g. lists for engineering, business, and applied linguistics. A vocabulary list usually comes from a corpus, and a corpus for building a specialized vocabulary list should come from representative and authentic texts in the discipline with an appropriate size in order to show real language use.

A specialized list benefits specialized learners because it contains only necessary words, and there are not too many words to learn. These reasons help learners not to waste their time in learning unnecessary words (Ward, 1999). This leads to effective and efficient learning. Nevertheless, corpus creation for vocabulary lists need to be well-organized.

Apart from the single words, multi-word units also have a key role in specialized texts. In existing paradigms and lists, only single word exists; multi-words units are not included, though they play a significant role in all kinds of texts. Noun-noun combinations, a kind of multi-words unit, will be considered in this study because they convey specialized meanings in specialized texts and they can cause difficulty for learners. Therefore, they will be discussed in the next part.

1.2.4 Noun-Noun Combinations (NNCs)

Multi words or noun phrases or word combinations are two or more words which frequently occur together. They appear in academic texts more than in other kinds of texts. They also contain the contents of texts (Martin, 2001). Engineering texts often contain them (Ward, 2007; Wasuntarasophit, 2008). Noun-noun combination (NNCs) consists of a head noun and another noun as pre-modifier which together makes a single concept or a unit of meaning. However, their meanings are difficult to interpret because they lose some meanings from their combination processes (Sinclair, 2004). NNCs are used as technical terms because when two nouns are combined they have special meanings and convey specific meanings (Pueyo & Val, 1996). As sports science texts are specialized, NNCs are worth learning. Previous studies have demonstrated the significance of NNCs in terms of natural use (Crystal, 2003; Schmitt & McCarthy, 1997), a high proportion of occurrence (Wasuntarasophit, 2008), and discipline specific presentation (Hyland & Tse, 2007). However, they are not included in NP and BNC HFWL. Consequently, NNCs will be investigated as to how much they should be taken into account in sports science texts.

All the vocabulary lists, paradigm, or syllabi mentioned above cannot be learned because of the very large number of words, their appropriateness, and usefulness to learners with specific purposes. Therefore syllabus designers, teachers, and learners have to choose the most effective list. The questions are how to choose, and on what criteria the choice should be based.

1.2.5 Approaches to vocabulary syllabi: the qualities of a good vocabulary syllabus

In order to have a good vocabulary syllabus for specialized purpose learners such as sports science students, four criteria are set to assess the usefulness of the existing vocabulary paradigm, existing word lists, and the vocabulary lists which will be created from the corpora of the sports science sub-discipline corpora in this study. The vocabulary paradigms and the words lists will be treated as vocabulary syllabi to be assessed according to whether they are representative, comprehensive, efficient, and practical.

1. Being representative

- The vocabulary syllabus should come from a well-organized corpus which shows the representativeness of the field. The collected texts should represent the present language used which is not too old. Further, the size of the corpus should be appropriate for the purpose of the study. For sports science learners, a good vocabulary syllabus should come from a well-organized corpus specific to sports science with an appropriate size and containing representative texts. The specialized corpus in this study represents a sub-discipline of sports science.
- NP may not be representative in terms of the age of the text of the GSL and the biased disciplines of the AWL. It is too broad and is not specific to any particular field. The GSL comes from a corpus created nearly sixty years ago and from various fields. The AWL comes from a corpus created from only four academic

disciplines. The BNC HFWL may not be representative because it comes from various kinds of texts in all contexts. Specialized lists which come from the sub-discipline of sports science corpora should be representative in terms of text discipline because they are specific to the sub-discipline of sports science. Therefore, only texts in the sports science sub-discipline have been collected. In terms of age, the corpora were built in 2013, so they are up-to-date. In terms of size, it is appropriate to build a corpus for specialized purpose studies of about ten-thousand to several hundred thousands of words (Bowker & Pearson, 2002).

2. Being comprehensive

- The vocabulary syllabus covers, as much as possible, the words that students who study the material of a sub discipline of need, and it also covers a high text coverage as possible.

- NP be comprehensive for sports science sub-discipline learners because it contains a lot of words and has higher than 95% of text coverage in other fields, as was the original idea of Nation in 2001. Hence, it may have high text coverage in sports science as well. The BNC HFWL has high text coverage in other fields as well, so words in the BNC HFWL may occur highly in sports science. The sports science sub-discipline lists can be comprehensive because they are from sports science sub-discipline corpora. All of the words in the lists occur in the corpora.

3. Being efficient

- The vocabulary syllabus only contains necessary words. Unnecessary words are cut out, and as a result, it is worth learning and helps learners who read the sports science sub-discipline academic materials to spend less time comprehension.
- NP may not be efficient for sports science learners because it includes general, academic words in the paradigm some of which may not be necessary for sports science learners. The BNC HFWL may not be efficient either because it contains only high frequency words from the BNC. However, specialized lists possibly are comprehensive because all the words come from the sports science corpora.

4. Being practical

- The vocabulary syllabus contains the appropriate size of words not too many words but adequate for reading comprehension.
- NP contains 2,000 word families from the GSL, 570 word families from the AWL, and some of technical words which may be too many for learners in a specialized purpose to learn. The BNC HFWL has 14 lists each of 1,000 word families; this makes too many to know. Conversely, specialized lists in a specific discipline may not have as many words in the existing paradigm and proposed list because they are specific to sports science. However, the question is whether they are of an adequate level to facilitate the students to comprehend the texts well.

In order to build a vocabulary syllabus for graduate students in sports science, representative specialized authentic sports science texts are needed for the creation a corpus. In addition, a core sub-discipline of sports science is required because building a corpus collected from the whole sports science discipline makes it too broad and too big. Exercise physiology is a core sub-discipline and the one which is most popularly selected for study; and, therefore, it is used for this investigation.

The next section will show the significance of the vocabulary investigation in exercise physiology corpora for exercise physiology learners.

1.3 Significance of the study

1.3.1 The results from the assessment of the vocabulary syllabi namely Nation's Paradigm, the British National Corpus High Frequency Word List, and Exercise Physiology are useful for sports science learners. The results help teachers to design a vocabulary syllabus for graduate students in sports science with the most useful vocabulary syllabus and words that have a high occurrence.

1.3.2 Exercise physiology word lists and exercise physiology noun-noun combination lists derived from the two corpora investigation will: 1) be beneficial to graduate students in the exercise physiology field to comprehend exercise physiology texts more effectively and efficiently by showing them how many words and which words or combinations should be learned; 2) enable language teachers and syllabus designers for exercise physiology to select useful words and combinations to teach; 3) show the readers of exercise physiology textbooks, research articles, together with people who are in the field of exercise physiology which words or combinations play an important role in the field, and which words or combinations should be learned; 4)

help not only graduate students but also undergraduate students who use exercise physiology textbooks and research articles or study the exercise physiology course; and 5) help learners in other sub-disciplines of sports science because exercise physiology and others sub disciplines share something in common as they are all in the field of sports science.

1.4 Purposes of the study

This research study aims;

1.4.1 To compare the usefulness of Nation's Paradigm (NP), British National Corpus High Frequency Word List (BNC HFWL), and specialized list (Exercise Physiology List) in Exercise Physiology Textbook Corpus (EPTC) and Exercise Physiology Research Article Corpus (EPRAC);

1.4.2 To create word list and noun-noun combination list from Exercise Physiology Textbook Corpus (EPTC) and Exercise Physiology Research Article Corpus (EPRAC); and

1.4.3 To compare vocabulary used in the Exercise Physiology Textbook Corpus (EPTC) and Exercise Physiology Research Article Corpus (EPRAC)

1.5 Research questions

1.5.1 Is Nation's Paradigm a useful basis for a sports science vocabulary syllabus? Would a simple paradigm such as the British National Corpus High Frequency List (BNC HFWL), or a subject-specific list (the Exercise Physiology List), be better?

1.5.2 How do the vocabulary requirements differ between the Exercise Physiology Textbook Corpus (EPTC) and the Exercise Physiology Research Article Corpus (EPRAC)?

1.5.3 Do we need to account for noun-noun combinations (NNCs) and if so how?

1.6 Definitions of operational terms

Noun-Noun Combinations (NNCs) is the occurrence of two nouns, where the second noun is used as the headword and the first noun is used as a pre modifier of the headword. It conveys a unit of meaning.

Exercise Physiology Textbook Corpus (EPTC) is a corpus obtained a textbook named Exercise Physiology: Energy, Nutrition, and Human Performance. It consists of seven chapters randomly selected, and contains 134,633 running words.

Exercise Physiology Research Article Corpus (EPRAC) is a collection of research articles related to exercise physiology selected from research articles in journals from the field of exercise physiology. The number of words in the EPRAC is 134,029 running words.

Online Exercise Physiology Text Corpus (OEPTC) is a collection of exercise physiology texts collected from the internet. There are 137,287 running words.

General words are words in the General Service List (GSL)

General Service List (GSL) is a list of the 2,000 most useful general service headwords and families for English language learners created by Michael West in 1953**.**

Academic words are words in the Academic Word List.

Academic Word List (AWL) is a list of formal vocabulary that is common across the academic fields, and which was created by Averil Coxhead in 2000. There are 570 word families.

Technical words are words with have meanings related to or specific to exercise physiology.

Nation's Paradigm (NP) is Nation's notion of vocabulary classification. It covers three types of vocabulary: high frequency words or general words, academic words, and technical words.

Exercise Physiology Textbook Corpus List (EPTCL) is the list of technical word types from the Exercise Physiology Textbook Corpus.

Exercise Physiology Research Article Corpus List (EPRACL) is the list of technical word types from the Exercise Physiology Research Article Corpus.

Exercise Physiology List (EPL) is the list of technical word types from the Exercise Physiology Textbook Corpus (EPTC), and the Exercise Physiology Research Article Corpus (EPRAC).

Exercise Physiology Textbook Corpus Noun-Noun Combination List (EPTNL) is the list of technical NNCs from the Exercise Physiology Textbook Corpus.

Exercise Physiology Research Article Corpus Noun-Noun Combination List (EPRNL) is the list of technical word types from the Exercise Physiology Research Article Corpus.

Exercise Physiology Noun-Noun Combination List (EPNNL) is the list of technical noun-noun combinations from the Exercise Physiology Textbook Corpus (EPTC), and the Exercise Physiology Research Article Corpus (EPRAC).

1.7 Summary of Introduction

From the sections in this introductory chapter, it can be stated that vocabulary is one of the most important factors relating to English learning especially in specialized field. Sports science learners need vocabulary, and exercise physiology, a sub-discipline of sports science, has been selected for vocabulary investigation because it is a core sub-discipline of sports science. There are some existing vocabulary syllabi for pedagogical purposes; however none of the studies confirms the usefulness of vocabulary in the field of exercise physiology. Therefore, vocabulary in the exercise physiology field for graduate students is of interest to the current researcher and is the justification for this study.

Before moving on to the methodology of the investigation, the literature will be reviewed in the next chapter.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the theoretical background and previous studies related to the current study. Vocabulary, vocabulary syllabi, reading in specialized texts, and multi- word units are presented respectively.

2.1 Vocabulary

This study investigated the usefulness of Nation's Paradigm (Paul Nation's vocabulary classification notion), the British National Corpus High Frequency Word List (BNC HFWL), and the Exercise Physiology List (EPL) which are treated as vocabulary syllabi as mentioned in research question 1. Research question 1 is "Is Nation's Paradigm a useful basis for a sports science vocabulary syllabus? Would a simple paradigm such as the British National Corpus High Frequency List (BNC HFWL), or a subject-specific list (the EPL), be better?"

2.1.1 Roles of vocabulary in reading

Nation (2001) proposed that the factors related to reading and language learning are vocabulary, grammar, and background knowledge. Among these factors, vocabulary seems to play more important role than the other factors (Carnine, Silbert, Kameenui, & Tarver, 2004; Meara, 1996; Nation, 2001; Okamoto, 2015). Wilkins (1972, p.111) stated that "without grammar, little can be conveyed, without vocabulary, nothing can be conveyed" in all skills especially in reading. Laufer (1992), Stahl (2003),

and Hsu (2011) agreed that the important factor affecting reading comprehension is vocabulary. Learners, both native and non-native, cannot comprehend text well if they do not understand the vocabulary in the text (Laufer, 1992, 1997; Zhang & Annual, 2008). Vocabulary affects reading at every learning level (Grabe, 2009), including academic texts (Morris & Cobb, 2004). Readers will unsurprisingly encounter difficulty without adequate vocabulary, which causes poor reading (Anderson & Freebody, 1983). Zhang and Annual (2008) demonstrated that unknown words which students could not comprehend or interpret will make the learners miss information affecting their comprehension and ability to use reading to acquire new knowledge. Morris and Cobb (2004) indicated that vocabulary knowledge is a good predictor of academic success. Evidence has shown from Becker's (1977) observation that vocabulary knowledge was the primary factor related to grade 3 students reading and academic success. Grabe and Stoller (1997) conducted a case study on reading and vocabulary development in a second language. This study aimed to explore the extent to which extensive reading practice would enhance reading ability and vocabulary development in Portuguese. The subject read daily Portuguese newspapers without instructional reading. The results showed that after a month, the subject correctly identified 25% of the words tested and after five months, he could correctly identify 50% of the words tested. From the study, they suggested that reading in a second language is strongly related to learning words and vice versa. Chen's study (2009) suggested that there is a correlation between vocabulary breadth knowledge, vocabulary depth knowledge, and reading comprehension. It appeared that vocabulary breadth knowledge or vocabulary size has a stronger relationship to reading comprehension. He added that learners at different levels have different vocabulary knowledge and they comprehend differently.

From the information reviewed above, it certainly shows that vocabulary affects reading comprehension. It depends on the learners' vocabulary size (Hsu, 2011; Qian, 2002). Moreover, vocabulary can reliably predict reading comprehension (Zhang & Annual, 2008).

2.1.2 Vocabulary text coverage in reading

Text coverage is the percentage of particular running words in a text (Nation & Kyongho, 1995). That is, if the text coverage of the word *sports* is 5% in a text, it means that it occurs on average 5 times in every 100 running words in the text. Or if we know 95% of text coverage in a text, it means we know 95 out of 100 running words from the whole text. Chujo (2005) claims that we can predict text comprehension if we know the proportion of words that learners understand in the text. Numerous scholars have discussed text coverage to reach different goals of reading comprehension.

Laufer (2010), Nation (2006), Hirsh and Nation (1992), and Nation and Coady (1988) postulated that in order to read independently, effectively, and to get meaning from the context, readers should know 98-99% of the running words. The question is how many words are needed to reach 98-99% of text coverage. Nation and Coady (1988) advised 5,000 word families or 8,000 lexical items, while Dang and Webb (2014) recommended 8,000 word families. Laufer (2010) suggested 8,000 word families, and Stahl and Nagy (2006) proposed 40,000 words are needed to cover 98-99% of the text.

Laufer (2010) proposed that academic reading comprehension requires 95% of lexical coverage to comprehend well and effectively. Laufer (1997) suggested that the vocabulary size adequate for reading comprehension is about 3,000 word families or about 5,000 lexical items. Nation (2001) suggested at least 3,000 word families which

consist of 2,000 word families from the General Service List, 570 word families from the Academic Word List (AWL), and 1,000 or more from technical words, proper nouns, and low frequency words. Text coverage should come from 80% general words, 10% from academic words, and 5% from technical words. Meanwhile, Engels (1968) and Coady (1997) recommended 3,000 words to reach that text coverage. Nation (2001) claimed that, if readers cross the vocabulary threshold, they can comprehend sufficiently. It can be claimed that readers have to reach the vocabulary threshold in order to acquire the adequate comprehension in text reading.

Scholars and researchers have agreed that the text coverage for pleasurable reading is 98-99 %, while for academic reading it should be 95%. Exercise physiology texts are academic and therefore, 95% of text coverage may be needed for reading comprehension. The question about how many words are required to reach the exact text coverage depends on the different ways of counting words, or the word counting units. This will be discussed in the following part.

2.1.3 Issues in text coverage: word counting unit

Word counting units affect the text coverage estimation. There are four ways of counting words: running words (tokens), types, lemmas, and word families. A word token or a running word is the number of word forms in a text. For example, *exercise physiology is a sub discipline of sports science* contains 9 running words. Word type refers to each different individual word in a text. If *exercise* occurs three times in a text, it is called one word types. For example, *exercise physiology is the study of the body responses and adaptations to physical exercise* contains 12 word types. *The* occurring two times is counted as one word type. *Physical* appearing once is counted as one word type. A lemma is a word from the same part of speech, and consists of a headword and

its inflections and reduced forms, e.g. *sports* and *sport* are counted as one lemma. A word family (WF) is a headword with its inflected and derived forms (Coxhead, 2000; Nation, 2001), or easily defined, it consists of the parent word and family members (Coxhead, 2012) which means that there are members in a word family, for instance, *effect* (headword), *effective, effectively*, *efficient, efficiency*, and *efficiently* are counted as one word family (Bauman, 2012). Baurer and Nation (1993) proposed the affixes for making a word family as the following:

1. Regularly inflected words are part of the same family. The inflectional categories are – plural; third person singular present tense; past tense; past participle; -ing; comparative; superlative; possessive
2. -able, -er, -ish, -less, -ly, -ness, -th, -y, non-, un-, all with restricted uses
3. -al, -ation, -ess, -ful, -ism, -ist, -ity, -ize, -ment, -ous, in-, all with restricted uses.
4. -age (leakage), -al (arrival), -ally (idiotically), -an (American), -ance (clearance), -ant (consultant), -ary (revolutionary), -atory (confirmatory), -dom (kingdom; officialdom), -eer (black marketeer), -en (wooden), -en (widen), -ence (emergence), -ent (absorbent), -ery (bakery; trickery), -ese (Japanese; officialese), -esque (picturesque), -ette (usherette; roomette), -hood (childhood), -i (Israeli), -ian (phonetician; Johnsonian), -ite (Paisleyite; also chemical meaning), -let (coverlet), -ling (duckling), -ly (leisurely), -most (topmost), -ory (contradictory), -ship (studentship), -ward (homeward), -ways (crossways), -wise (endwise; discussion-wise), anti- (anti-inflation), ante- (anteroom), arch- (archbishop), bi- (biplane), circum- (circumnavigate), counter- (counter-attack), en- (encage; enslave), ex- (ex-president), fore- (forename), hyper- (hyperactive), inter- (inter-African, interweave), mid- (mid-week), mis- (misfit), neo- (neo-colonialism), post- (post-date), pro- (pro-British), semi- (semi-automatic), sub- (subclassify; subterranean), un- (untie; unburden).
5. -able, -ee, -ic, -ify, -ion, -ist, -ition, -ive, -th, -y, pre-, re-.

A word family is useful to ease the learning burden. Learners who know a member of a word family can learn other member in the same word family more easily

with a lighter burden (Nation, 2001). Word families are suitable for counting in research which is focused on comprehension (Nation & Webb, 2011). On the other hand, previous studies showed that a word family used to count words is known to be misleading for vocabulary knowledge testing or learning because knowing one member of the family does not necessarily mean that the other members will be known (Hancioglu et al.,2008; Ward, 1999). When words are investigated from a text, not all members in a word family occur. Even if only one member or two members of a word occur, a word family occurrence is counted which causes overestimation. Studies have counted words variously depending on their purposes and assumption. In the GSL, AWL, and BNC HFWL, which were created by Nation, word families are used. The word counting unit in the BNC is the lemma. In some other studies, types and/or tokens and/or lemmas and/or word families or all are employed. In this study, word family will be used for the purposes of comparison. Token, type, and lemma will be used to see the occurrence of words in the corpora as well.

When considering the vocabulary coverage in a text, not only single words but also multi-word units are taken into account. Multi-word units are taken into consideration because they are important for vocabulary learning. However, they are not included in the existing vocabulary syllabi. Multi-word units and noun-noun combinations were investigated to answer research question 3; therefore they will be reviewed later in 2.4.

Before moving forward to noun-noun combinations, vocabulary syllabi are reviewed in the following section.

2.2 Vocabulary syllabi

There are different definitions of a vocabulary syllabus, and the one related to this study is either the list of words selected for teaching and learning (Sinclair & Renouf, 1988) or which words should appear in language textbooks and teaching materials (Okamoto, 2015). Sinclair and Renouf mentioned that a vocabulary syllabus shows to teachers, course designers, and learners the things that are worth learning.

A vocabulary syllabus widely used and accepted among scholars and researchers is Paul Nation's vocabulary classification notion (Nation, 2001), hereafter called Nation's Paradigm which is mentioned partly in Chapter1. Hence, the following section will present some more details about the usefulness and issues proposed in previous studies.

2.2.1 Nation's Paradigm (NP)

Nation's Paradigm is Paul Nation's concept about vocabulary classification and use. Nation (2001) classifies vocabulary into four types; high frequency words or general words, academic words, technical words, and low frequency words. High frequency words are words in the General Service List of English Words or General Service List or GSL (Nation, 2001; West, 1953). Academic words are words in the Academic Word List (Coxhead, 2000; Nation, 2001). Technical words are words specific to particular area and which occur frequently in that particular field (Nation, 2008), such as in engineering (Mudraya, 2006; Ward, 1999, 2007; Ward & Chuenjundaeng, 2009; Wasuntarasophit, 2008), business (Chujo & Utiyama, 2006), linguistics and anatomy (Chung & Nation, 2003). Low frequency words occur rarely (Nation, 2008). Words that occur frequently in general texts (Nation, 2001), general

words, or words in the General Service List (GSL) and New General Service List (NGSL) are presented next.

2.2.1.1 General Service List (GSL)

Usefulness of GSL

West (1953), Coxhead (2000), Nation (2001, 2008), Hancioglu et al (2008), and Muñoz (2015) proposed that the General Service List or General Service List of English Words (GSL) is a list of the 2,000 most useful 'general service' headwords and families for English language learners. The GSL has been used widely and is needed in speaking and writing, both for academic and non academic language (Nation, 2008). Therefore, it can be said that it aims at pedagogical purposes (West, 1955, cited in Bauman, 2012). Schmitt and McCarthy (1997) claimed that the GSL is the best available list because the list creation concerned not only frequency and range but also meaning. Examples of the words in the GSL are *place, take,* and *nation* (West, 1953). Engels (1968) considered the first 1,000 words of the GSL are the good choices because the words have a high frequency and wide range. The GSL has high text coverage in many texts. Studies have shown that the text coverage of words in the GSL provides almost 80% of the running words in general texts (Nation, 2001), 90% in conversations and novels, up to 90% in fiction texts (Hirsh, 1993), up to 75% in nonfiction texts (Hwang, 1989), up to 76% in academic texts (Coxhead, 1998), 76% in agricultural texts (Muñoz, 2015), 85% in British academic spoken English (Dang & Webb, 2014), 71% in electronics (Farrell, 1990) and 82.5% in economic textbooks (Nation, 2001).

From the text coverage mentioned above, it is indicated that the GSL plays an important part with high text coverage in general, academic, and specialized texts. However, some issues with the GSL are proposed, as follows.

Issues with the GSL

Engels (1968), Nation and Kyongho (1955), and Schmitt and McCarthy (1997), Nation and Webb (2011), and Muñoz (2015) pointed out that the GSL needs revision. Engels found that the first 1,000 words in GSL covered 73.1% of the running words in the texts; the second 1,000 words in the GSL covered only 7.7%. This also occurred as well in electronics texts for which the figure was 5.9% (Farrell, 1990). Therefore, it can be claimed that the first 1,000 words can be considered as good 'general service words'. Thus, the first issue is that the second 1,000 words cannot be good general service words because of the low frequency occurrence. Engels reported that the second 1,000 words of the GSL did not occur frequently. Secondly, Hancioglu et al. (2008) proposed the inconsistencies of counting word families in the GSL. They asserted that the problem areas are US/UK spelling, word forms, singular/plural, archaic words, and out of date words. In addition, some words have the same spelling but completely different meanings. Examples are *saw (the tool)* and *saw (the past tense of see)* which are treated as one family. Using a word family as a word counting unit causes a difficulty in word classification and semantic understanding. For instance, *pride* and *proud* are treated as separate headwords; hence there is a question of what word family they really belong to. Ward (1999) and Hancioglu et al (2008) proposed that using a word family as a word counting unit can cause a misleading estimation of vocabulary knowledge. Next, Engels (1968) argued that the size of the GSL corpus for a word list creation is small and cannot be a good representative of general word use.

There are 5,000,000 running words in the corpus. Fourthly, Schmitt and McCarthy (1997) stated that there are some errors and unreliability in the GSL which was created based solely on written texts. Lastly, Richards (1974) argued that the age of the corpus, which was based on data originally published in 1938 and 1949, is too old.

To sum up, the following are the issues with the GSL from the previous studies which have been discussed: 1) the frequency and range of the second 1,000 word families, 2) consistencies in the counting, 3) the size of the corpus, 4) some errors and the unreliability of the corpus, and 5) the age of the texts used for the GSL's creation. One more issue is the number of words in the GSL which is around 2,000 word families. They may be too many for general purpose learning.

Because of the issues with the GSL mentioned above, the New General Service List or NGSL was created by Dr. Charles Browne, Dr. Brent Culligan, and Joseph Phillips in 2013. The NGSL was created for students of English as a second language (http://www.newgeneralservicelist.org) from 273 million-word subsection of the 2 billion words in the Cambridge English Corpus (CEC). It contains approximately 2,800 high frequency words which are 800 words more than the old GSL. The purposes of the NGSL creation were 1) to update the list of the GSL and expand the size of its corpus with the hope of generalizing and validating the list, 2) to create the most important high-frequency English word list which gives the highest text coverage with the fewest words, 3) to make the NGSL based on clearer definitions, 4) to be a starting point for discussion among interested scholars and educators around the world. The NGSL is not included because it is not widely used and accepted.

In this present study, the researcher examined the 2,000 word families of the GSL occurring in the exercise physiology textbook corpus and exercise

physiology research article corpus in terms of word occurrence, meanings related to the field of exercise physiology, words as parts of noun-noun combinations, and the differences between the two corpora.

2.2.1.2 Academic Word List (AWL)

Academic words are words that occur frequently in academic texts, and words in the GSL are excluded (Chung & Nation, 2003; Hyland and Tse, 2007; Nation, 2001, 2008). Another name for an academic vocabulary is a sub-technical vocabulary which occurs and has the same meaning in several scientific or technical disciplines (Trimble, 1985).

Usefulness of the AWL

Nation (2008) proposed that the AWL is the most useful list of formal and academic English words for learning after the first 2,000 words. It has a high frequency of occurrence and covers a wide range of academic discipline. The AWL is used widely in academic discourse even though there are various disciplines (Chen & Ge, 2007). The 570 word families in the AWL consist of vocabulary with good coverage in academic texts, regardless of the subject areas. In Coxhead's work (2000), the first sublist covers over one- third of the total coverage of Coxhead's academic corpus, and the first two sublists account for half of the total coverage. The AWL covers 9% of the running words in the texts (Nation, 2001), 9.3 % in the whole of Coxhead's academic corpus, and around 8.5% in the sub group corpus (Coxhead, 2000), 11.6% in Cobb and Horst's work (2004), 12.36% in the EFLC, 17.43% for AESPC (Shabania & Tazikb, 2014), 9.96% in a chemistry research article corpus (Valipouri & Nassaji, 2013), and 12.82% in environmental science. Martinez, Beck and Panza (2009) investigated academic vocabulary in agriculture research articles. The results revealed

that the AWL covered 9.06% of the tokens in the corpus. They demonstrated that academic vocabulary text coverage is reduced because learners pay more attention to a specific field; further, they claimed that there are distinctions in the vocabulary in different genres and disciplines. Vongpumivitch, Huang, and Chang (2009) explored the use of words in the Academic Word List in applied linguistic journal articles with a 1.5 million word corpus. The results revealed that the AWL words covered 11.17% of the whole corpus and most of the words belonged to the first and second sublists. Coxhead (2000) stated that the first sublist accounted for around 33% of the text coverage, while the second sublist accounted for 1.8% of the corpus. Chen and Ge (2007) conducted a lexical study on the word frequency and text coverage of the 570 word families from the AWL in medical research articles based on a corpus of 190,425 running words. They found that the AWL covered 10.07% of the medical corpus and around 10% in the five sections of the research articles. The abstract section had the highest text coverage (11.18%), whereas the results sections had the lowest text coverage (9.28%). The abstracts and discussion sections had the highest text coverage of the AWL. The sections that functioned to express ideas tended to use more from the AWL, hence the discussion sections use more from the AWL than the result sections (Chen & Ge, 2007; Martinez et al., 2009). The methods and materials, and the results sections had the lowest text coverage, because academic words are often used when people express abstract ideas rather than when they describe phenomena. It can be claimed that academic words such as in the AWL, have a widely accepted significance and are a necessity for academic purpose learners. From the previous studies, the AWL can be claimed to cover around 10% in academic texts. On the other hand, some issues with the AWL are proposed.

Issues with AWL

Hyland and Tse (2007), Muñoz (2015), Paribakht and Webb (2015), and Cobb and Horst (2015) discussed the issue that the creation of the AWL is biased towards a limited number of the disciplines, that it is based on the GSL, and that it has a distribution of semantic and collocational behaviors across various fields. Therefore, they recommended having an academic word corpus from specialized fields or genres because academic word forms may be used differently in each science discipline. They mentioned that in order to make it more useful, the AWL should be related to word meaning and use, not only to frequency and range. Wang and Nation (2004) proposed that it is necessary to build word lists from specific disciplines and that the students' specific target context should be taken into account in the teaching. Martinez, Beck, and Panza (2009) asserted that a list that is built based on semantic and pragmatic consideration would be more useful than one based on frequency only.

The AWL plays a crucial role in formal and academic English (Nation, 2008), at least in the field of medical research, engineering, anatomy, and applied linguistics. Conversely, some studies argue against the bias of the corpus towards these four specific disciplines, its basis from the GSL, and the meanings in different disciplines. Therefore, an academic word list for each specific discipline is suggested. The role and use of academic words in the exercise physiology corpora were investigated in this study.

Because of the issues with the AWL mentioned above, the New Academic Word List or NAWL was created by Brezina and Gablasova in 2013 (http://www.newacademicwordlist.org/). The NAWL is a list of 964 words from an academic corpus which contains 288 million words. The corpus came from the

Cambridge English Corpus's academic, oral, and textbook corpora (http://www.newacademicwordlist. org/).

As the NAWL is a new list created in 2013, it is not yet well known, and very few studies have investigated its usefulness, even though it contains more words than the old AWL. Therefore, it is not investigated in the exercise physiology texts.

2.2.1.3 Technical words

Nation (2001, 2008) proposed that technical vocabulary is used in specific disciplines and is useful for learners with specific goals because it is common, occurs frequently, and is closely related to the subject area. It conveys specialized meanings in a specific field, and represents concepts of a discipline (Cabŕe, 1999), therefore it can help specific purpose learners to study more effectively.

Nation (2001) proposed that a technical vocabulary covers 5% of specialized texts. However, it is interesting that Nation and Chung's (2003) study about technical vocabulary in anatomy and applied linguistics texts found that technical vocabulary covered 37.6% (types) and 31.2% (tokens) in the anatomy field, while it covered 16.3% (types) and 20.6% (tokens) in the applied linguistics. In electrical engineering, Wasuntarasophit (2008) demonstrated quite a high percentage as well. He found that technical vocabulary covered 17.17% of the lexical unit tokens. Wang and Ge (2008) proposed 12.24% of medical words in a research article corpus. From the previous studies mentioned above, it can be concluded that technical vocabulary gives different text coverage in different specialized disciplines (Nation, 2008). They are different because of the discipline differences and because of the approaches used for vocabulary classification.

Nation (2001) proposed four categories to distinguish a technical vocabulary depending on the degree of technicality which is restricted to a particular discipline. The four categories are: 1) the word form appears rarely outside this particular field; 2) the word form is used inside and outside this particular field but has different meanings; 3) the word form is used inside and outside this particular field and the specialized meaning can access to the meaning outside the field; and 4) the word form is common in this particular field and has a more precise meaning. Category1 shows the most technicality and category 4 shows the least. Chung and Nation (2004) proposed that the four different approaches used to identify the technicality are rating scale, clues, technical dictionary, and corpus-based.

The four step rating scale approach is used to identify how much the word is related to the field by looking at the meaning in the context, ranging from the least related to the most.

The technical dictionary approach is used to identify whether the word is technical or not based on whether it is in a technical dictionary. Therefore, the technical dictionary should be large and up-dated. However this approach relies on only a writer or a group of writers or a compiler's judgment. This approach depends on the consistency of dictionaries.

Clues provided in the text approach are used to look at the word's definition signals to show its technicality such as 1) definition, 2) typographical clues like bold print, italics, and bracket, and 3) labels in diagrams or illustrations. However, the clues are not easy to recognize. Typographical signals can have more functions than indicating a technical word, and not every labels or illustration leads to a technical word.

The corpus-based approach is employed in two instances; statistical and linguistic. A statistical approach shows the occurrence of words based on frequency and range. Then, they can be used for ratio calculation and the ratio can show the specialization of the words. A linguistic approach is used to see the word form, part of speech, grammatical structure and lemmatization. Technical words are likely to occur in a specialized area with a high frequency and having a limited range and low dispersion (Nation, 2008).

In Chung and Nation's study (2004) entitled *Identifying technical vocabulary*, they compared four different approaches used for technical word identification in an anatomy text. The results showed that the rating scale approach had a high degree of reliability. It identified terms and non-terms 100% correctly. Using a technical dictionary and a computer-based source gave around 80% accuracy. However, using clues provided in the text was the least accurate approach with 70%. As the rating scale is an approach shown to have 100% accuracy for vocabulary identification, it is interesting to show it in use.

The four step rating scale for a technical vocabulary identification in the anatomy field (Chung & Nation, 2004, p.254) is as follows:

Step 1: Words such as function words that have a meaning that has no particular relationship with the field of anatomy, that is, words independent of the subject matter. Examples are: the, is, between, it, by, adjacent, amounts, common, commonly, constantly, early, and especially.

Step 2: Words that have a meaning that is minimally related to the field of anatomy in that they describe the positions, movement, or features of the body. Examples are: superior, part, forms, pairs, structures, surrounds, supports, associated, lodge, protects.

Step 3 Words that have a meaning that is closely related to the field of anatomy. They refer

to parts, structures, or functions of the body, such as the regions of the body and systems of the body. Such words are also used in general language. The words may have some restrictions of usage depending on the subject field. Examples are: chest, trunk, neck, abdomen, ribs, breast, cage, cavity, shoulder, girdle, skin, muscles, lungs, heart, organs, liver, breathing. Words in this category may be technical terms in a specific field like anatomy and yet may occur with the same meaning in other fields and not be technical terms in those fields.

Step 4: Words that have a meaning specific to the field of anatomy and are not likely to be known in general language. They refer to structures and functions of the body. These words have clear restrictions of usage depending on the subject field. Examples are: thorax, sternum, costal, vertebrae, pectoral, fascia, trachea, mammary, periosteum, hematopoietic, pectoralis…

Previous studies have revealed the significance of technical vocabulary in specialized texts with high text coverage (Li & Qian, 2010). Technicality in different texts is different from discipline to discipline depending on the restriction of a word to that particular discipline (Liu & Han, 2015; Muñoz, 2015). The text coverage in different disciplines is different because of the vocabulary classification approach used.

It can be concluded that the technical vocabulary plays an essential role in specialized texts. It covers more than 20% of the tokens in anatomy and applied linguistics texts. The role of the technical vocabulary in exercise physiology texts is taken into account in this study. As it is difficult to identify, expert intuition was employed to rate the scale for technical vocabulary identification. A rating scale (Chung and Nation, 2003) was used because it showed 100% accuracy for vocabulary classification.

Issues of technical vocabulary

As a technical vocabulary is different from discipline to discipline, it is difficult to identify how much of it is tied to a particular discipline without specialized knowledge. Technical vocabulary is classified differently according to the different approaches used. Hence, a reliable approach which shows 100% vocabulary classification (Chung and Nation, 2004) is needed. Moreover, words should be identified by knowledgeable people in that particular field, as expert intuition is used in the rating scale in the studies of Chung and Nation (2004) and Wasuntarasophit (2008). The same words in different texts are classified into different categories. For example, *wave* which is in the GSL is classified as a technical word in the electrical engineering discipline (Wasuntarasophit, 2008).

2.2.1.4 Low frequency words

Low frequency words are "1) words which are not quite frequent or wide range enough to be high frequency words, 2) technical words from other areas, and 3) words that just occur rarely" (Nation, 2008, p.11). Low frequency words cover 5% of the running words in conversation, 10% in newspaper, and 10% in academic texts (Nation, 2008).

2.2.1.5 Usefulness and Issues of Nation's Paradigm

Nation's Paradigm is substantial because it covers all kinds of vocabulary for all the different learners. It shows high text coverage of each vocabulary type in different texts. No other paradigm has dealt with vocabulary as clearly as Nation's Paradigm.

However, some arguments exist about the vocabulary in Nation's Paradigm. The first argument is about the vocabulary classification and its reliability,

whether the words from each vocabulary type fall into that particular type in all kinds of texts, genres, and specific disciplines or are they classified differently if the meanings in context are considered. Wasuntarasophit (2008) found that *wave* from the GSL is classified as a technical word in electrical engineering because its meaning in context is considered. Chujo and Utiyama (2006) showed that *market* and *cost*, which are in the GSL, are classified into technical vocabulary in a commerce and finance corpus. *Financial* which is in the AWL was classified as technical words in a finance corpus. Pueyo and Val (1996) classified *cake* which is in the GSL into a technical word in the field of plastics in which it means "a compact mass (to form into)" (p.261). Therefore a question about so-called words in exercise physiology texts occurs; for example *exercise,* which is in the GSL and *performance,* and *intensity* which are in the AWL. They were classified into the technical category in this study. In some disciplines, general words have a specialized meaning in that particular discipline (Muñoz, 2015). Furthermore, there are some arguments about the necessity of setting up the vocabulary level into general words, academic vocabulary, and specialized vocabulary (as Nation's Paradigm) for learners who have specialized goals (Hancioglu et al., 2008; Ward, 1999) because the distinction among them is not clear cut (Hancioglu et al., 2008). Thirdly, text coverage of words from three vocabulary types in different studies is different from one discipline to another, depending on the vocabulary classification approach used (Chung & Nation, 2003, 2004; Liu & Han, 2015; Muñoz, 2015). The exemplification of different text coverage is mentioned differently: Nation (2001) proposed that technical words cover 5% of text, but later he proposed another results from his study that technical vocabulary words cover more than 20% in specialized texts (Chung and Nation, 2003). Text coverage of vocabulary is inconsistent. Hence, in this current study,

the researcher would like to establish the text coverage or percentage or proportion of general, academic, and technical words and noun-noun combinations in the exercise physiology corpora. Fourthly, a word counting unit is an argument against Nation's Paradigm as well. It causes different results for text coverage. Vocabulary in the GSL and the AWL is counted by the word family which consists of a headword and its inflections and the derivations that means that there are members in a word family (Coxhead, 2000; West, 1953). When words are investigated from a text, not all members in a word family occur. Even if only one member or two members of a word occur; a word family occurrence is counted (Ward, 1999). It may cause overestimation. Simply because one word is known does not mean that all members in the same family are known. Previous studies showed that using a word family to count known word is misleading for vocabulary knowledge testing or learning (Hancioglu et al., 2008; Ward, 1999). Fifth, Ward (1999), Pueyo and Val (1996), and Hancioglu et al (2008) proposed that 2,000 word families from the GSL, 570 word families from the AWL may be an excessive amount of words to learn. Based on Nation's Paradigm, learners with specific purposes have to learn 2,570 word families from the GSL, the AWL, and some form of technical vocabulary. Hancioglu et al (2008), Liu and Han (2015), and Ward (1999) recommended creating a specialized list for a specific group of learners. Sixth, there is an argument about the GSL which was created by Michael West based on a general written corpus of 5,000,000 words in 1953, as reviewed in 2.2.1.1. It was a corpus based on the texts written nearly 60 years ago. The problem about the age and size of GSL has been argued. In addition, the low text coverage of the second 1,000 word families in the GSL has been questioned and a revision has been suggested. Seventh, the AWL was created by Coxhead in 1998 based on a corpus compiled from four broad academic

subject groupings of arts, commerce, law and science. Hancioglu et al (2008) asserted that the data collection was biased to particular disciplines, and that academic word lists for specific fields are recommended. The researcher also has doubts about the representativeness of the texts in the corpus. If the corpus is biased, the AWL based on that corpus cannot be representative of the vocabulary in the academic field as a whole, even if all the texts collected were academic. These seven arguments will be discussed in this investigation.

Beside Nation's Paradigm, there are vocabulary lists which are simpler, such as the British National Corpus High Frequency Word List (BNC HFWL), and specialized lists.

2.2.2 British National Corpus High Frequency Word List (BNC HFWL)

Nation created the British National Corpus High Frequency Word List (BNC HFWL). The list comes from the British National Corpus (BNC) which consists of around 100 million words from both written and spoken language from various sources collected from 1991-1994. Words in the BNC HFWL are common in British English and are proposed for their usefulness because there are no overlapping words since Nation (2012) classified each word to a specific list, and a word cannot be changed from one list to another, even though forms and meanings or both are considered. It is comprehensive because it contains a lot of words from lists 1-14 (Nation, 2012). Hancioglu et al (2008) and Nation (2004) proposed that the vocabulary from the first three lists of the BNC has a higher text coverage than the GSL and the AWL together. However, there is an argument about the BNC HFWL that it is inefficient because Nation did not create the BNC HFWL based on specific purposes. Hence, learners have to spend time in studying a lot of unnecessary words from all the lists.

The BNC HFWL was built from the BNC which is representative of updated texts. Nevertheless, there are issues: 1) it is not built for specialized purposes such as exercise physiology learning, and 2) there are too many words to learn. It may not suit exercise physiology learners. Therefore, these issues have led to the investigation.

2.2.3 Specialized vocabulary lists

Besides the vocabulary lists for EAP learners in general, there are vocabulary lists specific to particular fields, for example: lists for engineering (Ward, 1999, 2007; Wasuntarasophit, 2008), business (Chujo & Utiyama, 2006), applied linguistics (Chung & Nation, 2003, 2004), medicine (Wang et al., 2008), and environment (Liu & Han, 2015). A vocabulary list usually comes from a corpus. A corpus for building a specialized vocabulary list should come from representative and authentic texts in the discipline with an appropriate size in order to show real language use. Bowker and Pearson (2002) proposed that the appropriate size for specialized corpus building is from about ten thousand to several hundreds of thousands of words.

Ward (2009) investigated a basic engineering English word list for less proficient foundation engineering undergraduates from a corpus of 271,000 word tokens. His corpus was created from chemical, civil, electrical, industrial, and mechanical engineering textbooks. There are 299 words in the list. This list gives 16.4% of the text coverage in Engineering Corpus.

Chung and Nation (2003) investigated the technical vocabulary in anatomy and applied linguistics corpora. There are 450,000 tokens in anatomy corpus and 93,445 tokens in applied linguistics corpus. Words were classified into the four step rating scale. The results showed that the technical words cover 31.20% of the text coverage in anatomy texts and 20.60% of the text coverage in applied linguistics texts. The

anatomy list contains 4,270 word types and applied linguistics list contains 835 word types.

Chujo & Utiyama (2006) studied the level-specific specialized vocabulary using statistical measures which are log-likelihood, the chi-square test, and the chi-square test with Yates's correction in Commerce and Finance corpus. The corpus contains 7.3 million words extracted from British National Corpus. This corpus included 284 texts from business books and related fields books such as accounting, advertising, banking, public relations, trading, and sales, and also business articles. The results illustrated that the statistical measures can identify technical vocabulary correctly without content knowledge of that particular field.

Wasuntarasophit (2008) investigated technical vocabulary in electrical engineering textbooks. Five engineering textbooks consisting of 122,209 running words were compiled to build an electrical engineering corpus for the investigation. There are two approaches used to estimate the text coverage; comparing with the baseword lists in Range program and the four step rating scale adapted from Chung and Nation (2004). It was found that the technical word list covered high text coverage in the corpus which was around 50% by comparing with the baseword list approach and was over 30% by the rating scale approach.

Wang et al. (2008) established a Medical Academic Word List from a corpus containing 1,093,011 running words of online medical research articles. Specialized occurrence, range, and frequency of a word family were employed to select words into the list. The Medical Academic Word List contains 623 word families, which accounts for 12.24% of the tokens in the medical RAs in this study. The 10 top words in the list

are *cell, data, muscular, significant, clinic, analyze, respond, factor, method,* and *protein.*

Hancioglu et al (2008) and Ward (1999) claimed that the specialized list should contain only words that the specialized learners need, this helps the learners to learn effectively and efficiently (Chujo & Utiyama, 2006; Chung & Nation, 2003, 2004; Liu & Han, 2015; Wang et al., 2008; Ward, 2009; Wasuntarasophit, 2008). On the other hand, corpus creation for vocabulary lists needs to be well-organized and should be large enough to show real language use in authentic texts which means a large collection of texts (Bowker & Pearson, 2002). Bowker and Pearson proposed that corpus creation depends on the needs of the study, the availability of data, and time.

2.3 Reading in specialized texts

Sinclair (2004) referred a text to as a sequence of words: Titcher, Meyer, Wodak, and Vetter (2002) defined it as a longer piece of writing. It serves a communicative event that satisfies seven conditions (de Beaugrande & Dressler 1981, Sinclair, 2004). The seven conditions are cohesion, coherence, intentionality, acceptability, informativity, situationality, and intertextuality.

1. Cohesion is relationship of rules which presents the function of texts.
2. Coherence or textual semantics which represents the meaning of a text.
3. Intentionalityrelates to the attitude or purpose of text producers.
4. Acceptabilityis the mirror of intentionalitywhich shows how much recipient recognized the situation.
5. Informativity is information provided quantitatively and qualitatively.
6. Situationality means talk or speech situation playing significant role in a text.
7. Intertextuality, there are notions suggested that texts related to discourse and formal criteria

linked text together in particular genre or text. Schemas or frames of texts are;

- Narrative text varieties (tales, stories, etc) rely on temporal ordering principles.
- Argumentative text varieties (explanation, scientific article, etc) use contrastive devices.
- Descriptive text varieties employ predominantly local (that is spatial or temporal) elements (as in descriptions, portrayals, etc).
- Instructive text varieties (such as textbooks) are both argumentative and enumerative.

Examples of texts are a newspaper article, a traffic sign, and a novel (Titscher et al., 2000). The two different academic text types included in this current study are textbook and research article, which are used mostly by sports science graduate students as mentioned in Chapter1. Tribble (1996) suggested that academic written discourse is a text in the form of writing in academic fields to gain a mastery of the concepts and contents of the subject area as well as to develop an ability to express effectively and appropriately in a foreign language. Academic texts included in this investigation are specific to the specialized area of exercise physiology, a sub-discipline of sports science. Vocabulary in these two different text types was taken into consideration to answer research question 2, that "How do the vocabulary requirements differ between the exercise physiology textbook corpus (EPTC) and the exercise physiology research article corpus (EPRAC)?" These two text types or genres are included in this study. Swales (1991) suggested that the genre components include a linguistic feature, function, specific production, and receptive situation; Bhatia (1993) put forward that there are several aspects of genre; communicative purpose, structure, constraints, and members; and Flowerdew (2000) proposed that a genre consists of moves or a move structure which represent the writer's communicative purposes. That means that a genre

is written to serve a purpose, for a group of readers, using a writing structure, but with some restrictions. Examples of genre are an application letter, and a research article. Textbooks and research articles, which are academic texts, are in different genres according to the components of the genres considered above.

Textbook and research article genres were investigated because they are the main academic reading sources for sports science graduate students. They will be reviewed in the following section.

2.3.1 Textbooks

Dictionary.reference.com defined a textbook as "a book used by students as a standard work for a particular branch of study". Meanwhile, Conley (1992, p.23) defined a textbook as "printed material of any length that teachers use to teach content". Therefore, it can be said that textbook is a printed material used for students to learn and for teachers to teach.

2.3.1.1 Characteristics of textbooks

Conley (1992) stated that the purpose of a textbook is to serve as a vehicle to achieve higher level understanding in subject matters, while Alverman and Phelps (2002) suggested that the purposes of textbooks are to structure curricular goals and objectives, and to learn course content. Grabe (2009) proposed that textbooks aim to present the instructional frameworks of the course for the teacher to teach and to be the materials for the students. Swales (1995) stated that a textbook aims to present a body of knowledge. Textbooks are written by experts (Bowker & Pearson, 2002) mainly for students (Alred & Thelen, 1993) or professional audiences (Bowker & Pearson, 2002). Topics in textbooks are provided in several chapters (Alverman and Phelps, 2002; Hyland, 2003) which are based on the writer's theme (Conley, 1992).

The writer's theme is a general idea of writing to organize knowledge coherently. University of Victoria (Moon, 1997) proposed that textbooks are the products of authors' research and experiences. Textbooks are written in-depth, with complete, deep analysis, and broad historical perspective information. The development of textbooks move slowly, and it takes time for writing and publication. They are mostly published once, though revised editions may come out later. The length of textbooks varies 100 to several hundred pages. Moreover, Swales (1995) mentioned that publishers provide attractive covers and layouts to get the students' attention.

2.3.1.2 Roles of textbooks

Amiryousefi and Ketabi (2011), Grabe (2009), Hyland (2003), and Swales (1995) proposed that textbooks provide significant material for students and teachers both inside and outside classes. For learners, textbooks help to structure goals and learn the course content (Alverman and Phelps, 2002). Textbooks are effective parts of the materials, exercises and activities, reference sources, and a pre-determined syllabus (Amirryousefi & Ketabi, 2011). For teachers, textbooks can give guidance for their teaching because concept ideas, tasks, and instructional facilities are provided in textbooks. In terms of convenience, textbooks are easy for learners and teachers to use by following the instructional guidance in the textbooks. Herman, Anderson, Pearson and Nagy (1987), cited in Arnauld and Savignon (1997), suggested that learners can gain words and word meanings from textbooks.

A textbook is an academic text written for students as a material for a subject by teachers or experts in the field. Therefore, clear language use is employed to explain the course content.

One more academic genre included in this current study is the research article details of which are in the following section.

2.3.2 Research articles

Wright (2008, p. 267) submitted that "the articles are circulated to colleagues, submitted for publication, and, when published, often become part of the received body of knowledge". Hyland (2010) proposed that research articles are writings by researchers in order to present their research findings to the people in the same community. A research article aims to discuss and evaluate the researcher's contribution to the particular field and make claims of the researcher's new knowledge findings.

2.3.2.1 Characteristics of research articles

Carter and Skates (1996) and Hyland (2010) put forward that research articles aim to describe original research or experiments. Research articles are written by experts for other experts in the same fields and with the same interest and are published in scholarly, peer reviewed journals (Bowker & Pearson, 2002; Muñoz, 2015), and the authors try to make claims from their findings (Myers, 1992). On the other hand, the responsibility of research article readers, as proposed by Myers (1992), is that they should: 1) sort out the new findings from the old, 2) give credits to researchers, 3) make the assessments, 4) link between knowledge, 5) draw relations to other texts, 6) evaluate the illustrations. The structure of writing is in the form of the research processes.

The Abstract, Introduction, Materials and Methods, Results, and Discussion are the components of the writing of research articles (Bhatia, 1993). Bhatia (1993, p. 78) proposed that a research article abstract is "a description or factual

summary of a much longer report, and it is meant to give the reader exact and concise knowledge of the full article". It describes "what the author did; how the author did it; what the author found; and what the author concluded". The research article's Introduction introduces background knowledge or information about the relevant fields and data about the study which is being reported. Bhatia (1993) has proposed four move structure which are in a research article Introduction; establishing field, summarizing previous studies, preparing for present research, and introducing present research. Materials and Methods show the processes of the study to the readers. The Results section presents information and the outcome of the study, while the Discussion presents the results' review, interpretation, and evaluation. Different sections serve different purposes of communication; consequently, the language and vocabulary used are different also. Chen and Ge (2007) examined the lexical study of the word frequency and the text coverage of the Academic Word List in medical research articles. Academic words occur more often in the Abstract and Discussion sections than in Material and Methods, and the Results sections because academic words are often used to express abstract ideas rather than phenomena (Chen & Ge, 2007; Liu & Han, 2015). The Materials and Methods and the Results objectively describe the sample, procedures, methods and results of the study, and, therefore all are about the content, while the Abstract, Introduction, and Discussion explain more the abstract ideas such as concept, analysis, and theory.

However, there are some constraints on research article writing. The University of Victoria asserted on its website about research in book and journal (Moon, 1997) that journals are written in-depth but focus on a specific topic solely. They cover recent developments and events with little time given. As a result, information is current

but may be incomplete. They report original research and typically focus on one experiment. They do not have more spaces to provide much historical overview or context; therefore they are written concisely, and published in volumes and issues on a regular basis.

In summary, research articles are writings on research. Therefore, language is formal (Carter & Skates, 1996). Vocabulary use may have some similarities to a textbook because of the same field content, and may have some differences because of the research sections.

2.3.3 Distinctions between textbooks and research articles

The genres included in this study are textbooks and research articles which are different in terms of the components and vocabulary used (Bowker & Pearson, 2002; Hyland 2010; Muñoz, 2015). Miller (2011) indicated a similar notion that different text types have different lexico-grammatical profiles because they serve different purposes. Bhatia (1993) proposed that lexico-grammar, and word meanings are associated with a specific genre. Specialized meaning expressions are one key element for creating a specific genre.

Based on Bhatia (1993), the four main components in a genre are purpose, reader, structure, and constraint. Textbook and research article can be classified into two different genres, though generally they share the same academic field. The distinctions are: firstly, textbooks aim to facilitate learners to understand texts in the subject matter at a higher level, while research articles aim to present original research or experiments. Secondly, textbooks are written for students and teachers in that particular subject to be used as a material while research articles target students, teachers, scholar or researchers who are interested in a particular topic or a related topic.

Thirdly, textbooks are divided into parts or chapters based on the content while research articles are divided into parts (IMRD) based on the processes of the research study. Fourthly, though the language used in both textbooks and research articles is formal, research articles seem to use more technicality and complex words than textbooks because of the limited space provided in journals. Importantly, the language use in each chapter of a textbook and each part of a research article is different because in a textbook subject varies in the sub-topics in each chapter while in a research article subject varies in the processes of the study.

This study aims to investigate the vocabulary in textbooks and research articles because they are the main reading materials for sports science graduate students. Distinctions in vocabulary use between the two genres were investigated. The results can help readers to read effectively and facilitate teachers to guide their students in reading. The results will fill a gap because no studies have investigated the vocabulary used in exercise physiology textbook and exercise physiology research articles.

To sum up, textbooks and research articles are academic writings from the same field, but the purposes, audiences, structures, and constraints are different. Consequently the vocabulary used may be different.

In order to answer research question 2: “How do the vocabulary requirements differ between the Exercise Physiology Textbook Corpus and Exercise Physiology Research Article Corpus”? The vocabulary used and the reasons supported were investigated.

2.4 Multi-word lexical units

Lewis (1993) asserted that language consists of not only single words and grammar but also multi-words which have a single unit of meaning. A multi-word lexical unit or multi-word unit or collocation or noun phrase or word combination is where two or more words occur together. Moon (1997) defined multi-word item as a combination of two or more words, which are formed as a result of a semantic process and not grammatical rules.

This study focuses on noun-noun combinations (hereafter called NNCs), which are a kind of multi-word unit because they occur frequently and convey a technical meaning in specialized texts. The multi word patterns that occur in any texts can show readers the natural language use (Ellis, Simpson-Vlach, & Maynard, 2008). As exercise physiology texts are specialized, NNCs in the texts are taken into consideration to answer research question 3: that "Do we need to account for noun-noun combinations (NNCs) and if so how?" Consequently, NNCs are dealt with in the following section.

2.4.1 Noun-Noun Combination definitions

Fabb (2001) proposed that noun+noun compounds or noun-noun combinations consist of a head noun and a modifying noun. The head noun, which is the second word in the combination, shows the broad referential class of the combination, while the modifying noun, which is the first noun, acts as the class modifier with some additional semantic constraint. The exemplifications are *dinner plate*, *tooth brush,* and *book shelf* which occur in everyday activities (Master, 2003). Examples of NNCs which occur frequently in technical English are *fossil fuel, steam turbine: clock pulse,* and *wave function* (Linh, 2010). Besides the syntactic definition of NNCs, the semantic

perspective is considered. Trimble (1985) pointed out that NNCs convey the single unit of the meaning.

In short, a noun-noun combination is the combination of a head noun which represents the category and a modifier which represents the additional information, and it has a single unit of meaning.

2.4.2 Characteristics of Noun-Noun Combinations

The characteristics of Noun-Noun Combinations (NNCs) have been proposed by scholars and researchers as follow:

Firstly, NNCs are used in large numbers in any discourse (Schmitt & Carter, 2004); everywhere that students learned (Arnaud & Savignon, 1997); for both general purpose and for daily activities (Master, 2003); and for academic and specific purposes (Biber & Barbieri, 2007; Biber & Gray, 2010; Hyland, 2008, Linh, 2010; Ward, 2007; Wasuntarasophit, 2008). Martin (2001) stated that noun phrases, or NNCs in this study, occur mostly in all texts especially academic texts. NNCs in science and technology disciplines such as chemical engineering (Ward, 2007) have a high occurrence. Wasuntarasophit (2008) demonstrated that in the technical and academic vocabulary of electrical engineering textbooks noun phrases comprised 20.80% of the running words in the corpus. Biber and Barbieri (2007) mentioned that word combinations appear in every part of academic texts because of the characteristics of academic writing.

The next characteristic most often mentioned is the special meaning conveyed by NNCs (Arnaud & Savignon, 1997; Laufer, 1990; Pueyo & Val, 1996; Ward, 2007). Laufer (1990) pointed out that the whole lexical units have special meanings and have more significance than single units. They convey specific meanings which are used as technical terms because when two words are combined, they convey the compact

meaning of nouns (Pueyo & Val, 1996). NNCs help readers to understand the meaning in a specific text more than only single words do (Hyland, 2008). Therefore, they should be learned as fully form of meaning not only each component meaning (Arnaud & Savignon, 1997).

Thirdly, another characteristic of NNCs is the difficulty of interpreting the meaning. Master (2003) mentioned that the meanings of NNCs should be decoded as a whole and not just the components. Biber and Gray (2010) revealed in the results of their study about the complexity, elaboration, and explicitness in academic writing that the structure of academic writing is compressed through phrasal modification of noun phrases. The compressed style cannot show the meaning explicitly; however, it is efficient for expert readers to acquire a large amount of knowledge in academic professional writing. On the other hand, it causes difficulty for novice readers to understand the meanings clearly. This style occurs in both genres: research articles and textbooks. They claimed that to succeed in a profession, students have to learn to read and write this writing style efficiently.

One more reason why NNCs cause difficulty is that their meanings lost in their combination process (Sinclair, 2004). Difficulty of interpretation occurs in technical discourses. Trimble (1985) mentioned that it is difficult to learn and interpret the meaning of complex compounds in scientific and technical discourses. That is because they are used in scientific and technical discourses as technical terms with compressed and compact meanings (Pueyo & Val, 1996). Consequently, a meaning is not shown explicitly. With some compounds, it is more difficult to understand its meanings even for native speakers unless they know the subject well. Sometimes, there are a variety of meanings. For example, *a mouse hat* would always have to be a hat, but it could be

many kinds of hats, including *a hat with a mouse on it* or *a hat that a mouse wears* (Nicoladis, 2003). Another example in special text (Linh, 2010) is *voltage source*. It includes *source* as a head noun and *voltage* as another noun to modify *source*. *Voltage source* is a nominalization which is the formation of a noun phrase or word combination to show the process or compression instead of using a verb and adjective Therefore, its meaning is lost in this nominalization. As a result, *voltage source* could perhaps be interpreted either as a source of a voltage or as the voltage from a source, or the voltage of a source. To define meanings more easily, scholars have proposed noun-noun combination relation taxonomy types to understand the relationship of two nouns for facilitating the interpretation of the meaning. Master (2003) introduced the relationship type of a noun compound which can be used in NNCs in technical writing as follows:

1. Properties *requires adjective+ noun, e.g., strong wire, not a noun compound*
2. Material *copper wire (wire that is made of copper)*
3. Operation *friction brake (a brake that works by means of friction)*
4. Purpose *air filter (a filter for cleaning air)*
5. Location *field mouse (a mouse that lives in fields)*
6. Time *night hawk (a hawk that hunts at night)*
7. Shape/form *worm gear (a gear that is shaped like a worm)*
8. Inventor/Professional user *Bunsen burner (a burner that was invented by Robert Bunsen)*

He gave an example of a noun compound; *gear pump* can be classified as #3 (operation), and then defined as "*a pump that operates by means of gears*," because a gear pump operates by propelling liquids with elements that are shaped like gears (pp.4-5). If types are classified incorrectly, it leads to misinterpretation.

Levi (1978) proposed nine relationships of noun-noun combinations

1. Cause	*excitation energy*
2. Have	*insulation layer*
3. Make	*paper capacitor*
4. Use	*steam engine*
5. Be	*oscillator circuit*
6. In	*field mouse*
7. For	*bird sanctuary*
8. From	*peanut butter*
9. About	*abortion problem*

To sum up, NNCs occur frequently in specialized texts, and convey content which has specialized meanings. Because of the combination process which makes it compact, and concise, some parts are deleted. As a result, interpretation of the combination is not explicit which causes difficulty for novice learners and language learners. Nevertheless, relationship types and experts can help to define their meanings.

2.4.3 Roles of Noun-Noun Combinations

Nation (2001) suggested that knowing a word involves knowing its form, meaning, and use. Knowing a word's use involves grammatical functions, collocations, and constraints on use. Consequently, NNCs are an important aspect of knowing a word, because of the high proportion of word combinations in English, as mentioned in the previous section, they should be studied. Importantly, learning multi-word units is very efficient and more accurate than learning individual words (Schmitt & McCarthy, 1997). It helps learners to be fluent in language (Hyland, 2008), in all skills (Kazemia, Katiraeib, & Rasekh, 2014), and in all kinds of texts (Vincent, 2013). Kasahara (2011) found that combinations enhance vocabulary learning. All previous notions mentioned

above signify that words co-occur frequently or that noun-noun combinations are very vital in word learning.

Schmitt and McCarthy (1997) showed that NNCs can help learners use language naturally and reach native-like fluency. Lewis (2001) mentioned significantly about fluency that collocations help us think or communicate quickly and effectively, because when we memorize, we do it as a collocation, and when we want to produce it, we produce it as a whole collocation and not as a single word. This is faster and more natural, which is the ways that native speakers use language. Consequently, learners will use language well by memorizing and producing in units of language that are much larger than a word (Crystal, 2003). Adel and Erman (2011) investigated the use of English language lexical bundles, which are words that come or occur together, in academic writing by native and non-native advanced learners. The results showed that the native speakers used more lexical bundles and that they were more varied than those used by non- native speakers. They postulated that native speakers rely more on collocations than non-native speakers do. Arnauld and Savignon (1997) conducted a research on rare words and complex lexical units used by advanced learners. They reported that advanced learners did not perform differently from native speakers in the rare word test, but they performed lower than native speakers in complex lexical items. Therefore, from Arnauld and Savignon's study, it can be said that complex lexical units are difficult for non-natives because they cannot reach native-like proficiency in complex lexical units or multi word units.

Schmitt and McCarthy (1997) identified that the importance of collocations is that learners can store collocation in the form, and then produce them in forms which bring the faster and more natural words. This way of storing and producing, as Nation

(2001) put it, can enhance fluency and the appropriateness of language use. Lewis (2001) asserted that collocation makes thinking easier, and collocation makes learners understand the complex ideas quickly. Ward (2007) revealed that teaching students to learn words groups, which are words occurring together, can enhance their reading. Kasahara (2011) examined the effects of learning known and unknown word combinations and single words in terms of the retention and retrieval of meanings. The results indicated that word combinations make better retention and retrieval of meanings than single words. He claimed that word combinations can be remembered for longer than single words.

Quirk (1985) mentioned that scientific writing has a high proportion of noun phrases, therefore "…dealing with collocations helps tackle the difficulty of technicality caused by compression" (Ward, 2007, p.25). Hyland and Tse (2007) stated that learning the whole word unit is better than single words. Lewis (2001) suggested that it is difficult to explain complex ideas, so they are often expressed lexically. Hyland (2008) proposed that the differences can be seen in different texts and disciplines from multi-word units. Ward (2007) investigated collocation and technicality in EAP engineering and reported that phrases represent technicalisation more than single words do, and that there was a high proportion of noun in scientific writing. He also recommended that complex noun phrases are appropriate for learning. Alexander (1985) and Irujo (1986) claimed that learning multi word units is vital for advanced learners.

The significance of NNCs cannot be avoided. NNCs can be learned faster, and more easily. When speakers or writers know more word combinations, they can

produce language naturally like native speakers. Furthermore, NNCs convey a discipline's specific meaning in specialized texts.

To confirm the usefulness of NNCs in one more specialized discipline, noun-noun combinations in exercise physiology corpora were investigated.

2.5 Summary of the Literature Review

This chapter reviews vocabulary, vocabulary syllabi, and reading in specialized texts. Vocabulary is significant and worth learning because it is a basis of a language. It plays role in all learning skills especially reading. Vocabulary includes single words and multi-word units which were investigated in this study. Multi-word units are important as well because they occur frequently in specialized texts. NNCs have been studied and shown to aid fluency and naturally use. Moreover, they convey specialized meanings. However, the meanings of NNCs are not explicit, and so NNCs are taken into consideration.

There are word lists created by scholars e.g. NP, the BNC HFWL, and specialized lists. NP and the BNC HFWL are used widely among EAP learners, but their usefulness for specialized learners is doubted. Some scholars have created specialized lists specific to particular disciplines, and claimed that specialized lists are more useful for specialized learners than NP and the BNC HFWL. To find out what is more useful for sports science learners, assessment was made in this study. All word lists were treated as vocabulary syllabi. The results from the assessment will be useful for vocabulary syllabus creation for sports science learners.

Besides vocabulary, vocabulary syllabi, and multi-word units, genres are reviewed also. Textbook and research article genres are important for graduate science

students because the students use them as their main academic reading materials. There are some distinctions between these two genres based on the genre's components, as proposed by Bhatia. A genre's components are purpose, audience, structure, and constraints. According to these components, the writing and vocabulary used are different. Knowing the similarities and differences between two genres can facilitate readers to transfer known vocabulary from one genre to another.

The research background, rationale, theories, and related previous studies are discussed in Chapter 1 and 2. The next chapter will illustrate the study design, tools, and methods.

CHAPTER 3

RESEARCH DESIGN AND METHODS

This current chapter outlines the research design, research tools, and research methods. The design, tools, and methods mentioned in this chapter help to find answers for the three research questions of this investigation.

3.1 The design of the study

This study is designed to answer the following three research questions:

3.1.1 Research question 1

Is Nation's Paradigm a useful basis for a sports science vocabulary syllabus? Would a simple paradigm such as British National Corpus High Frequency Word List (BNC HFWL), or the Exercise Physiology List, be better?

Nation's Paradigm or NP is a concept of vocabulary classification, as mentioned in Chapters 1 and 2. It is widely accepted for pedagogy in many fields; however, some scholars (Engels, 1968; Nation & Kyongho, 1995; Schmitt & McCarthy, 1997; Nation & Webb, 2011; Muñoz, 2015) have doubts about its usefulness. This researcher also questions its usefulness in the sports science field because no studies have investigated the words in Nation's Paradigm for this particular field. Therefore, in this study NP was assessed (by using the four criteria set). Comparison was made between NP and the simpler lists (i.e. the BNC HFWL, and an Exercise Physiology List) in order to know which will be more useful for creating a vocabulary syllabus for exercise physiology learners.

The BNC HFWL is simpler than NP because it was created based simply on frequency of occurrence. The specialized list in this study was created from exercise physiology texts as mentioned the justification in Chapter 1. Therefore, the subject-specific list, which comes from exercise physiology texts, is called the Exercise Physiology List (EPL). The EPL was created based on the frequency of occurrence and meanings specific to the field of exercise physiology. NP, the BNC HFWL, and EPL were compared as vocabulary syllabi. Their usefulness was assessed in this study. NP and the BNC HFWL are existing vocabulary syllabi, but the Exercise Physiology List (EPL) is not. Therefore, the EPL had to be created first. To create the syllabus, corpus building (the Exercise Physiology Textbook Corpus (EPTC) and Exercise Physiology Research Article Corpus (EPRAC)), text coverage estimation, vocabulary classification, and word list creation were undertaken. Details of the EPL creation are shown in the research methods section.

To assess the usefulness of the three vocabulary syllabi, the exercise physiology syllabus from the EPTC and EPRAC was created. Then, the assessment was done later.

3.1.2 Research question 2

How do the vocabulary requirements differ between the Exercise Physiology Textbook Corpus (EPTC) and the Exercise Physiology Research Article Corpus (EPRAC)?

The distinctions between the uses of vocabulary in two different genres were investigated. Text coverage, words, NNCs, and technicality in the two corpora were compared and were used as evidence to show the distinctions between the two genres.

The results show the differences and similarities of the vocabulary use in the EPTC and EPRAC. Moreover, they help to evaluate the vocabulary requirements of exercise physiology graduate students.

3.1.3 Research question 3

Do we need to account for noun-noun combinations (NNCs), and, if so, how?

NNCs which play an important role in specialized texts as mentioned in Chapter 2 were considered and identified in this study. The NNCs were investigated to see how frequently they are used and how technical they are in exercise physiology texts. They were identified and classified into technical and non-technical categories, as mentioned in the research methods.

The results of the process are the noun-noun combination lists from the Exercise Physiology Textbook Corpus (EPTC) and Exercise Physiology Research Article Corpus (EPRAC).

3.2 Research tools

3.2.1 WordSmith Tools

WordSmith Tools is a software program for looking at how words behave in texts (Scott, 2004). The WordList, Concord, and KeyWord functions are included in the program. WordList shows how many times each word occurs in the whole corpus in frequency order and alphabetical order, and it also provides the statistical data. The Concord function shows the words or phrases in context in order for user to know what sort of company they keep. KeyWord is used to identify key words in a text by comparing the words in the text with a large reference corpus. If any word occurs outstandingly in its frequency in the text, it is considered as a key word in that text.

In this study, WordList was used. WordList made word lists of the two corpora in both frequency and alphabetical order.

3.2.2 Range program

Range is a program designed by Paul Nation and Averil Coxhead, and programmed by Alex Heatley (Heatley, Nation, & Coxhead, 2002). It is employed to compare words occurring in a corpus or corpora that need to be studied with the baseword lists. These word lists use a word family as a counting unit, and each word list is called a baseword list. There are three sets of baseword lists:

- The first set is what has been called Nation's Paradigm including baseword list 1, baseword list 2, and baseword list 3.
  - Baseword list 1 or hereafter called NP1 is the first 1,000 word families of the GSL.
  - Baseword list 2 hereafter called NP2 is the second 1,000 word families of the GSL.
  - Baseword list 3 hereafter called NP3 is the 570 word families of the AWL.
- The second set is the BNC HFWL, including baseword list 1-to baseword list 14. However, only baseword lists 1-3 were used in this study to make it equivalent for comparison with the three baseword lists of Nation's Paradigm.
  - Baseword list 1 or hereafter called BNC1 is the first 1,000 word families sublist of the BNC.
  - Baseword list 2 or hereafter called BNC2 is the second 1,000 word families sublist of the BNC.
  - Baseword list 3 or hereafter called BNC3 is the third 1,000 word families sublist of the BNC.

The program and baseword lists are available online at hhtp://www.vuw.ac.nz/lals/staff/Paul_Nation.

- The third set is Online Exercise Physiology Text Corpus baseword list which comes from the Online Exercise Physiology Text Corpus (OEPTC). The OEPTL was changed to a baseword list in order to use it in Range program.

- There is one baseword list of the Online Exercise Physiology Text Corpus which is a specialized list specific to exercise physiology field.

Range can show: 1) how many words in the corpus occur in each baseword list; 2) what percentage of words in the corpus occurs in each baseword list; and 3) what words in the corpus occur in each baseword lists ranked in alphabetical order. For example, if one would like to know how many words in an exercise physiology corpus are GSL words or would like to easily establish the text coverage of the GSL in the corpus, Range can be run against baseword list 1-2 of Nation's Paradigm because baseword list 1 is the first 1,000 word families, and baseword list 2 is the second 1,000 word families of the GSL. The results show the percentage of the GSL words occurring in the exercise physiology corpus which is the same as the percentage of words occurring in baseword lists 1-2. The percentage of words in baseword lists 1-2 is called text coverage of the GSL words in the exercise physiology corpus.

In this study, Range was used to find the words in exercise physiology corpora occurring in the NP1-3, the BNC1-3, and the OEPTC. The text coverage of the GSL, AWL, and sublists 1-3 of the BNC HFWL in the exercise physiology corpora can be seen.

The procedures of running the Range are open *Range* - *File* (open the file to process) - *Save* - *Number of Baseword files* (select number of baseword files) - *Process File* - *Open* (the file saved in the previous procedure) - see the processing output. Below is an example of the processing output that compared the exercise physiology corpus against the three NP baseword lists.

Table 3.1: An example of the output from running a corpus against the baseword lists

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
one	76,220/56.61	2,144/19.73	864
two	10,614/ 7.88	1,093/10.06	565
three	15,902/11.81	1,440/13.25	507
not in the lists	31,897/23.69	6,191/56.97	-
Total	**134,633**	**10,868**	**1,936**

From the table, the last line shows that there are 134,633 tokens or running words in the corpus. The second line shows that 76,220 running words, covering 56.61% in the corpus, occur in baseword list one. That means the first 1,000 word families of the GSL cover 56.61% of the corpus. The third line shows that 10,614 of the running words cover 7.88% of the corpus occurring in baseword list two. That is, the second 1,000 word families of the GSL cover 7.88% of the corpus. If baseword list 2 is combined with baseword list1, it means that the GSL covers 64.49% of the text. The fourth line shows that 15,902 of the running words cover 11.81% of the corpus occurring in baseword list three. That means the AWL covers 11.81 % of the text. However, 31,897 of the running words (in the fifth line) covering 23.69 % of the corpus do not occur in any lists.

Moreover, two corpora can be run at the same time against the baseword lists by using the Range program. It shows the frequency of words used in the two corpora. Below is an example of a table showing the same words used in the EPTC and EPRAC occurring in NP1.

Table 3.2: An example of types found in base list one from running two corpora against the baseword lists

TYPE	RANGE	FREQ	F1	F2
abilities	1	6	0	6
ability	2	68	25	43
able	2	31	8	23
about	2	265	220	45
above	2	141	72	69
accept	2	5	3	2
acceptable	2	7	1	6
acceptance	2	2	1	1
accepted	2	14	3	11

*F1= corpus 1, F2= corpus 2

From the table, it shows that the word *abilities* occurs: a) in one corpus (RANGE); b) six times (FREQ); c) does not occur in corpus 1(F1); and d) appears six times in corpus 2 (F2). The word *accepted* occurs: a) in two corpora (RANGE); b) 14 times (FREQ); c) three times in corpus 1 (F1); and d)11 times in corpus 2(F2).

3.2.3. The rating scale

The rating scales adapted from the original four step rating scale of Chung and Nation (2004) were employed to identify technical words and technical NNCs in the exercise physiology field.

As reviewed in Chapter 2 (2.2.1.3), the four step rating scale created by Chung and Nation is used to rate the technicality of words related to the field of anatomy: step 1 is words having no meanings specific to the field of anatomy; step 2 is words having minimal meanings specific to the field of anatomy; step 3 is words having meanings closely specific to the field of anatomy; and step 4 is words having meanings specific to the field of anatomy. The rater rates the words into steps by considering the meanings related to the field. Words falling into steps 3-4 are classified as technical words because their meanings are specific to anatomy, while words falling into steps 1-2 are not. The original rating scale of Chung and Nation (2004) is adapted for use in the exercise physiology field. It is adapted because anatomy and exercise physiology are, by nature, different. Exercise physiology is a multi disciplinary science which includes biology, chemistry, sports, exercise, physical education, anatomy, physiology, and medicine. It is the study of the functions of biological systems, and how the body responds to sports and exercise activities (Thatcher et al., 2009). Therefore, adaptation is necessary to fit the nature of exercise physiology.

There are two adapted rating scales in this study: the first one is the adapted rating scale for word classification, and the second one is the adapted rating scale for noun-noun combination classification.

3.2.3.1 The adapted rating scale for word classification

The adapted rating scale for exercise physiology word classification is adapted from Chung and Nation's original rating scale. The number of the steps in the original and the adapted rating scale are the same because they are used for word classification. However, the definitions for each step are partly changed because of the

discipline's phenomena, as mentioned in the previous section, and some clarifications are added. The adapted rating scale is presented as follows:

The adapted four step rating scale to identify words in exercise physiology field.

Step 1: Words such as function words or grammatical words that meanings have no relationship with the field of exercise physiology, and independent to the subject matter. They include articles, demonstratives, prepositions, questions words, auxiliaries, modals, pronouns, possessives, ordinals, cardinals, conjunctions, and some adverbs, such as *the, of, and, in, to, for, with, that, or, on during, at, as, an,* and *this*.

Step 2: Content words including nouns, verbs, adjectives, and adverbs that meanings are used inside and outside the field. They have no particular relationship with exercise physiology, e.g. *American, research, figure, women,* and *level.*

Step 3: Content words including nouns, verbs, adjectives, and adverbs are used inside and outside the field. They have a meaning related to the field of exercise physiology, that are words in biology, chemistry, anatomy, physiology, sports/exercise, medical, and sports science. The examples are *acid, atom, cell, tissue,* and *muscle*

Step 4: Content words including nouns, verbs, adjectives, and adverbs that meanings have specific to the field of exercise physiology. They are used mostly in exercise physiology, not likely to be known in general language. They are about studying of functions of biological systems, and how the body respond to exercise activities, e.g. *endurance,* and *fitness*.

Words rated into steps 3-4 were classified as technical words because their meanings are related to or specific to exercise physiology, while words rated into steps 1-2 were classified as non-technical words.

3.2.3.2 The adapted rating scale for Noun-Noun Combination classification

The adapted rating scale for noun-noun combination classification is adapted from the original rating scale of Chung and Nation (2004). The first step in the original one is excluded because of the requirement of the noun-noun combination formation which needs two nouns. Therefore, only three steps are included in the adapted rating scale for noun-noun combinations as follows:

The adapted three step rating scale to identify NNCs in the exercise physiology field.

Step 1: NNCs are used inside and outside the field that meanings have no necessary relationship with exercise physiology e.g. *sea level, standard deviation*

Step 2: NNCs are used inside and outside the field that have a meaning related to the field of exercise physiology. They are NNCs in biology, chemistry, anatomy, physiology, sports/exercise, medical, and sports science. When they are used in exercise physiology, their meanings are related to exercise physiology e.g. *amino acid, blood cell,* and *plasma volume*.

Step3: NNCs that have meanings specific to the field of exercise physiology, and they are used mostly in exercise physiology. They are not likely to be known in general language. They are about studying of functions of biological systems, and how the body responds to exercise activities e.g. *endurance capacity,* and *exercise intensity*.

NNCs rated into steps 2-3 were classified as technical NNCs because their meanings are related or specific to the exercise physiology field, while NNCS rated into step 1 were classified as non-technical NNCs.

3.2.3.3 The reliability checking

To ensure the reliability of the rating scale, inter-raters are needed to measure

the consistency of the rating (Chung & Nation, 2004). Three specialists, who are experienced in the exercise physiology field and have taught this course for years, rated the 60 random words and 45 random NNCs by using the rating scales to check the rating reliability.

To rate accurately, they were trained to use the scale. The researcher explained to the experts the purposes of the study, the purposes of the reliability, and how to rate the words into the steps. For the training stage, 40 random words and 30 random NNCs were used. The number of 40 random words is 10 words from each step in the adapted four step rating scale, while 30 random NNCs were made up of 10 NNCs from each step in the three step rating scale. The 10 words or NNCs taken from each step are the same as the number used for the training process in Chung and Nation's study (2004). The researcher and the experts rated together first and the results were compared with the researcher's results one by one. In case where the results were different, the experts and the researcher discussed the differences and found the solution together.

For the main rating, the 60 random words and 45 random NNCs which were randomized by the randomizer from all steps were classified by the inter-raters or experts independently. The number of 60 random words was made up of 15 words from each step in the adapted four step rating scale, while the 45 random NNCs comprised 15 NNCs from each step in the adapted three step rating scale. The 15 words or NNCs taken from each step are the same as the number used in Chung and Nation's study (2004). The experts' task was rating the words into four steps and the NNCs into three steps of the rating scale by considering word relationship to the field of exercise physiology. The experts worked independently.

When the inter raters finished the rating, the reliability accuracy score of the rating was investigated and compared between the researcher's and the experts' to see the degree of agreement (Chung & Nation, 2003). Finally, the reliability was checked. The reliability value in each group was over 0.7 (Rosenthal, 1987); therefore they are acceptable. That means that the researcher knows the words well and can rate accurately, and, hence, the researcher's rating is reliable.

The reliability agreement of the words and NNCs in each corpus is shown in the following table.

Table 3.3: Inter-rater reliability of the rating scale for word types in the EPTC classification

No	Words in EPTC	Rater	Expert 1	Expert 2	Expert 3	Agreement
1	according	2	1	2	2	1
2	adipocytes	3	3	3	4	1
3	after	1	1	1	1	1
4	almost	1	1	1	1	1
5	alone	2	1	2	2	1
6	ambient	3	3	3	4	1
7	anticodon	3	3	2	3	1
8	application	2	3	2	3	0
9	below	1	1	1	1	1
10	breath	3	4	3	3	1
11	bronchial	3	4	3	3	1
12	calisthenics	4	4	3	3	0
13	can	1	1	1	1	1
14	cascade	3	3	2	2	0
15	cdc	3	3	2	3	1
16	compressor	2	2	2	3	1
17	concepts	2	3	2	4	0
18	death	3	3	3	4	1
19	does	1	1	1	1	1

Table 3.3: Inter-rater reliability of the rating scale for word types in the EPTC classification (Cont.)

No	Words in EPTC	Rater	Expert 1	Expert 2	Expert 3	Agreement
20	elderly	3	3	3	4	1
21	endurance	4	4	4	4	1
22	excel	2	3	2	2	1
23	few	1	1	1	1	1
24	fiber	3	4	4	4	0
25	fit	4	4	4	4	1
26	fitness	4	4	4	4	1
27	fits	4	4	4	4	1
28	flexibility	4	4	4	4	1
29	functions	2	4	2	4	0
30	gradient	4	3	3	4	0
31	gradients	4	3	3	4	0
32	her	1	1	1	1	1
33	ideal	2	3	2	2	1
34	initiates	2	2	2	2	1
35	it	1	1	1	1	1
36	mars	2	2	2	2	1
37	medial	2	3	3	3	0
38	net	2	3	3	4	0
39	others	1	1	1	1	1
40	performance	3	4	4	4	0
41	perfuses	3	3	3	4	1
42	pneumonia	3	2	3	3	1
43	provided	2	2	2	2	1
44	pulse	3	3	4	4	0
45	regard	2	2	2	2	1
46	rom	4	4	4	3	1
47	second	1	1	1	4	1
48	serving	2	4	2	4	0
49	skiing	3	4	3	4	0
50	some	1	1	1	1	1

Table 3.3: Inter-rater reliability of the rating scale for word types in the EPTC classification (Cont.)

No	Words in EPTC	Rater	Expert 1	Expert 2	Expert 3	Agreement
51	suffering	3	3	2	3	1
52	tdee	4	4	4	4	1
53	that	1	1	1	1	1
54	third	1	1	1	1	1
55	which	1	1	1	1	1
56	workouts	3	4	4	4	0
57	wounds	3	3	3	3	1
58	wrist	3	3	3	4	1
59	yes	1	1	1	1	1
60	zinc	3	3	3	4	1
						45
						45/60
						0.75 =75%

Table 3.4: Inter-rater reliability of the rating scale for word types in the EPRAC Classification

No	Words in EPRAC	Rater	Expert 1	Expert 2	Expert 3	Agreement
1	adls	3	3	2	3	1
2	adult	3	3	3	4	1
3	balance	3	4	3	4	0
4	below	1	1	1	1	1
5	besides	1	1	1	1	1
6	compensate	3	3	3	4	1
7	competition	3	4	3	4	0
8	contractile	3	3	3	4	1
9	department	2	2	2	3	1
10	did	1	1	1	1	1

Table 3.4: Inter-rater reliability of the rating scale for word types in the EPRAC Classification (Cont.)

No	Words in EPRAC	Rater	Expert 1	Expert 2	Expert 3	Agreement
11	displayed	2	2	2	3	1
12	dizziness	3	3	3	3	1
13	doust	2	2	2	2	1
14	dyslipidemia	3	3	3	3	1
15	efi	4	4	4	2	1
16	endurance	4	4	4	4	1
17	expenditure	3	4	3	4	0
18	fitness	4	4	4	4	1
19	following	2	1	2	2	1
20	four	1	1	1	1	1
21	gerbino	2	2	2	2	1
22	interventions	3	3	3	3	1
23	involves	2	2	2	2	1
24	itself	1	1	1	1	1
25	maltodextrin	3	3	3	4	1
26	ms	2	2	2	2	1
27	must	1	1	1	1	1
28	neurons	3	3	3	4	1
29	not	1	1	1	1	1
30	oets	4	4	4	4	1
31	once	1	1	1	1	1
32	ot	4	4	4	2	1
33	pal	4	4	3	4	1
34	parameters	2	3	2	3	0
35	peh	4	4	4	3	1
36	peps	4	3	4	4	1
37	plyometric	4	4	4	4	1
38	posttracking	3	4	2	3	0
39	presented	2	2	2	2	1
40	pwb	4	3	2	3	0

Table 3.4: Inter-rater reliability of the rating scale for word types in the EPRAC Classification (Cont.)

No	Words in EPRAC	Rater	Expert 1	Expert 2	Expert 3	Agreement
41	rated	2	3	2	3	0
42	reach	2	2	2	2	1
43	session	2	2	2	4	1
44	sex	3	3	3	4	1
45	some	1	1	1	1	1
46	sprints	3	4	4	3	0
47	strength	4	4	4	4	1
48	strengths	4	4	4	4	1
49	stressful	3	3	3	3	1
50	substantial	2	2	2	4	1
51	them	1	1	1	1	1
52	these	1	1	1	1	1
53	third	1	1	1	1	1
54	to	1	1	1	1	1
55	tolerance	4	4	4	4	1
56	vhir	4	4	4	4	1
57	vhirb	4	4	4	4	1
58	where	1	1	1	1	1
59	whereas	1	1	1	1	1
60	written	2	2	2	2	1
						52
						52/60
						0.86=
						86%

Table 3.5: Inter-rater reliability of the rating scale for NNCs in EPTC classification

No	NNCs in EPTC	Rater	Expert 1	Expert 2	Expert 3	Agreement
1	bar graphs	1	2	2	2	0
2	barley syrup	1	2	1	1	1
3	cancer institute	2	2	1	2	1
4	carbohydrate replacement	2	2	3	3	0
5	cardiorespiratory capacity	3	2	3	3	1
6	cell membrane	2	2	2	3	1
7	college gymnasium	1	3	1	3	0
8	competition performance	3	3	2	3	1
9	control subjects	1	2	1	3	0
10	data courtesy	1	2	1	1	1
11	data points	1	2	1	1	1
12	decompression experiments	2	2	2	2	1
13	end point	1	2	2	3	0
14	endurance activities	3	3	3	3	1
15	endurance benefits	3	3	3	3	1
16	endurance exercise	3	3	3	3	1
17	energy supply	3	3	3	3	1
18	energy transformation	3	3	3	3	1
19	flexor strength	3	3	2	3	1
20	flight experience	1	3	2	2	0
21	fruit yogurt	1	2	1	1	1
22	gas transfer	3	2	3	3	1
23	human side	1	2	1	2	0
24	laboratory data	2	2	3	2	1
25	lifestyle modification	2	2	2	2	1
26	lung fitness	3	3	3	3	1
27	motor neuron	2	2	2	3	1
28	overtraining response	3	3	3	3	1
29	premature deaths	2	2	3	2	1
30	research center	1	2	1	1	1
31	road race	2	3	2	2	1
32	sex life	1	2	1	1	1

Table 3.5: Inter-rater reliability of the rating scale for NNCs in EPTC classification (Cont.)

No	NNCs in EPTC	Rater	Expert 1	Expert 2	Expert 3	Agreement
33	strength improvement	3	3	3	3	1
34	strength training	3	3	3	3	1
35	target tissues	2	2	2	3	1
36	transfer mechanism	3	2	3	3	1
37	transport capacity	3	2	3	3	1
38	water losses	2	2	3	3	0
39	weight control	2	3	3	3	0
40	women exercisers	2	3	2	3	0
41	energy intake	3	3	3	3	1
42	exercise training	3	3	3	3	1
43	protein conversion	2	2	3	3	0
44	state university	1	1	1	1	1
45	volume training	3	3	3	3	1
						34
						34/45
						0.75 =75%

Table 3.6: Inter-rater reliability of the rating scale for NNCs in EPRAC classification

No	NNCs in EPRAC	Rater	Expert 1	Expert 2	Expert 3	Agreement
1	balance measurements	3	3	2	3	1
2	balance recovery	3	3	2	3	1
3	body overweight	2	3	2	3	0
4	confidence interval	1	2	1	1	1
5	confidence level	1	2	1	1	1
6	correlations results	1	2	1	1	1
7	cycling performance	3	3	2	3	1
8	endurance activities	3	3	3	3	1
9	endurance capability	3	3	3	3	1
10	endurance cycling	3	3	3	3	1
11	endurance time	3	3	3	3	1
12	energy availability	3	3	3	3	1
13	energy balance	3	3	3	3	1
14	energy expenditures	3	3	3	3	1
15	energy production	3	3	3	3	1
16	energy utilization	3	3	3	3	1
17	fitness status	3	3	3	3	1
18	fluid retention	2	2	3	3	0
19	force development	3	3	3	3	1
20	heart work	2	3	3	3	0
21	hospital environments	1	1	1	1	1
22	intensity exercises	3	3	3	3	1
23	intensity training	3	3	3	3	1
24	life support	1	2	2	2	0
25	lifestyle modifications	1	3	3	2	0
26	male endurance	3	3	3	3	1
27	music exposure	1	2	1	1	1
28	overweight adults	2	2	2	3	1
29	phenylalanine uptake	2	2	2	2	1
30	quality studies	1	2	1	1	1
31	research article	1	2	1	1	1
32	resistance exercise	3	3	3	3	1

Table 3.6: Inter-rater reliability of the rating scale for NNCs in EPRAC classification (Cont.)

No	NNCs in EPRAC	Rater	Expert 1	Expert 2	Expert 3	Agreement
33	sample sizes	1	2	2	1	0
34	slalom canoeists	2	3	2	2	1
35	sports competence	3	3	2	3	1
36	sprint work	2	3	2	2	1
37	study sample	1	2	1	1	1
38	tachycardia threshold	2	2	2	2	1
39	threshold duration	1	2	3	2	0
40	threshold variables	1	2	2	2	0
41	training cycle	2	3	3	3	0
42	trial power	2	3	2	2	1
43	university hospital	1	2	1	1	1
44	validation study	1	2	1	1	1
45	water intake	2	3	3	3	0
						35
						35/45
						0.77= 77%

3.3 Research methods

3.3.1 Corpus creation

Corpus is “a large collection of authentic texts that have been gathered in electronic form according to a specific set of criteria, which helps us understand the real language used in the authentic world” (Bowker & Pearson, 2002, p.9). Hence, corpora were created to investigate vocabulary in exercise physiology texts. The procedures of the corpus creation started with authentic text selection.

3.3.1.1 Text selection

Studying vocabulary from texts in every sub-discipline of sports science may be not possible. Therefore, narrowing the texts and sub-discipline down by conducting the interviews was necessary.

Interviews

Semi-structured interviews were arranged to get information about the sports science program in order to establish the main sub-discipline; sports science materials were used in order to create the corpora; and the problem related to learning vocabulary were identified in order to know what kinds of words cause difficulties. This information led to the focus of the investigation.

Seven sports science graduate students and six lecturers from three universities in Thailand, namely Srinakarinwirot University, Burapha University, and Khon Kaen University, were interviewed. The various perspectives about the study of sports science in Thailand were needed from the students and their teachers from these universities, each of which runs a sports science. The interviews focused on sports science doctoral degree students because: 1) a Ph.D. degree is the highest educational level. The students use advanced texts which contain complicated and in-depth knowledge content as a results of using varied and complicated vocabulary; and, 2) advanced knowledge and complicated vocabulary which covers most of the content specific to the field can be applied to teach students in the same field at lower levels of master's degree and bachelor's degree.

The answers from question 1 about the sports science program showed that there are three main sub-disciplines of sports science; sports psychology, sports biomechanics, and sports physiology. Sports physiology is a key sub-discipline which

is of interest to students and is open at the three universities mentioned. Moreover, it is offered as a core course for every student in this field. Therefore, sports/ or exercise physiology, the study of the functions of biological systems and how the body responds to sports and exercise activities (Thatcher et al, 2009), can be a very good representative of the sports science field. For question 2 about academic reading materials and the main academic reading materials which sports science graduate students use, the interviewees reported that students use more academic materials in English than in Thai because of the availability, and up-dated information provided. Textbooks are used to get the content of theories while research articles are used to get new and up dated knowledge from other scholars' studies. The journals which the students and their lecturers recommended are at the international level related to sports science and exercise physiology, for instance *Sports Nutrition*, *Sports Biomechanics*, *Sports Medicine*, and *Exercise Physiology*. Though the students have to read English texts, they still have difficulties with English reading materials. Vocabulary, both non-technical and technical words, causes the most difficulty in understanding the texts. Some interviewees reported that they encounter difficulty with words specific to exercise physiology as although they are advanced learners, they do not know some technical words. Meanwhile, some reported that they understand words specific to the field better than other kinds of words. As texts are advanced, complicated words are employed and even though they are advanced sports science learners, they are not advanced language learners. Also, they do not know words in other fields well and, as they are not yet experts in their own field, they do not yet know all the technical words occurring in the texts.

Vocabulary in exercise physiology textbooks and research articles, which are the main academic reading materials for the students studying for a sports science doctoral degree, was investigated. Two exercise physiology corpora were created, one for textbooks and one for research articles. Both textbooks and research articles are academic reading materials written for advanced reader, and, consequently, the language and vocabulary used are of various types: general, formal or academic, and specific to the field.

Learning useful vocabulary from a good vocabulary syllabus which comes from a well- organized corpus will support students of exercise physiology to learn and read the texts effectively and efficiently.

From the interviews and based on the students' use and the lecturers' recommendations, the researcher chose the most popular exercise physiology textbook. The most widely known textbook in the sports and/or exercise physiology course is Exercise Physiology: Energy, Nutrition, and Human Performance. It is recommended because of the detailed and in-depth knowledge provided. There are two parts to this book: exercise physiology and applied exercise physiology. There are seven sections: the first three sections are in the first part, while the last four sections are in the second part of the book. The seven sections consist of: 1) Nutrition: The Base for Human Performance, 2) Energy for Physical Activity, 3) Systems of Energy Delivery and Utilization, 4) Enhancement of Energy Capacity, 5) Exercise Performance and Environmental Stress, 6) Body Composition, Energy Balance, and Weight Control, and 7) Exercise, Successful Aging and Disease Prevention. There are 1,005 pages altogether.

The research articles which are in the exercise physiology field were selected from the journals recommended by the students and lecturers. The researcher made a judgment as to which research articles related to the field of exercise physiology by looking at the key words and the abstracts. The research articles were collected from the databases of Suranaree University of Technology, Burapha University, Khon Kaen University, and online journals. There are 41 research articles which were from: 1) Journal of Exercise Physiology-online, 2) Physiology and Behavior, 3) Exercise Science and Fitness, 4) Psychology of Sports and Exercise, 5) Science and Sports, 6) Clinical Nutrition, and Physical Medicine and Rehabilitation, and 7) Journal of Science and Medicine in Sport, were collected because of the recommendations and availability.

The next step for corpus building is sampling.

3.3.1.2 Sampling

Generally, all pages in a textbook are not allowed to be used. Therefore, sampling and randomness were used to select number of pages and randomness of page selection from the textbook to build up the corpus. There are 1,005 pages in Exercise Physiology: Energy, Nutrition, and Human Performance.

The following formula for the calculation of sampling was adopted because it is widely used and accepted.

$$n = \frac{N}{1+Ne^2}$$

N = 1005

e = 0.05

$$n = \frac{1005}{1+1005(0.05)^2}$$

$$n = 286$$

The samples are 286 pages from the 1,005 in the book. Then, the research randomizer available on www.randomizer.com (Urbaniak & Plous, 2011) was used to select random pages from the textbook. It was used because it is convenient and widely accepted. Moreover, this program is best described as a "pseudo-random number generator" because the numbers are generated by use of a complex algorithm (Urbaniak & Plous, 2011). The running words of the textbook corpus total 134,633.

Research articles were chosen from the journals mentioned above which related to the topic of exercise physiology with an equivalent number of running words. The abstracts and keywords were considered to see whether articles were in the field of exercise physiology, all of which were published not later than 2009. The content, in an amount equivalent to the sections in the textbook, was selected. The whole of the research articles was employed, and totals 134,026 running words.

3.3.1.3 Text conversion into electrical form for corpus building

Each of the randomized pages from the textbook was scanned and converted into a text file to be machine readable, and then all randomized pages were merged into a text file. References, numbers, tables, figures, punctuations, and signs were deleted from the file because they are not included in the study. Consequently, only the words were contained in the file, which is called the Exercise Physiology Textbook Corpus (EPTC).

When the research articles were selected based on the criteria mentioned above, they all were converted into text files. All the files were merged into a single file. References, numbers, tables, and signs were deleted from files because they are not included in the study. Consequently, only the words were contained in the file, which is called the Exercise Physiology Research Article Corpus (EPRAC).

These are the two corpora in this current study: the Exercise Physiology Textbook Corpus (EPTC), and the Exercise Physiology Research Article Corpus (EPRAC).

3.3.2 Text coverage of the words in the EPTC and EPRAC

Text coverage was used in order to see the role of the words in the exercise physiology corpora by comparison with other word lists. To find out the text coverage, Range program was used to estimate whether and how much the words in the EPTC and EPRAC occur in the baseword lists of NP, the BNC HFWL, and the OEPTC.

3.3.2.1 Text coverage in NP

Words in the EPTC and EPRAC were compared with the baseword lists in NP (NP1-3) by the Range program to find the percentage of words in the two corpora which occurred in the baseword lists. Each corpus was compared with the three baseword lists of NP according to the following procedures: open *Range- File- Open* the file which was to be run- *Save* the file selected - select the *Number of Baseword Files* (3= NP1, 2, and 3) run Range against the NP 1- to3 - *File- Save* –click *Process File*- open the file saved to see the result. The two corpora were compared at the same time with the three baseword lists of NP.

If one corpus was compared with the baseword lists, the number and percentage of the words occurring in each baseword list and of those not in any

baseword lists were shown in tokens, types, and families. It also showed words occurring in each baseword list with their frequency. After the two corpora were compared with the baseword lists, the number and the percentage of the words occurring in the two corpora in each baseword list and of those not in the lists were shown in tokens, types, and families. Moreover, it shows, for each of the words occurring in each baseword list, which word occurs, in how many corpora it occurs, how many times it occurs in the two corpora, in which corpus it occurs, and how many times it occurs in each corpus.

Therefore, from this stage there can be seen the text coverage of the words in the EPTC and EPRAC that occur in the GSL (NP1-2), and the AWL (NP3), and the text coverage of the words not in the GSL and AWL. In addition, the difference in the word frequency between the EPTC and EPRAC was shown.

3.3.2.2 Text coverage in the BNC HFWL

Words in the EPTC and EPRAC were compared with the three baseword lists from the BNC HFWL (BNC1, 2, and 3) by the Range program. The program was used to find the percentage of words in the two corpora which occurred in the baseword lists. The procedures running Range for the two corpora against the BNC HFWL are the same as the procedures for running Range against the baseword lists of NP, although the baseword lists used for comparison are different. The two corpora were compared at the same time with the BNC 1-3.

If a single corpus is investigated, the number of words and the proportion of words in each baseword list and of those not in the lists were shown in tokens, types, and families. It shows the words occurring in each baseword list with their frequency. If the two corpora are compared, the number of words and the percentage of words in

the two corpora in each baseword list and those not in the lists were shown in tokens, types, and families. Further, the output shows for each of the words occurring in each baseword list whether which word occurs, in how many corpora it occurs, how many times it occurs in the two corpora, in which corpus it occurs, and how many times it occurs in each corpus.

Therefore, from this stage there can be seen the text coverage of the words in the EPTC and EPRAC that occur in the three BNC1-3. In addition, the differences in words used between the EPTC and EPRAC were shown.

3.3.2.3 Text coverage in the OEPTC

Words in the EPTC and EPRAC were compared with the OEPTC to compare the text coverage of the EPTAC and EPRAC with another exercise physiology corpus. To show the validity of the EPTC and EPRAC, the same kind of corpus should be used for comparison. Hence, the OEPTC which was created from exercise physiology texts was run to see whether the words in the EPTC and EPRAC cover high or low text coverage in the same kind of corpus. If the words in the EPTC and EPRAC had a high text coverage in the OEPTL, the words in the EPTC and EPRAC could be a good representative for the exercise physiology field.

OEPTC or Online Exercise Physiology Texts Corpus was created from online texts from the websites of universities, companies, organizations, and associations related to exercise and/or sports physiology. The texts included were accessed from May to June, 2015. The google search engine was employed to search for the texts or articles which were equivalent to the topics in the exercise physiology textbook. The key words are exercise physiology, sports physiology, nutrition and sports, nutrition and exercise, sports and body, exercise and body, energy expenditure

to sports, energy expenditure to exercise, body responses to sports, body responses to exercise, sports and disease prevention, and exercise and disease prevention. There are 168 texts which contain 137,287 running words in the corpus. OEPTC was created to see the validity of Exercise Physiology List (EPL).

From the text coverage estimation in 3.3.2, the words in the EPTC and EPRAC were classified into word types which are in the NP1-3 and the BNC1-3. Word types in NP are the GSL words (NP1-2), and the AWL words (NP3). The wordlists of the BNC HFWL are list 1 (BNC1), list 2 (BNC2), and list 3 (BNC3). Words in NP and the BNC HFWL are general words or high frequency words and academic words. No baseword lists or types in either vocabulary syllabi (both NP and the BNC HFWL) have mentioned words specific to the field or the technical words in the EPTC and EPRAC. Even though technical words are significant in specialized area, as reviewed in Chapter 2, they cannot be identified and classified by the Range program. Depending on the significance of the technical words in the exercise physiology discipline, the technicality in the EPTC and EPRAC was studied.

3.3.3 Technicality identification

3.3.3.1 Word list creation

After creating the EPTC and EPRAC, the words in two corpora were listed separately in order of frequency and in alphabetical order using the WordList tool. The tool shows how many times each word occurs in the whole corpus in order of frequency and in alphabetical order. In order of frequency, the word with the highest frequency is ranked first. Words which occur with high frequency mean that they have high text coverage and may play important roles in texts. The alphabetical order ranks the words alphabetically in order of their occurrence which makes it easier to see how

many words are in the same lemma or same word family (e.g. *aerobic, aerobically, aerobics)* because they are ranked adjacently. The procedures start from *WordList - Setting- Choose Text – File - Start- Make a word list now*, and then the order of frequency and the alphabetic order of the word lists are shown based on word forms (tokens). The statistical data for the whole corpus is shown as well.

Therefore, there are two word lists in frequency order from EPTC and EPRAC.

3.3.3.2 Word selection for investigation

Content words occurring at least three times were selected from each frequency order word list: EPTC word list and EPRAC word list. This number of occurrence (at least three times) is based on the previous studies. Coxhead (2002) selected words occurring at least 100 times from the 5,000,000 word corpus in the academic fields for the AWL word investigation. Ward (2009) selected the words occurring at least 5 times from the 250,000 word corpus in the engineering field for a technical word investigation. Chujo and Utiyama (2006) chose words occurring at least 100 times from a 7.3 million word commerce and finance corpus for vocabulary investigation. That means that words occurring one time out of approximately 50,000 running words in the corpus were selected for the investigation.

The number of running words in the researcher's corpus is approximately 130,000; therefore, it was considered appropriate to select words occurring three times for investigation.

3.3.3.3 Technical word rating

There are various approaches for technicality identification (Nation, 2001). However, the rating scale shows a high degree of reliability, and 100% accuracy

for the identification of terms and non-terms (Chung & Nation, 2004). Consequently, the rating scale, which is an approach considering meanings related to the field, was employed for the technicality identification in this study.

Words occurring at least three times in the EPTC word list and EPRAC word list were rated by the researcher into the steps of the four step rating scale adapted from Chung and Nation (2004). The original four step rating scale is applied into the exercise physiology discipline to find the words meanings related to exercise physiology. The details of the four step rating scale are mentioned in 3.2.3. There are two main procedures for the word rating: the researcher training and the real rating.

1) The training procedure for the researcher was done in order to confirm the understanding of the researcher toward words in exercise physiology field as follows:

   - The researcher rated 80 random words which are 40 random words from each corpus into the four steps of the rating scale.
   - Then, three experts rated the 80 random words into the four steps of the rating scale to find out if there was rating agreement with the researcher.
   - The researcher rated 80 more random words which are random words from each corpus into the four steps of the rating scale
   - The same group of experts rated the 80 random words into the four steps of the rating scale to find out if there was rating agreement with the researcher again.
   - After the second session of training, if the rating was not reliable, the researcher training procedure was started again. If

researcher and experts agreed on the word rating, the researcher proceeded to the main rating.

2) The main rating procedure was done by the researcher as follows:

- The researcher rated all words occurring at least three times from the two corpora by using the adapted four step rating scale. Words were rated semantically considering the meanings in the exercise physiology field. General dictionaries and technical dictionaries in the field of sports science were consulted by the researcher to understand the word meanings. Details of the dictionaries will be presented in 3.2.4.

To check the reliability of the word classification, the three experts in the exercise physiology field were used. The two procedures of the reliability checking are the expert training and the rating, as mentioned in 3.2.3.3.

Then, the proportion of the technicality and words in other word types based on Nation's Paradigm were calculated.

3.3.3.4 Exercise Physiology List (EPL) creation

As the rating is reliable, the procedures for the creation of the Exercise Physiology List were as follows:

- Words rated by the researcher into step 3-4 were classified into technical words in the exercise physiology field, while words rated into steps 1-2 were classified as non-technical words.
- The technical words were classified as to whether they are words from the GSL, AWL, or not from any lists by the Range program.
- Real technical words, the GSL words used with technical meaning

words, the AWL words used with technical meaning, the AWL words, and the GSL words in the EPTC and EPRAC were calculated to see the proportion of each word type.

- From this procedure, there are two technical word lists which are EPTC Word List or EPTCL from EPRAC Word List or EPRACL.
- The EPTCL and EPRACL are combined and called Exercise Physiology List (EPL). EPL is treated as exercise physiology vocabulary syllabus.

3.3.3.5 Noun-Noun Combination identification

Not only single words but also multi-word units play a substantial role in specialized texts. In this study, noun-noun combinations (NNCs) which are a kind of multi-word units were considered in order to answer research question 3, that "Do we need to account for noun-noun combinations, and, if so, how?"

3.3.3.5.1 Noun-Noun Combination identification

From the exercise physiology word lists (frequency order), nouns which occur at least three times were selected to be head nouns or modifying nouns to identify the NNCs. Nouns which occurred together with another noun were identified manually and collected from the two corpora.

3.3.3.5.2 Noun-Noun Combination classification

Classification of NNCs was by the adapted three step rating scale as mentioned in 3.2.3.2. Classifying the NNCs was done by considering the meanings related to the exercise physiology field. There are two procedures for identification of NNCs: researcher training, and the real rating.

1. The researcher training

- For training, the researcher rated 60 random NNCs, which were 30 random NNCs from each corpus, into the three step rating scale.
- Then, three experts rated the 60 random NNCs into the steps of the rating scale to find agreement.
- For the next step, the researcher repeated the same procedures with 60 more random NNCs with 30 random NNCs from each corpus.
- The same group of experts rated the 60 random NNCs again.
- After the second rating, if the ratings were not reliable, they would be started again. If is the rating was reliable, the main rating was done by the researcher.

2. The main rating

- The researcher rated all the NNCs by using the adapted three step rating scale.

After that the reliability was checked by the experts following the procedures mentioned in 3.2.3.3

3.3.3.5.3 Exercise Physiology Noun-Noun Combination List (EPNNL) creation

When the rating was reliable, the procedures for the creation of the Exercise Physiology Noun-Noun Combination List creation were as follows:

- NNCs falling into steps 2 and 3 were classified as technical NNCs because in step 2 their meanings related to exercise physiology, and in step 3 their meanings are specific to the field of exercise physiology which shows the technicality of the NNCs (Chung & Nation, 2004). NNCs rated into step 1 were classified as non-technical NNCs.
- The proportion of technical and non-technical NNCs in each corpus was estimated to see the role of NNCs in exercise physiology texts.
- The list of NNCs from EPTC is called the EPTC NNC list or EPTNL.
- The list of NNCs from EPRAC is called the EPRAC NNC list or EPRNL.
- Finally, the two technical NNC lists were combined, ranked in frequency order, and called the Exercise Physiology Noun-Noun Combination List (EPNNL). EPNNL is treated as noun-noun combination syllabus.

The Exercise Physiology List (EPL) demonstrates the phenomena of vocabulary used in the exercise physiology texts. To see it clearly, comparison with the other vocabulary lists which are NP and BNC HFWL was employed.

3.3.4 Vocabulary syllabus assessment

Research question 1 that is, ‘Is Nation’s Paradigm a useful basis for a sports science vocabulary syllabus? Would a simple paradigm such as the British National Corpus High Frequency Word List (BNC HFWL), or the Exercise Physiology List

(EPL), be better? To answer research question 1, vocabulary syllabi were assessed as follows:

The vocabulary syllabi were assessed by comparing the usefulness of the Exercise Physiology List (EPL) which is treated as Exercise Physiology Vocabulary Syllabus, Nation's Paradigm which is treated as Nation's Paradigm Vocabulary Syllabus (NPVS), and the British National Corpus High Frequency Word List which is treated as the British National Corpus High Frequency Vocabulary Syllabus (BNC HFVS). Usefulness was analyzed based on a four criteria set: being representative, comprehensive, efficient, and practical (as mentioned in Chapter 1).

Therefore:

1) Are NPVS/ the BNC HFVS/ and the EPVS representative of the exercise physiology field? Which vocabulary syllabus is more representative for the exercise physiology field? In other words, it should represent the whole field of exercise physiology. Information about the corpus creation was assessed, such as representativeness of text selection, size of corpus, and corpus creation organization.

2) Are NPVS/ the BNC HFVS/ and the EPVS comprehensive for exercise physiology learners? Which vocabulary syllabus is more comprehensive for exercise physiology learners? That means that the vocabulary syllabus should cover a lot of words in the exercise physiology field, as assessed from the text coverage, and which of the three vocabulary syllabi among the three gives the highest text coverage.

3) Are NPVS/ the BNC HFVS/ and the EPVS efficient for exercise physiology learners? Which vocabulary syllabus is more effective for exercise physiology learners? It means that there should not be many unnecessary words. There was evidence that a number of words from NP and the BNC HFWL do not occur in the

exercise physiology corpora. If there are words occurring in NP or the BNC HFWL which do not occur in the EPTC and EPRAC, it means that those words may be unnecessary for exercise physiology learners.

4) Are NPVS/ the BNC HFVS/ and the EPVS practical for exercise physiology learners? Which syllabus is more practical for exercise physiology learners? In other words there should not be too many words to learn taking into account the evidence shown by the number of words in each vocabulary syllabus. If there are a lot of words in the vocabulary syllabus, it may be too much or too difficult to learn.

The results from the assessment enable learners, teachers, and course designers in the exercise physiology discipline to judge which vocabulary syllabus should be taken into consideration and be learned.

3.3.5 Vocabulary comparison between two genres

Research question 2 is, 'How do the vocabulary requirements differ between the exercise physiology textbook corpus (EPTC) and the exercise physiology research article corpus (EPRAC)?

As mentioned in Chapter 2 (2.3) textbooks and research articles are the key sources of academic reading materials for sports science graduate students. These two kinds of text are classified into different genres based on purpose, audience, structure, and constraints; hence, vocabulary use in the two kinds of genre may be different. The occurrence of vocabulary was used to show the distinctions between the two genres. Words (tokens, types, lemmas and word families) used in the EPTC and EPRAC were compared in terms of text coverage, technicality, proportion of word types, so-called words, and NNCs.

3.4 Summary

In order to investigate the vocabulary used in the two genres, the Exercise Physiology Textbook Corpus (EPTC) and Exercise Physiology Research Article Corpus (EPRAC) were created. The vocabulary used in the two kinds of text was compared to see the distinctions between them and compared with the vocabulary in the existing vocabulary syllabi, which are Nation's Paradigm (NP) and the British National Corpus High Frequency Word List (BNC HFWL) to see which one is more useful for sports science learners.

The steps of investigation were: 1) after the two corpora were created, the text coverage of the two corpora was investigated by comparison with NP and the BNC HFWL; 2) words in each corpus were listed by using the WordLister tool from the WordSmith program; 3) word types occurring at least three times were selected; 4) technicality was rated by the rating scale approach; 5) word types were classified into technical and non-technical words; 6) non-technical word types were classified into the GSL and AWL with the Range program; 7) then, the percentages of word types were calculated; 8) NNCs were identified manually, then they all were classified into steps of the adapted rating scale for NNCs. This step was investigated to answer research question 3; 9) 1-7 resulted in the EPL which is derived from the EPTC and EPRAC; 10) next, the EPL was compared with the NP and BNC HFWL using the criteria set for being representative, comprehensive, efficient, and practical to answer research question 1; 11) vocabulary use in the two corpora was compared to see the distinctions between the two genres in terms of technicality, text coverage, words, and NNCs. This step was generated to answer research question 2.

The Exercise Physiology List (EPL) and Exercise Physiology NNC List (EPNNL) were created in this study. Moreover, the EPL was compared with the NP and BNC HFWL to see which one is more useful for sports science learners. After the results are shown, exercise physiology learners, teachers will be aware of what vocabulary from which vocabulary syllabus should be studied and taken into consideration. Moreover, course designers who are in-service or pre-service will have empirical evidence to choose the most useful vocabulary syllabus as a basis for creating a pre-sessional EAP course in sports science.

CHAPTER 4

RESULTS

After the Exercise Physiology Textbook Corpus (EPTC) and Exercise Physiology Research Article Corpus (EPRAC), and the Online Exercise Physiology Corpus (OEPTC) were created, the vocabulary text coverage, vocabulary classification, and noun-noun combinations (NNCs) were investigated.

4.1. Text coverage in the three corpora

4.1.1 Text coverage of baseword lists of NP in the EPTC, EPRAC, and OEPTC

4.1.1.1 Text coverage of baseword lists of NP in EPTC

The Range program designed by Nation (Heatly, Nation, & Coxhead, 2002) was run against the baseword lists of NP to estimate the words in the EPTC. There are three baseword lists which were employed for comparison purposes. Baseword list 1 (hereafter called NP1) is the first 1,000 word families of the General Service List (GSL), baseword list 2 (hereafter called NP2) is the second 1,000 word families of the GSL, and baseword 3 (hereafter called NP3) is 570 word families of the Academic Word List (AWL). The text coverage of NP1-3 of NP in the EPTC is shown as follows:

Table 4.1: Text coverage of NP in the EPTC

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
GSL 1 (NP1)	76,220/56.61	2,144/19.73	864
GSL 2 (NP2)	10,614/ 7.88	1,093/10.06	565
AWL (NP3)	15,902/11.81	1,440/13.25	507
Not in the lists	31,897/23.70	6,191/56.96	-
Total	**134,633**	**10,868**	**1,936**

The results show that NP1 covers 56.61%, NP2 covers 7.88%, NP3 covers 11.81%, and words not in any lists cover 23.70% of the text coverage in 134,633 tokens of the EPTC. That means that words in NP1 and 2 (i.e. the GSL) cover 64.49%, words in NP3 (i.e. the AWL) cover 11.81%, and words not in the GSL and AWL cover 23.70% of the tokens in the EPTC.

4.1.1.2 Text coverage of baseword lists of NP in the EPRAC

The EPRAC consists of 134,029 tokens or running words. Text coverage of NP 1-3 in the EPRAC is shown below:

Table 4.2: Text coverage of NP in the EPRAC

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
GSL1 (NP1)	81,829/61.05	1,802/20.51	774
GSL2 (NP2)	8,935/ 6.67	723/ 8.23	412
AWL (NP3)	14,977/11.17	1,195/13.60	474
not in the lists	28,288/21.11	5,067/57.66	-
Total	**134,029**	**8,787**	**1,660**

The table shows that NP1 covers 61.05%, NP2 covers 6.67%, NP3 covers 11.17%, and the words not in any lists cover 21.11%. That means the GSL covers 67.72%, the AWL covers 11.17%, and the words not in either the GSL or AWL cover 21.11% of the text coverage in the EPRAC.

4.1.1.3 Text coverage of baseword lists of NP in the OEPTC

The OEPTC consists of 137,287 tokens or running words. Text coverage of NP1-3 in the OEPTC is shown below.

Table 4.3: Text coverage of words in the OEPTC compared with NP

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
GSL1 (NP1)	93,195/67.88	2,174/25.76	866
GSL2 (NP2)	11,131/ 8.11	1,062/12.58	560
AWL (NP3)	10,756/ 7.83	1,216/14.41	480
not in the lists	22,205/16.18	3,988/47.25	-
Total	**137,287**	**8,440**	**1,906**

The table shows that NP1 covers 67.88 %, NP2 covers 8.11 %, NP3 covers 7.83 %, and the words not in any lists cover 16.18% of the text coverage in the OEPTC. It means the GSL covers 75.99% and the AWL covers 7.83%, and technical and high frequency words cover 16.18% of the text coverage in the OEPTC.

The results of the text coverage of the baseword lists of NP in the EPTC, EPRAC, and OEPTC demonstrate that the first 1,000 word families of the GSL cover higher text coverage than the other lists, followed by words not in any lists, the AWL, and the second 1,000 word families of the GSL occur, respectively.

4.1.2 Text coverage of baseword lists of the BNC HFWL in the EPTC, EPRAC, and OEPTC

4.1.2.1 Text coverage of baseword lists of the BNC HFWL in the EPTC

The EPTC was run against the three baseword lists of the BNC HFWL: the first 1,000 baseword list (hereafter called BNC1), the second 1,000 baseword families list (hereafter called BNC2), and the third 1,000 baseword list (hereafter called BNC 3) which together total 3,000 word families (Nation, 2012). The text coverage of the first three baseword lists of the BNC HFWL is shown as follows:

Table 4.4: Text coverage of the BNC HFWL in the EPTC

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
One (BNC1)	79,022/58.69	2,381/21.91	864
Two (BNC2)	19,682/14.62	1,728/15.90	731
Three (BNC3)	6,046/ 4.49	889/ 8.18	483
not in the lists	29,883/22.20	5,870/54.01	-
Total	**134,633**	**10,868**	**2,078**

The table illustrates that BNC1 covers 58.69% of the tokens, BNC2 covers 14.62%, BNC3 covers 4.49%, and the words not in any lists cover 22.20% of the text coverage in the EPTC. BNC1 or the words in the first 1,000 word families of the BNC HFWL have the highest text coverage than the other lists.

4.1.2.2 Text coverage of baseword lists of the BNC HFWL in the EPRAC

The EPRAC was run against the first three baseword lists of the BNC HFWL. Details of the BNC HFWL were mentioned in the previous paragraph. The text coverage of BNC1-3 in the EPRAC is shown below:

Table 4.5: Text coverage of the BNC HFWL in the EPRAC

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
One (BNC1)	85,632/63.89	1,999/22.75	811
Two (BNC2)	17,123/12.78	1,297/14.76	610
Three (BNC3)	4,508/ 3.36	560/ 6.37	341
not in the lists	26,766/19.97	4,931/56.12	-
Total	**134,029**	**8,787**	**1,762**

It shows that BNC1 covers 63.89%, BNC 2 covers 12.78%, BNC3 covers 3.36%, and words not in any lists cover 19.97% of the tokens. BNC1 has the highest text coverage than the other lists.

4.1.2.3 Text coverage of baseword lists of the BNC HFWL in the OEPTC

The OEPTC was run against BNC 1-3. The text coverage of BNC1-3 in the OEPTC is shown below:

Table 4.6: Text coverage of the BNC HFWL in the OEPTC

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
One (BNC1)	96,662/70.41	2,442/28.93	911
Two (BNC2)	16,988/12.37	1,612/19.10	716
Three (BNC3)	4,045/ 2.95	759/ 8.99	453
not in the lists	19,592/14.27	3,627/42.98	-
Total	**137,287**	**8,440**	**2,080**

The table shows that BNC1 covers 70.41%, the BNC2 covers 12.37%, the BNC3 covers 2.95%, and the words not in any lists cover 14.27% of the text in OEPTC. The first 1,000 word families of the BNC HFWL have higher text coverage than the other lists.

The results of the text coverage of the baseword lists of the BNC HFWL in the EPTC, EPRAC, and OEPTC indicate that that the first 1,000 word families of the BNC HFWL (BNC1) have higher text coverage than the other lists, followed by words not in any lists, the second 1,000 word families, and the third 1,000 word families of the BNC HFWL, respectively.

4.1.3 Proportion of the Exercise Physiology List (EPL) in the EPTC, EPRAC, and OEPTC

There are 1,739 word types in the EPTCL and 1,104 word types in the EPRACL. The words from the two lists were combined, resulting in 2,208 word types in the Exercise Physiology List or EPL. The EPL was compared with the EPTC, EPRAC, and OEPTC. The results are as follows:

Table 4.7: Proportion of word types of the EPL in the EPTC, EPRAC, and OEPTC

WORD LIST	EPTC	EPRAC	OEPTC
EPL	1,928 (17.74%)	1,508 (17.16%)	1,317 (15.60%)
not in the lists	8,940 (82.26%)	7,279 (82.84%)	7,123(84.40%)
Total	**10,868 (100%)**	**8,787 (100%)**	**8,440(100%)**

The table shows that the EPL covers 17.74% of all the word types of EPTC, 17.16% of all the word types in the EPRAC, and 15.60% of the all the word types in the OEPTC.

Not only the word type comparison is considered, but the word tokens are considered as well. There are 134,633 word tokens in the EPTC, 134,029 word tokens in the EPRAC, and 137,287 word tokens in the OEPTC. There are 2,208 word types and 65,077 word tokens in the EPL. To investigate the text coverage of the EPL in terms of tokens, the EPL was compared with the EPTC, EPRAC, and OEPTC. The results are as follows:

Table 4.8: Text coverage of word tokens by the EPL in the EPTC, EPRAC, and OEPTC

WORD LIST	EPTC	EPRAC	OEPTC
EPL	65,077 (48.33%)	65,077 (48.55%)	65,077 (47.40%)
Not in the lists	69,556 (51.67%)	68,952 (51.45%)	72,210 (52.60%)
Total	**134,633**	**134,029**	**137,287**

The table shows that the EPL covers 48.33% of all the word tokens of the EPTC, 48.55% of all the word tokens in the EPRAC, and 47.40% of all the word tokens in the OEPTC. That means that the EPL has approximately 47-49% of the text coverage in the three corpora. Proportion of EPL in OEPTC can show validity of EPL in other texts in the field of exercise physiology well.

4.1.4 Distinctions between the text coverage of NP and the BNC HFWL in the EPTC and EPRAC

The differences between the text coverage of the baseword lists of NP and the BNC HFWL are shown below.

Table 4.9: Distinctions between text coverage of words in the EPTC and EPRAC compared with NP and the BNC HFWL

	Text Coverage of NP	**Text Coverage of the BNC HFWL**	**Differences between NP and the BNC HFWL**
EPTC	NP1=56.61% NP2= 7.88% NP3=11.81% Total 76.30%	BNC1=58.69% BNC2=14.62% BNC3= 4.49% Total 77.80%	2.08% (BNC higher) 6.74%(BNC higher) 7.32%(NP higher) 1.50%(BNC higher)
EPRAC	NP1=61.05% NP2= 6.67% NP3=11.17% Total 78.89%	BNC1=63.89% BNC2=12.78% BNC3= 3.36% Total 80.03%	2.84% (BNC higher) 6.11%(BNC higher) 7.81%(NP higher) 1.14%(BNC higher)
Differences between EPTC and EPRAC	NP1= 4.44% (EPRAC higher) NP2= 1.21% (EPTC higher) NP3= 0.64% (EPTC higher) Differences 2.59% (EPRAC higher)	BNC1= 5.20% (EPRAC higher) BNC2= 1.84% (EPTC higher) BNC3= 1.13% (EPTC higher) Differences 2.23%(EPRAC higher)	

The above table shows that the GSL and the AWL of NP covers 76.30% of the text in the EPTC, and 78.89% of the text in the EPRAC. It means that the GSL and the AWL occur in the EPTC 2.59% less than in the EPRAC.

The three baseword lists of the BNC HFWL cover 77.80% of the words in the EPTC and 80.03% of those in the EPRAC. That means that the baseword lists of the BNC HFWL occur in the EPRAC 2.23% more than in the EPTC.

The text coverage by BNC HFWL of the EPTC is 1.50% greater than that of the NP of the EPTC. In addition, the text coverage of the BNC HFWL in the EPRAC is 1.14% higher than NP in the EPRAC.

The first three baseword lists of the BNC HFWL have slightly higher text coverage than the GSL plus the AWL in both the EPTC and EPRAC. It is 1.50% higher in the EPTC and 1.14% in the EPRAC.

The 2,570 word families of NP and 3,000 word families of the BNC HFWL were estimated to see how much text coverage they give of the EPTC and the EPRAC.

The vocabulary size and text coverage relationship is shown as follows:

Table 4.10: Vocabulary size and text coverage

Vocabulary Size		**Text Coverage**			
NP (WF)	**BNC HFWL(WF)**	**NP**		**BNC HFWL**	
		EPTC	**EPRAC**	**EPTC**	**EPRAC**
1,000	1,000	56.61%	61.05%	58.69%	63.89%
1,000	1,000	7.88%	6.67%	14.62%	12.78%
570	1,000	11.81%	11.17%	4.49%	3.36%
2,570	3,000	76.30%	78.89%	77.80%	80.03%

The results indicate that with the vocabulary size of 2,570 word families (the GSL and the AWL together), a learner knows 76.30% of the tokens in the textbook, and 78.89% of the tokens in the research articles. With the vocabulary size of 3,000 word families of the BNC HFWL, a learner knows 77.80% of the tokens in the textbook and 80.03% of the tokens in the research articles.

In order to cover 95% of the text in the EPTC, the GSL supplying 64.49% as for table 4.11 plus the AWL giving 11.81% need an additional 18.70% from the technical running words is required. That means that the exercise physiology textbook readers need 1,938 word families (from the GSL plus AWL) plus 18.7% from the technical words in the EPTC. There are 571 word families of the GSL and 63 word families in the AWL that do not occur in the EPTC which means that a total of 634 word families in NP are unnecessary for reading this exercise physiology textbook.

In order to cover 95% the text in the EPRAC, 67.72% coverage by the GSL (see table 4.11), plus 11.17% from the AWL plus 16.11% of the technical running words is required. That means that the exercise physiology research article readers need 1,660 word families (from the GSL plus the AWL) plus 16.11% from the technical words in the EPTC. There are 910 word families (from the GSL plus the AWL) which do not occur in the EPRAC which means that those 910 word families in NP are unnecessary for reading the exercise physiology research articles.

In order to have 95% of text coverage in the EPTC, readers take the 77.80% coverage by baseword lists 1-3 of the BNC HFWL, and readers need 17.20% of the technical. There are 922 word families of baseword lists 1-3 which do not occur in the EPTC which means that 922 word families in the BNC HFWL are unnecessary for reading in the exercise physiology textbook.

In order to cover 95% of the text in the EPRAC, readers have 80.03% coverage by baseword lists 1-3 so readers need 14.97% coverage by the technical words. There are 1,238 word families of baseword lists 1-3 which do not occur in the EPTC which means that 1,238 word families in the BNC HFWL are unnecessary for reading exercise physiology research articles.

4.2 The classification of the technical word types in the EPTC and the EPRAC

As mentioned in Chapters 1-3, the vocabulary classifications of NP and the BNC HFWL have some flaws. One of the flaws is the consistency of classification. Therefore, this study investigated the two approaches of vocabulary classification in exercise physiology texts in order to establish the technicality of the vocabulary in the exercise physiology texts.

4.2.1 Classification of word types in the EPTC

The rating scale adapted from Chung and Nation (2004) was used to classify technicality. Content words occurring at least three times were selected from each frequency order word list. This number of occurrences (at least three times selected) is based on the previous studies' ratios (Chujo & Utiyama, 2006; Coxhead, 2002; Ward & Chuenjundaeng, 2009). In the EPTC, 4,869 word types were classified into four steps of word classification. The findings for the technical and non-technical words are presented as follows:

Table 4.11: Non-technical and technical word types in the EPTC

Step	**Number of Types**		**Percentage**		**Classification**
1	174	3,130	3.57	64.28%	**Non-Technical**
2	2,956		60.71		**64.28%**
3	1,730	1,739	35.53	35.72%	**Technical**
4	9		0.19		**35.72%**
Total	**4,869**		**100**		**100%**

Table 4.12: Proportion of technical and non-technical word tokens in the EPTC

Step	**Number of Tokens**		**Percentage**		**Classification**
1	41,325	88,517	32.93%	70.54%	Non-Technical
2	47,192		37.61%		70.54%
3	36,636	36,957	29.20%	29.46%	Technical
4	321		0.26%		29.46%
Total	**125,474**		**100%**		**100%**

Words in step 1 are function words or grammatical words. They include articles, demonstratives, prepositions, questions words, auxiliaries, modals, pronouns, possessives, ordinals, cardinals, conjunctions, and some adverbs. The table shows that there are 174 word types in step 1 which is 3.57% of the word types selected for investigation. The first six highest occurring words in the EPTC are the words in step 1. They are *the* (6,904 times), *of* (4,901 times), *and* (4,653 times), *in* (2,923 times), *to*

(2,911 times), and *for* (1,711 times) which shows that function words occur so frequently.

Words in step 2 are content words including nouns, verbs, adjectives, and adverbs whose meanings are used inside and outside the exercise physiology field. They have no particular relationship with exercise physiology. There are 2,956 word types in this step which is 60.71% of the words in all the steps which means that the words in this step occur more often than those in the other steps. The words in this step are not directly semantically related to exercise physiology. Examples of words in this step are *age* (166 times), *average* (115 times), *example* (920 times), *factor* (163 times), and *figure* (380 times).

Words in step 3 are content words including nouns, verbs, adjectives, and adverbs which are used inside and outside the exercise physiology field. They have meanings related to the field of exercise physiology but they are also used in fields such as biology, chemistry, anatomy, physiology, sports/exercise, medicine, and sports science. There are 1,730 word types which is 35.53% of the types occurring three times. That means that words in exercise physiology related to the exercise physiology field occurs relatively highly. Examples of step 3 words with high occurrences are *exercise* (1,512 times), *body* (827 times), *energy* (722 times), *muscle* (609times), *blood* (584 times), *training* (493 times), *fat* (470 times), and *oxygen* (463 times).

Words in step 4 are content words including nouns, verbs, adjectives, and adverbs whose meanings are specific to the field of exercise physiology. They are used mostly in exercise physiology, and are about studying the functions of biological systems, and how the body responds to exercise activities. Only 9 word types occur in step 4 which is 0.19% of the words in all the steps. These words are *endurance* (146 times), *fitness* (116 times),

fit (22 times), *fits* (3 times), *gradient* (8 times), *gradients* (4 times), *calisthenics* (4 times), *ROM* (15 times), and *TDEE* (3 times). The last two words are abbreviations standing for *range of motion* and *total daily energy expenditure* respectively.

Words rated into steps 1-2 were classified as non-technical word types. Words rated into steps 3-4 were classified as technical word types because their meanings related to or are specific to exercise physiology. Therefore, 3,130 word types were non-technical words which are 64.28% of the words which occur three times, while 1,739 word types were technical words which are 35.72% of the word types which occurs three times in the whole corpus.

If word tokens are counted, there are 41,325 word tokens in step 1, 47,192 tokens in step 2, 36,636 tokens in step 3, and 321 tokens in step 4. There are 125,474 tokens in all the steps; 88,517 tokens are non-technical and 36,957 tokens are technical.

From the classification of word types in the EPTC, the Exercise Physiology Textbook Corpus List or EPTCL was created from technical word types. There are 1,739 word types in the EPTCL. The examples of the 20 highest frequency technical word types in the EPTCL are as follows.

Table 4.13: The 20 highest frequency word types in EPTCL

Word Types	**Frequency**	**Word Types**	**Frequency**
exercise	1512	activity	319
body	827	weight	287
energy	722	aerobic	267
muscle	609	rate	265
blood	584	mass	264
training	493	protein	262
fat	470	water	255
oxygen	463	performance	245
heart	357	risk	236
physical	332	disease	206

4.2.2 Classification of word types in the EPRAC

The findings of the word type classification of the EPRAC into technical and non-technical word types are presented as follows:

Table 4.14: Non-technical and technical word types in the EPRAC

Step	Number of Types		Percentage		Classification
1	178	2,659	4.73	70.66%	Non-Technical
2	2,481		65.93		70.66%
3	1,080	1,104	28.70	29.34%	Technical
4	24		0.64		29.34%
Total	**3,763**		**100**		**100%**

Table 4.15: Proportion of technical and non-technical word tokens in the EPRAC

Step	Number of Tokens		Percentage		Classification
1	45,883	96,417	36.84	77.42	Non-Technical
2	50,534		40.58		77.42%
3	27,334	28,120	21.95	22.58	Technical
4	786		0.63		22.58%
Total	**124,537**		**100%**		**100%**

Word types occurring three times in the EPRAC, which total 3,763 word types, were classified into the four steps of word classifications. There are 178 word types in step 1 which means function words occur as 4.73% of the all the word types. The first five highest word types in the EPRAC are function words which are *the* (7,143 times), *and* (4,725 times), *of* (4,708 times), *in* (3,078 times), and *to* (2,977 times).

There are 2,481 word types in step 2 which is 65.93% of all the word types occurring three times. That means the words in step 2 occur more often than those in the other steps. Examples are *significant* (392 times), *group* (336 times), *high* (309 times), *effect* (304 times), and *mean* (244 times).

There are 1,080 types of words in step 3 which is 28.70% of the word types in all the steps, so that means words in exercise physiology related to exercise physiology fields occur relatively highly. *Exercise* occurs as the highest (1,830 times) in the EPRAC, while *performance, training, physical, body*, and *blood* occur very highly as well. They were found 515, 462, 452, 392, and 305 times, respectively.

There are only 24 word types in step 4 which is 0.64% of all the word types occurring three times. Examples are *strength* (192 times), *fitness* (174 times), *endurance* (114 times), and *tolerance* (18 times).

Words rated into steps 1-2 were classified as non-technical word types. Words rated into steps 3-4 were classified as technical word types because their meanings related to or are specific to exercise physiology. Therefore, 2,659 word types were non-technical words, which are 70.66% of all the word types occurring three times, while 1,104 word types were technical words which are 29.34% of all the word types occurring three times.

If word tokens are counted, there are 45,883 tokens in step 1, 50,534 tokens in step 2, 27,334 in step 3, and 786 tokens in step 4. There are 124,537 tokens in all the steps of which 96,417 tokens are non-technical and 28,120 tokens are technical.

From the classification of word types in the EPRAC, the Exercise Physiology Research Article Corpus List (EPRACL) was created from technical word types. There

are 1,104 technical word types the EPRACL. Examples of the 20 highest frequency word types in the EPRACL are as follows:

Table 4.16: The 20 highest frequency word types in the EPRACL

Word Types	Frequency	Word Types	Frequency
exercise	1,830	heart	308
performance	515	blood	305
training	463	running	287
physical	452	aerobic	265
energy	402	performed	243
intensity	394	players	208
body	393	weight	197
vo	372	recovery	194
muscle	350	strength	192
activity	327	intake	183

4.3 Word types in the Exercise Physiology List (EPL)

1,739 word types of the EPTCL were combined with 1,104 word types of the EPRACL to create the Exercise Physiology List (EPL). 635 word types are overlapped; therefore there are 2,208 word types in the EPL.

Examples of the 20 highest frequency word types in the EPL are as follows:

Table 4.17: The 20 highest frequency word types in the EPL

Word Types	Frequency	Word Types	Frequency
Exercise	3342	Fat	620
Body	1220	Oxygen	571
Energy	1124	Intensity	546
Muscle	959	Aerobic	532
Training	956	Weight	484
Blood	889	Protein	436
Physical	784	Mass	433
Performance	760	Running	417
Heart	665	Vo	372
Activity	646	Risk	370

4.4 Word types from the GSL and AWL used as technical word types

The vocabulary classification of Nation's Paradigm has raised arguments about overlapping words because some technical words in many fields are words which are in the GSL and AWL.

Some technical word types in the exercise physiology field have been questioned in regard to the vocabulary overlapping, and so they were investigated.

4.4.1 Word types from the GSL and AWL classified as technical word types in the EPTC

There are 1,739 word types in the EPTCL. They were run against the baseword lists of NP with the Range program in order to know whether they are words from the GSL or AWL. The results are shown below:

Table 4.18: Text coverage of EPTCL in NP

WORD LIST	TYPES/%		FAMILIES	
One (NP1)	166/ 9.55%	19.15%	76	174
Two (NP2)	167/ 9.60%		98	
Three (NP3)	129/ 7.42%		60	
not in the lists	1,277/73.43%		-	
Total	1,739		234	

Word types from the EPTCL were compared with NP, and the results show that 9.55% come from NP1, 9.60% from NP2, and 7.42% from NP3 of NP. This means that the technical word types in the EPTCL, 19.15% come from the GSL, and 7.42% from the AWL. The other technical word types cover 73.43%. Thus technical words from the GSL plus AWL are 26.57% of all the words in the EPTCL.

Word types from EPTCL were compared with the BNC lists, and the results are shown as follows:

Table 4.19: Text coverage of the EPTCL in the BNC HFWL

WORD LIST	TYPES/%	FAMILIES
One (BNC1)	177/10.18	76
Two (BNC2)	233/13.40	113
Three (BNC3)	151/ 8.68	97
Not in the lists	1,178/67.74	-
Total	**1,739**	**286**

Word types from the EPTCL were compared with the BNC1-3, and the results shows that 10.18 % of the technical word types come from the BNC1, 13.40 % from the BNC2, and 8.68% from the BNC3 of BNC HFWL. That means that the technical words in the EPTC come from all three baseword lists of the BNC HFWL. The proportion of words not in the lists is higher than the total of BNC 1, 2, 3. That means that 67.74% of the technical word types in the EPTC technical word list are words which are not in the first three high frequency word lists.

4.4.2 Words from the GSL and AWL classified as technical words in the EPRAC

There are 1,104 technical word types in the EPRACL. They were run against the NP1-3 and the BNC1-3. The findings are shown as follows:

Table 4.20: Text coverage of the EPRACL in NP

WORD LIST	TYPES/%		FAMILIES	
One (NP1)	128/11.59%	230/20.83%	70	132
Two (NP2)	102/ 9.24%		62	
Three (NP3)	106/ 9.60 %		56	
Not in the lists	768/69.57%		-	
Total	**1,104 /100%**		**188**	

The table shows that 11.59 % of the technical words come from NP1, 9.24% from the NP2, and 9.60% from the NP3. That means that 20.83% of the word types in the EPRACL come from the GSL, and 9.60% from the AWL. The real technical word types in the EPRACL include 69.57% of technical word types not in the GSL and AWL, while 30.43% of the technical word types come from the GSL plus the AWL.

Word types from the EPRACL were compared with the BNC HFWL, and the results are shown as follows:

Table 4.21: Text coverage of the EPRACL in the BNC HFWL

WORD LIST	TYPES/%	FAMILIES
One (BNC1)	137/12.41%	66
Two (BNC2)	163/14.76%	89
Three (BNC3)	82/ 7.43 %	57
not in the lists	722/65.40%	-
Total	**1,104**	**212**

Words types from the EPRACL were compared with the BNC HFWL and the results show that 12.41 % of the word types come from BNC1, 14.76% from BNC2, and 7.43% from BNC3. That means that the technical words in the EPRACL come from the baseword lists 1-3 of the BNC. The real technical words are 65.40% (722 types).The proportion of words which are not in the lists is higher than others words which are in the lists.

4.5 Noun-Noun Combinations (NNCs) in the two corpora

Because of the significance of NNCs, as mentioned in Chapters 1-3, instances where two nouns occurred together were identified from each corpus, and then they were classified into categories to see the technicality of the NNCs**.**

4.5.1. Noun-Noun Combinations (NNCs) in the EPTC

There are 3,410 noun-noun combinations (NNCs) in the EPTC. All the NNCs were classified into the adapted three step rating scale to classify technical NNCs in the exercise physiology field. There are three classifications or steps and results are as follows:

Table 4.22: Non technical and technical NNCs in the EPTC

Step	Number of NNCs	Percentage	Classification
1	469	13.76%	Non-technical NNCs 13.76%
2	2,828	82.93%	Technical NNCs 86.24%
3	113	3.31%	
Total	**3,410**	**100%**	**100%**

NNCs used inside and outside the field that have meanings which do not necessarily have a relationship with exercise physiology were classified into step 1. There are 469 NNCs which comprise 13.76% of all the NNCs in the EPTC. The examples of NNCs in the EPTC are *sea level, individual differences, space shuttle, crew members, age group, exchange ratio,* and *control group.*

NNCs in step 2 are those used inside and outside the field that have a meaning related to the field of exercise physiology. They are NNCs in biology, chemistry, anatomy, physiology, sports/exercise, medicine, and sports science. When they are used in exercise physiology, their meanings are related to exercise physiology. There are 2,828 NNCs which are 82.93% of all the NNCs in the EPTC. The examples of NNCs in step 2 are *body fat, heart rate, oxygen consumption, body mass, blood flow,* and *body composition.* Their occurrences are 171, 142, 138, 131, 89, and 85, respectively.

NNCs in step 3 have meanings specific to the field of exercise physiology, and they are used mostly in exercise physiology. They are about studying the functions of biological systems, and how the body responds to exercise activities. There are 113 of these NNCs in the EPTC which is 3.31% of all the NNCs in the EPTC. The examples of step 3 NNCs in the EPTC are *exercise performance, endurance exercise, muscle strength,* and *strength improvement.*

NNCs rated into steps 2-3 were classified as technical NNCs because their meanings are related to and are specific to the exercise physiology field, while NNCs rated into step 1 were classified as non-technical NNCs. Therefore, 2,941 technical NNCs were found which form 86.24% of the all NNCs in the EPTC, while non-technical NNCs were found 469 which cover 13.76% of the all NNCs in the EPTC.

Technical NNCs in the EPTC are called Exercise Physiology Textbook Corpus Noun-noun combination List or EPTCNL. The list contains 2,491 NNCs. The 20 NNCs with the highest occurrence in the EPTCNL are as follows:

Table 4.23: The 20 NNCs with the highest occurrence in the EPTCNL

NNCs	FREQUENCY	NNCs	FREQUENCY
body fat	171	exercise performance	71
heart rate	142	resistance training	69
oxygen consumption	138	heart disease	60
body mass	131	weight loss	57
energy expenditure	92	exercise intensity	55
blood flow	89	exercise training	54
body composition	85	muscle fibers	53
blood pressure	78	blood lactate	51
carbon dioxide	74	energy transfer	46
body weight	71	stroke volume	41

4.5.2 Noun-Noun Combinations in the EPRAC

There are 2,010 noun-noun combinations (NNCs) in the EPRAC. All NNCs were classified into the adapted three step rating scale to identify NNCs in the exercise physiology field. Details are shown below.

Table 4.24: Noun-Noun Combinations (NNCs) in the EPRAC

Step	Number of NNCs	Percentage	Classification
1	487	24.23%	Non-technical NNCs 24.23%
2	1,451	72.19%	Technical NNCs
3	72	3.58%	75.77%
Total	**2,010**	**100%**	**100%**

There are 487 NNCs or 24.23% of all NNCs in the EPRAC which are classified into step 1. The examples of step 1 NNCs in the EPTC are *control group* (55 times), *standard deviation* (47 times), *video game* (36 times), and *sample size* (21 times).

There are 1,451 NNCs or 72.19% of all NNCs classified into step 2. The examples of NNCs in step 2 are *heart rate, body mass, blood pressure, body weight, muscle damage, and muscle soreness.* The numbers of times that theses NNCs occur are 244, 116, 95, 80, 73, and 72, respectively.

There are 72 NNCs, which is 3.58% of all NNCs in the EPTC, in step 3. The examples of step 3 NNCs in the EPTC are *balance performance, endurance training, exercise performance,* and *intensity exercise.*

NNCs rated into steps 2-3 were classified as technical NNCs because their meanings are related to and are specific to the exercise physiology field, while NNCs rated into step 1 were classified as non-technical NNCs. Therefore, 1,523 technical NNCs are found which are 75.77%, while 487 non-technical NNCs are found which are 24.23 % of all NNCs in the EPRAC. That means that the technical NNCs occur more often than non-technical NNCs in the EPRAC.

The technical NNCs in the EPRAC are called Exercise Physiology Research Article Corpus Noun-noun Combinations List or EPRACNL. The list contains 1,523 technical NNCs in the EPRAC. The 20 highest occurrences of NNCs in the list are as follows:

Table 4.25: The 20 highest occurrences of NNCs in the EPRACNL

NNCs	FREQUENCY	NNCs	FREQUENCY
heart rate	244	risk factors	50
energy expenditure	158	oxygen uptake	49
body mass	116	trial performance	46
blood pressure	95	blood lactate	45
body weight	80	power output	44
muscle damage	73	body fat	41
muscle soreness	72	beta cell	40
exercise intensity	65	blood glucose	40
exercise training	58	exercise group	40
intensity exercise	51	body composition	39

4.5.3 Distinctions between NNCs in EPTC and EPRAC

The differences between the uses of NNC in the two corpora were compared in order to see the similarities and differences in NNCs between the two genres in the same discipline. The results are shown below:

Table 4.26: Distinctions between NNCs in the EPTC and EPRAC

STEP	NNCs						Percentage					
	EPTC		EPRAC		No of NNC Differences		EPTC		EPRAC		Percentage Differences	
1	469		487		18 EPRAC higher		13.76%		24.23%		10.47% EPRAC higher	
2	2,828	2,941	1,451	1,523	1,377 EPTC Higher	1,418 EPTC Higher	82.93%	86.24%	72.19%	75.77%	10.74% EPTC higher	10.47% EPTC higher
3	113		72		41 EPTC Higher		3.31%		3.58%		0.27% EPRAC higher	
Total	**3,410**		**2,010**		**1,400** EPTC Higher		**100%**		**100%**		-	

Differences in NNCs used in the two corpora were compared. It indicates that more NNCs were employed in the EPTC than in the EPRAC (1,400 NNCs more). In addition, more technical NNCs were used in the EPTC than in the EPRAC (1,418 NNCs more).

There are 2,941 technical NNCs in the EPTC and 1,523 technical NNCs in the EPRAC. NNCs from the two corpora were combined, so that together there are 4,464 NNCs. However, there are 405 overlapping NNCs. They are combined as Exercise Physiology Noun-Noun List (EPNNL). Therefore, there are a total 4,059 NNCs in the EPNNL.

4.6 Summary of Results

From the results shown above, the 3 research questions can be answered in the following section.

The existing vocabulary lists, which are NP and BNC HFWL, and Exercise Physiology Vocabulary List (EPL) were assessed to answer research question 1: Is Nation's Paradigm a useful basis for a sports science vocabulary syllabus? Would a simple paradigm such as the British National Corpus High Frequency List (BNC HFWL), or a subject-specific list (the Exercise Physiology List), be better? The results are shown in 4.1.1, 4.1.2, 4.1.4, 4.1.5, 4.2.1, 4.2.2, 4.3, and 4.4. The EPL is suitable for sports science learners. As all the words come from the EPTC and the EPRAC, they are all in exercise physiology texts. On the other hand, all of the words in NP and the BNC HFWL are not from exercise physiology texts; hence there are some unnecessary words for sports science learners.

Both single words and NNCs were investigated to see the distinctions in vocabulary use in both the EPTC and EPRAC to answer research question2: How do the vocabulary requirements differ between the Exercise Physiology Textbook Corpus (EPTC) and the Exercise Physiology Research Article Corpus (EPRAC)? The results are shown in 4.1.5 and 4.5.3 that the text coverage of the GSL occurs more in the EPRAC than in the EPTC. The EPTC contains more technical single words than the EPRAC (a difference of 635 word type). The number of NNCs in the EPTC is higher than the number of NNCs in the EPRAC with the NNCs having 1,400 more.

The NNC lists were investigated to answer research question 3: Do we need to account for noun-noun combinations (NNCs), and, if so how? The results from 4.5.1 and 4.5.2 answer this research question as many NNCs occur in both EPTC and EPRAC. In the EPTC, there are 3,410 NNCs of which 2,941 are technical (NNCs classified into steps 2 and 3). In the EPRAC, there are 2,010 NNCs of which 1,523 are technical NNCs (NNCs classified into steps 2 and 3). The number of NNCs occurring in both the EPTC and EPRAC is very high and when two nouns are combined they are usually be technical. Therefore, it is plausible to take account of NNCs, especially in exercise physiology texts. In the corpora, there are 4,464 technical NNCs of which 2,941 technical NNCs are from the EPTC and 1,523 technical NNCs are from the EPRAC. There are 405 NNCs occurred in both corpora, as the result of 4,059 NNCs in Exercise Physiology Noun-noun Combinations List (EPNNL). Therefore, the use of the EPNNL is suggested.

Discussion from the findings will be mentioned in Chapter 5.

CHAPTER 5

DISCUSSION

5.1 Lexical Profiling

For the purpose of reading an exercise physiology text, readers should learn the characteristics of the text to understand it well (Biber & Barbierie, 2007). Lexical Frequency Profiling or LFP is used to measure the characteristics of a text in order to describe the lexical content of the text in terms of frequency bands (Laufer & Nation, 1995). Moreover, it is a way of assessing whether a text is suitable for use with learners at a specified level of proficiency. Lexical Behavior Profiling or LBP refers to senses, relations, and collocations/ colligations. The interesting dimension of lexical relations is collocations: recurrent co-occurrence patterns for word pairs/ triplets (and other linguistic types) within a given distance of each other (Sinclair, 1991).

Lexical profiling in terms of frequency and behavior of collocations will be discussed as follows:

5.1.1 Lexical profiling: Frequency or Frequency band according to NP

The frequency bands according to Nation's Paradigm are NP1, 2, and 3 (previously referred to respectively as GSL1, 2 and AWL frequency baseword lists (BWL1-3) of Nation's Paradigm (2001).

5.1.1.1 Frequency of words in NP

The frequency of words (or probability of encountering words) in the text is an indicator showing the characteristic of the text and which word category in

NP plays an important role. Frequency is a main criterion for selecting words for learning (Richards, 2001). Moreover, lexical frequency profiling is a reliable and valid measure of lexical use in texts (Laufer & Nation, 1995). The single words in both the EPTC and EPRAC are classified into the categories of Nation's Paradigm by running the Range program against the baseword lists. The text coverage of running words in baseword lists 1-3 (NP1-3) in the EPTC and EPRAC is shown below.

Table 5.1: Proportion of different categories of NP words in the EPTC

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
One (NP1)	76,220/56.61	2,144/19.73	864
Two (NP2)	10,614/ 7.88	1,093/10.06	565
Three (NP3)	15,902/11.81	1,440/13.25	507
not in the lists	31,897/23.70	6,191/56.96	-
Total	**134,633**	**10,868**	**1936**

Table 5.2: Proportion of different types of NP words in the EPRAC

WORD LIST	TOKENS/%	TYPES/%	FAMILIES
One (NP1)	81,829/61.05	1,802/20.51	774
Two (NP2)	8,935/ 6.67	723/ 8.23	412
Three (NP3)	14,977/11.17	1,195/13.60	474
Not in the lists	28,288/21.11	5,067/57.66	-
Total	**134,029**	**8,787**	**1660**

Nation (2001) proposes that the GSL covers 80%, the AWL covers 10%, and technical and low frequency words cover 10% of the text coverage. The findings

in this study show that GSL (BWL1-2) covers more than 60% of all running words in both the EPTC and EPRAC, while the AWL covers about the same as claimed by Nation (2001). However, words not in any lists give higher coverage than the claims of NP, with a figure of 21%-24% of the text.

The text coverage of the GSL (NP1-2) is high because general words are included in every kind of text. This agrees with the recommendations of West (1953) and Bauman (2012) that as general words are the most common words in English, they cover high text coverage in every discipline (Chung & Nation, 2003; Nation, 2001). In this respect, the exercise physiology discipline is not exceptional.

However, the text coverage of the GSL and AWL in the corpora is around 15% lower than the NP estimation. It may come from the nature of the exercise physiology texts which are technical texts. As a result, the GSL occurs in this expected proportion but the technical vocabulary occurs in a higher proportion than expected. The studies of Chung and Nation (2003) in the anatomy field, Wasuntarasophit (2008) in engineering, and Wang and Ge (2008) in medicine show the same results as this study that the GSL's occurrence is lower than Nation's claim.

The text coverage of the AWL is close to the claim of Nation (2001) because the two corpora were created from academic genres; a textbook and research articles. It is in line with other academic disciplines (Coxhead, 2000; Martinez et al., 2009; Vongpumivich et al., 2009), that the AWL occurs in around 10% of the text coverage.

Words not in any of the lists in the two corpora have very high text coverage. Words not in the lists can be technical or low frequency words and they play a significant role. The major role of technical words may come from the nature of the

texts, which are technical, and as a result technical words have a high occurrence. It is in line with Coxhead (2002) in an academic corpus, and Valipouria and Nassajib (2013) in a chemistry corpus based on research articles. In the chemistry research article corpus, technical words occurred in 24.57% of the text. Technical words play a role because they are in exercise physiology texts which are specialized texts. As Nation (2001, 2008) mentioned, technical vocabulary is used in specific disciplines and it is useful for learners with specific goals because it is common, occurs frequently, and is closely related to the subject area.

5.1.1.2 High text coverage of technical word types from the rating scale approach

Word types occurring three times from each corpus were classified into non-technical and technical word types by using the adapted rating scale, as presented in Chapter 3. The results were shown in Chapter 4. The outstanding findings are the high text coverage of technical word types in both the EPTC and EPRAC, the proportions of which are shown below.

Table 5.3: Proportion of technical word types in the EPTC

Step	**Number of Types**		**Percentage**		**Classification**
1	174		3.57		**Non-Technical**
2	2,956	3,130	60.71	64.28%	**64.28%**
3	1,730		35.53		**Technical**
4	9	1,739	0.19	35.72%	**35.72%**
Total	**4,869**		**100%**		**100%**

Table 5.4: Proportion of technical word types in the EPRAC

Step	**Number of Types**		**Percentage**		**Classification**
1	178	2,659	4.73	70.66	Non-Technical
2	2,481		65.93		70.66%
3	1,080	1,104	28.70	29.34	Technical
4	24		0.64		29.34%
Total	**3,763**		**100**		**100%**

Word types were analyzed and it was found that non-technical word types (step 1 and 2) occurred more than technical word types (step 3 and 4) in both the EPTC and EPRAC.

Non-technical word types were classified by running the Range program against the NP1-3. It was found that most of the non-technical word types in the EPTC come from the GSL because the GSL words are the greatest common words in all disciplines (Bauman, 2012; West, 1953). Examples of the GSL in the EPTC are *figure, high, increase, effect,* and *chapter.* Some non-technical word types are words in the AWL e.g. *capacity*, and *individual*. Some technical word types do not occur in any lists such as, *VO, min, kg, max, maximal,* and *abbreviation.* Some are abbreviations; therefore, they are not in any list.

There are many non-technical word types in the EPRAC related to research writing components (Bhatia, 1993): Abstract (*purpose, objective*), Introduction (*test, study*), Materials and Methods (*group, subjects*), and Results (*result, significant, findings*).

It is in line with Shabania and Tazikb (2014) and Valipourin and Nassajib (2013) that the word *result* occurred frequently. The examples of non-technical word types in this study are *study, significant, subjects, studies, group, test,* and *results*. Muñoz (2013) proposed that non-technical words are a function to: 1) "evaluate the propositional content that it is *best, important*: 2) guide the reader through the texts" e.g. *for example, following*; and 3) talk about the subject matter". Non-technical words in 1-3 of Muñoz's proposal occur in the EPRAC as well.

The technical words in the EPTC are related to exercise and how the body responds to exercise; they can show the content of the discipline clearly, for example *body, blood, carbohydrate, consumption, intake, response, strength*, and *endurance*. The words that come from the GSL are *body*, *blood*, and *strength*. They are GSL words but they have technical meanings because they occur in exercise physiology texts and have meanings directly related to the field. They convey discipline-specific content (Muñoz, 2015) and express the concepts of exercise physiology clearly. The examples of words that come from the AWL are *abnormal, chemical, consumption,* and *energy*. It is in line with the studies of Muñoz (2015), and Cabŕe (1999) that technical words include not only highly specialized words but also general words which have meanings specific to that particular field. Schmitt and Schmitt (2012) pointed out that technical words may be the subset of general words. Words in this group come from the GSL, AWL, and words not any lists. Most of them show the nature of exercise physiology clearly, e.g. the first 9 words with the highest occurrence words are *exercise, body, energy, muscle, blood, training, fat, oxygen,* and *heart.* The kinds of words in this group are nouns because a noun always shows the semantic job of specificity.

In the technical words in the EPRAC group, there are 50 word types occurring at least 100 times, consisting of 2 adjectives, 5 abbreviations, and 43 nouns.

In both the EPTC and EPRAC, abbreviations are used often to show the content of exercise physiology and they are known well by specialists in the field; examples are KCAL, PO, LDL, CO, RDA, and HDL. However, in the corpora the full words are presented first, and then abbreviations are presented later because it is easier, faster, and more time saving to use abbreviations at the second time of writing.

The highest occurrence of a content word type in both the EPTC and EPRAC is *exercise* (1,512 times in the EPTC and 1,830 times in the EPRAC). The first 8 content word types with the highest occurrence in the EPTC are *exercise, body, energy, muscle, blood, training, fat,* and *oxygen.* These 8 content words are all nouns and they present the specific content of the exercise physiology textbook well. These words demonstrate the characteristics of exercise physiology in the textbook which serves to help the understanding of achievement in a specific subject matter (Conley, 1992) and aim to present the body of knowledge (Swales, 1995). In the EPRAC also, these 8 words occur frequently. Besides these words, some other words which are frequently present and show the nature of the research articles are *study, significant, subjects, group,* and *results.* They occur frequently because every single research article serves a purpose and follows the established research procedures. The purpose of a research article is to describe original research or experiments (Carter & Skates, 1996). The components of research articles are Abstract, Introduction, Materials and Methods, Results, and Discussion (Bhatia, 1993). Hence, words in the EPRAC are employed to serve the different purposes of communication in each component or section of a research article.

Technical word types cover 35.72% of all single words occurring three times in the EPTC and 29.34% of all single word types occurring three times in the EPRAC. This demonstrates the crucial role of technical words in specialized texts: thus technical words should be prioritized for specialized learners.

5.1.1.3 Overlapping of technical word types

Technical words classified by using the rating scale were investigated to see whether they are real technical words or words from GSL or AWL.

The Range program was employed to investigate whether the technical word types in both the EPTC and EPRAC are in any other word categories of NP. The findings indicate that some single technical words in both the EPTC and EPRAC come from the GSL and AWL (Pearson, 1998; Muñoz, 2015)

Single technical words in the EPTC include words from 333 types (19.15%) of the GSL, 129 types (7.42%) of the AWL, and 1,277 real technical word types (73.43%). The examples of words from the GSL are *action, activity, blood,* and *exercise.* The examples of words from the AWL are *abnormal,* and *injury*.

Technical word types in the EPRAC include 230 words from the GSL (20.83%), 106 from the AWL (9.60%), and 768 technical words types (69.57%). The examples of words from the GSL are *attack, force,* and *breath*. The examples of words from the AWL are *response, transport*.

The GSL plus the AWL total 26.57% of all technical words in the EPTC. The GSL plus the AWL is 30.47% of all technical words in the EPRAC. The proportions of so-called technical words in both corpora are very high. From these proportions, it can be said that the classification of words in NP has some overlapping of words. It can be claimed that technical words can come from other vocabulary

classifications but they are technical because they convey the specialized meanings specific to exercise physiology. That means words based on NP do not always belong to their original classifications. It confirms the problem overlapping in NP classification as some words are classified differently from discipline to discipline, if meanings specific to a particular discipline are considered. This issue was found in the studies of Wasuntarasophit (2008), Chujo and Utayama, (2006), and Peuya and Val (1996). The inconsistency of word classification in NP causes difficulty for learners and makes NP unreliable.

The most frequent phrases are composed from the most frequent words which are normally nouns (Stubbs, 2002). In this study, there are 2,227 nouns out of 4,869 word types in the EPTC, for example *exercise, body, energy, muscle, blood, training, fat, oxygen, heart,* and *activity.* There are 1,479 nouns out of 3,763 word types in the EPRAC, for example *exercise, study, performance, training, time, energy, intensity, body, rate,* and *subject.* As to the crucial role of nouns in specialized texts, not only single nouns but also noun-nouns combinations were investigated. Details are discussed in the next section.

5.1.2 Collocations: Noun-Noun Combinations

5.1.2.1 High proportion of technical NNCs

All noun-noun combinations occurring in the EPTC and EPRAC are classified into non-technical and technical NNCs by using the adapted rating scale, as presented in Chapter 3. The results were shown in Chapter 4. An outstanding finding is the very high proportion of technical noun-noun combinations in exercise physiology texts. The proportions of technical NNCs in the EPTC and EPRAC are shown below.

Table 5.5: Proportion of technical Noun-Noun Combinations (NNCs) in the EPTC

Step	**Number of NNCs**		**Percentage**		**Classification**
1	469		13.76%		Non-technical NNCs 13.76%
2	2,828	2,941	82.93%	86.24%	Technical NNCs 86.24%
3	113		3.31%		
Total	**3,410**		**100%**		**100%**

Table 5.6: Proportion of technical Noun-Noun Combinations (NNCs) in the EPRAC

Step	**Number of NNCs**		**Percentage**		**Classification**
1	487		24.23%		Non-technical NNCs 24.23%
2	1,451	1,523	72.19%	75.77%	Technical NNCs 75.77%
3	72		3.58%		
Total	**2,010**		**100%**		**100%**

There are 3,410 NNCs in the EPTC and 2,010 NNCs in the EPRAC which are very high numbers and which means that NNCs occur very often and play an important role in all disciplines (Quirk, 1985).

The proportions of the technical NNCs in the two corpora are very large. There are 2,941 technical NNCs in the EPTC which is 86.24% of all NNCs occurring in the EPTC while there are 1,523 technical NNCs in the EPRAC which is 75.77% of

all NNCs occurring in the EPRAC. This shows that NNCs tend to show technicality by combination of two nouns. Technical NNCs occur more than non-technical NNCs in both the EPTC and EPRAC (6 times more in the EPTC and 3 times more in the EPRAC). Nearly half of the non-technical NNCs, which are 224 out of 487 NNCs, in EPRAC are words related to research such as those relating to statistics, research processes, and research article writing. The exemplifications of NNCs related to statistics are *standard deviation, meta analysis, standard error, confidence interval, effect size, covariance analysis,* and *regression analysis*. The exemplifications of NNCs related to research processes are *sample size, control group, treatment group, study design, future research,* and *data collection*. NNCs related to conducting research form a high proportion because the EPRAC comes from the research article genre. The same genre shares the same purpose, structure, and constraint (Bhatia, 1993). Therefore, the same words are used in the same genre.

The 10 highest occurring NNCs in the EPTC and their meanings from the specialized dictionary (Kent, 1994) are as follows:

Table 5.7: The 10 highest occurrence NNCs in the EPTC

Noun-noun Combinations	**Meanings**
body fat	*A measurement of the amount of fat in human body, usually expressed as a percentage of total body weight. The percentage body fat of an average adult male is between 15-17 percent, and that of a female about 25 percent; values of athletes tend to be less..(p.64).*
heart rate	*Number of heart beat per minute. The heart rate is commonly taken in four positions: sitting, supine, quick standing, and after standing for one minute…(p.201).*

oxygen consumption	*The volume of oxygen used for metabolism by the human body in a given period of time. It is usually expressed in 1 min (p.315).*
body mass	*The mass of the human body measured to the tenth of a kg when the subject is nude, or with clothing of known mass so that a correction to nude mass can be made (p.64).*
energy expenditure	*The energy cost of body activities. The most common expression of energy expenditure is the kilocalorie but in the scientific work there is a movement to use the joule. The daily energy expenditure of a person is dependent on sex, basal metabolic rate, body mass, body composition, and activity level..(p.149).*
blood flow	*The volume of blood flowing through a vessel or organ at a particular time (p.62).*
body composition	*The relative percentage of fat muscle, bone, and other tissue in a human body. The most common approach to analysis of body composition has been to estimate percentage body fat and lean body mass (p. 63).*
blood pressure	*The force exerted by blood against a unit area of blood vessel. It is the driving force which moves the blood through the circulatory system. Usually two measurements are made: systolic pressure and diastolic pressure..(p.62).*
carbon dioxide	*A colourless gas which occurs in the atmosphere as result of oxidation of carbon and carbon compounds. Carbon dioxide gas is more dense than air and does not support combustion. It is produced as a waste product of aerobic respiration throughout the body and is carried in the veins, mainly as bicarbonate, to the lungs of excretion.*

	Inspired air contains only 0.04 percent carbon dioxide, but expired air contains approximately 4 percent. The concentration of carbon dioxide in the blood is the main stimulus to breathing. Concentrations above 6 percent are toxic (p.76).
body weight	*The gravitational force that the earth exerts on a human body at or near its surface. Body weight is the product of body mass(in kg) and acceleration due to gravity (9.81 ms-2) measured in newstons (p.65).*

The ten highest occurrences of NNCs in the EPRAC and their meanings from the specialized dictionary (Kent, 1994) are as follows:

Table 5.8: The 10 highest occurrences of NNCs in the EPRAC

Noun-noun Combinations	**Definitions**
heart rate	*Number of heart beats per minute. The heart rate is commonly taken in four positions: sitting, supine, quick standing, and after standing for one minute…(p.201).*
energy expenditure	*The energy cost of body activities. The most common expression of energy expenditure is the kilocalorie but in the scientific work there is a movement to use the joule. The daily energy expenditure of a person is dependent on sex, basal metabolic rate, body mass, body composition, and activity level..(p.149).*
body mass	*The mass of the human body measured to the tenth of a kg when the subject is nude, or with clothing of known mass so that a correction to nude mass can be made (p.64).*

blood pressure	*The force exerted by blood against a unit area of blood vessel. It is the driving force which moves the blood through the circulatory system. Usually two measurements are made: systolic pressure and diastolic pressure..(p.62).*
body weight	*The gravitational force that the earth exerts on a human body at or near its surface. Body weight is the product of body mass(in kg) and acceleration due to gravity (9.81 ms-2) measured in newstons (p.65).*
muscle damage	*Muscle damage can be in the form of tearing (part or all) of the muscle fibers and the tendons attached to the muscle. The tearing of the muscle can also damage small blood, vessels, causing local bleeding, or bruising, and pain caused by irritation of the nerve endings in the area.(http://www.webmd.com/fitness-exercise/guide/muscle-strain)*
muscle soreness	*Pain and tenderness which typically occurs in a muscle after strenuous exercise particularly if the exercise involved eccentric contractions…(p.290-291).*
exercise intensity	*Exercise intensity refers to how much energy is expended when exercising. Perceived intensity varies with each person. It has been found that intensity has an effect on what fuel the body uses and what kind of adaptations the body makes after exercise (https://en.wikipedia.org/wiki/Exercise_intensity)*
exercise training	*The practice of human movement by using the large muscle group*
intensity exercise	*the exercise which uses high intensity to perform*

The definitions of NNCs in both the EPTC and EPRAC show us that two nouns combined in exercise physiology texts convey the precise and specific meanings in the exercise physiology discipline.

These high proportions of technical NNCs in the EPTC and EPRAC support the studies of Biber and Barbeiri (2007), Biber and Gray (2010), Hyland (2008), Linh (2010), Ward (2009), and Wasuntarasophit (2008), that NNCs are used highly in academic and specific texts. Exercise physiology textbooks and research articles are not exceptional because they have specialized content in two different academic genres. Moreover, they are used technically (Master, 2003).

As it is difficult for sports science graduate students to learn all the vocabulary syllabi, the most useful vocabulary syllabus should be prioritized. In order to know which syllabus is the most useful for sports science graduate students, the existing vocabulary syllabi and the created vocabulary syllabi should be assessed.

5.2 Usefulness of the existing vocabulary syllabi and the created vocabulary syllabus

It is difficult for specialized purpose learners to learn vocabulary from all lists or syllabi because there are too many words to learn. Therefore, the suitable vocabulary syllabi should be assessed to find out which one is the most useful vocabulary syllabus. This assessment started with the best known existing vocabulary lists are Nation's Paradigm (NP1, 2, and 3) and the British National Corpus High Frequency Word List (BNC 1, 2, and 3).

5.2.1 Nation's Paradigm (NP)

Nation's Paradigm (NP) is a well known classification of vocabulary. Nation (2001) classified vocabulary based on purposes into general, academic, technical, and low frequency words, as reviewed in Chapter 2. The following claims are made about its usefulness.

1. It is comprehensive because it covers a lot of words in language using 2,570 word families from the list of general words. There are GSL (2,000 word families) plus the list of academic words or AWL (570 word families), and some more technical words which are necessary in specialized fields. Moreover, vocabulary in NP covers high text coverage: about 80% of the tokens in an academic text are from the GSL, about 10% from the AWL, and about 5% or more technical words from the original proportion proposed by Paul Nation (2001).Therefore, all the words together are more than 95% of the text coverage which can help readers comprehend academic texts well. For the later proportion proposed, the technical vocabulary solely covers around 30% in specialized areas by the rating scale identification (Chung & Nation, 2003; Wasuntarasophit, 2008), which is very high. The GSL covers 64.49% in the EPTC, 67.72% in the EPRAC. The AWL covers 11.81% in the EPTC, 11.17% in the EPRAC. That means that the GSL plus the AWL cover great deal of exercise physiology texts.

2. It is efficient because each type of the vocabulary in NP was created based on purposes (general, academic, the specialized purposes). Therefore, learners can supposedly learn only necessary words in the types according to their learning purposes to make their learning easier and faster without unnecessary words. However, this depends on the reliability of the classification.

However, there are some weak points proposed by the previous studies and some evidence shown in this current study, as follows:

1. Inconsistency of vocabulary classification

1.1 The classification of GSL

General words or words in the GSL are classified into the first group of words in Nation (2001). For general purpose learners, it is suggested that the GSL is studied first. However, it has been found that words in the GSL are classified as technical words in exercise physiology texts. The examples are *exercise, blood, heart, activity,* and *performance. Exercise* is a word in the GSL everyone knows means the physical activity people do to keep healthy. The definition of *exercise* in the GSL is physical activity that is done in order to become stronger and healthier. The meaning of *blood* in the general dictionary (Oxford Advanced Learner's Dictionary, 2005, p. 153) shows that it means the red liquid flowing through the bodies of humans and animals. The definition of blood in the GSL is the red liquid that flows through the bodies of people and animals. Whenever people who are not in the field of exercise physiology give its meaning, it is the red liquid within our body. However, experts in exercise physiology define *blood* as a fluid tissue circulating through human and animal bodies to pump oxygen and transport nutrients to body cells. The meaning of *heart* given by the GSL is the organ in your chest that pumps blood through your body. In a technical dictionary it is defined as "a four chambered muscular organ between the lungs consisting of cardiac muscles" (Kent, 1994). The definition of *activity* given in the GSL is that it is something which you do for enjoyment. In exercise physiology texts, it always co-occurs with physical (physical activity), so that it means something you do by moving your body and it plays a part in the chemical reaction bringing about

various physiological processes. *Exercise, blood, heart,* and *activity* are words which ordinary people know; however, people in sports science know well that they have a deeper meaning with far more detail. The definition of *performance* given in the GSL is an activity people do for enjoyment (Kent, 1994). Nouns which occur together with performance are athletic (athletic performance), exercise (exercise performance), human (human performance), endurance (endurance performance), and motor (motor performance). The word *performance* in exercise physiology texts means the ability shown in physical activity and sports. The meaning of *performance* for general purposes is different; it means the *show* in general, whereas it means ability shown in doing an activity in the discipline of sports science.

1.2 The classification of the AWL

Academic words or words in the AWL are claimed to be important for academic learners. However, some of them are classified as technical words in the EPTC and EPRAC, for example *injury, transport*, *intensity*, and *recovery*. Although, these academic words are employed in academic texts, they convey different meanings in different disciplines. The general academic meaning of *injury* means damage from any causes. It means harm or damage caused by sports or exercises in exercise physiology texts. In medicine, it has a more detailed meaning of harm to any parts of the body including physical and chemical causes (The British Medical Association, 2008). *Transport* generally means moving something from one place to another but it means carrying oxygen or chemicals from one part of the body to another in exercise physiology texts. When people in this specific discipline think of this word it means carrying chemicals inside the body. However, it is a type of hardware in the discipline of computer science (Oxford dictionary of Computing for Learners of English, 1996).

In exercise physiology texts, *intensity* means the level or degree of exercising, and it always co-occurs with training (training intensity), exercise (exercise intensity), high (high intensity), moderate (moderate intensity), and low (low intensity). Thus, *intensity* is used to show how hard the exercise is. In physics, *intensity* means the power per unit which is carried out by a wave (Harrison, 1998). In exercise physiology texts, *recovery* means the physiological process of a return to normal after an acute round of exercise. In computer science, it means the process of finding data which are lost or damaged (Oxford dictionary of Computing for Learners of English, 1996). It can be seen that the roles of the AWL words in different kinds of academic texts are used in different ways. Some words are rated as general academic words while some are classified as technical words. Not all academic words play the same role in all academic disciplines.

1.3 The classification of technicality

Technical vocabulary classification in NP is claimed to be important for specialized area learners because it conveys the content of the discipline (Nation, 2001). However, technical word lists are not provided in all fields. Technical words in a discipline may not be technical words in another discipline or they may be technical words with different meanings. The exemplifications are *jumping*, and *gas*. *Jumping* is a technical word in sports science. *Jumping* is a kind of sport. Sports and exercise are a combination which is a branch of exercise physiology. Therefore, *jumping* is a technical word. *Gas* is classified as a technical word in both exercise physiology and chemical engineering. It means oxygen and carbon dioxide in exercise physiology; this was established by examining every occurrence in the corpora. It occurs 103 times in the EPTC and 18 times in the EPRAC. There are two kinds of *gas* appearing in the exercise physiology texts; gas inside the body and gas inside an oxygen tank for diving.

Different approaches used for technical vocabulary classification bring out different results. As in this study, words classified by running against the baseword lists of NP and words classified by the rating scale bring out different results, for example, *attack, cycling*, and *death. Attack* has a general meaning of violence: however, *attack* is classified in the GSL by comparing the with baseword list of NP. *Attack* often occurs with heart (heart attack). However, it is classified as a technical word by the rating scale approach because it is defined as a disease in exercise physiology. *Cycling* is classified as a general word by comparing with the baseword list of NP because it means riding a bicycle. However, it is classified as a technical word in exercise physiology because it is a kind of sport and sport is a base of exercise physiology. *Death* is classified as a general word by comparing with the baseword list of NP because it means the end of life. However, it is classified as a technical word in exercise physiology because it means the permanent stop of bodily functions by loss of a heartbeat without breathing and it means brain death in medicine. Medicine forms part of the basis of exercise physiology.

2. Corpus

The corpus created for the GSL is too old because it is sixty years old. The texts created for the AWL were from only four broad academic disciplines (arts, law, commerce, science) and based on only written texts without spoken discourse. Hence, the GSL and AWL cannot be representative of particular specialized areas.

It can be said that NP may not be suitable for sports science graduate students because learning vocabulary following NP may cause difficulty for learners and be a hard burden. Note that the GSL items as well as the AWL consist of word families: in

fact there are 8,000 words in the GSL, for example a word family of *accept* consists of 5 members (*accept, acceptable, acceptance, accepted,* and *accepts*).

In order to counteract the weaknesses of NP mentioned above, the New General Service List (NGSL) and New Academic word List (NAWL) were created in 2013. However, not many studies have investigated their usefulness. In addition, more words included which means that there are too many to learn.

Besides Nation's Paradigm, one list created lately by Nation and widely employed is the British National Corpus High Frequency Word List (BNC HFWL).

5.2.2 British National Corpus High Frequency Word List (BNC HFWL)

The British National Corpus High Frequency Word List (BNC HFWL) comes from the British National Corpus (BNC) and consists of 14 one thousand word family lists. However, the first three thousand word family lists were included in this study and details were presented in Chapter 2. Words in the BNC HFWL are common in British English, and are proposed on the basis of their usefulness because:

1. There are no overlapping words because the list is based on purely frequency, and cannot be changed from one list to another, even though forms and meanings or both are considered. For example, *action* and *inability*, which are words in BNC1, are classified into the first 1,000 baseword list of BNC no matter what their meanings are or how frequently they occur. In the case of learners wanting to learn from baseword lists 1-3, learners just follow this classification. Therefore, whenever one would like to classify words into the BNC HFWL lists, it is done easily by running the corpus against the word lists using the Range program.

2. The 3,000 word families from BNC HFWL lists 1-3 give higher text coverage than Nation's Paradigm. The studies of Hancioglu, Neufeld, and Eldridge (2008), and

Nation (2004) found that the vocabulary from the first three lists of the BNC HFWL covered higher text coverage than GSL plus AWL. In this study, first three baseword lists were employed which means that there are 3,000 word families. The first three baseword lists cover 77.80% of the EPTC, and 80.03% of the EPRAC.

Nevertheless, there is an argument about the BNC HFWL, as follows:

1. It is inefficient because the BNC HFWL was not built based on specific purposes; hence, learners have to spend their time studying a lot of unnecessary words from all the lists without any specific ones. Sports science graduate students do not know which words are necessary for them to learn or which words or which word list should be prioritized. In the case of sports science learners who need to read academic materials, they should start with the necessary words. Readers of the exercise physiology textbook may start with the first 10 word types; *ability, able, about, absolute, accept, acceptable, acceptance, accepted*, *accepts*, and *accounts.* Nine out of 10 word types mentioned are not words with meanings specific to the content of exercise physiology. The frequency occurrences of these words are 25, 8, 220, 26, 3, 1, 1, 3, 1, and 23, respectively. All of them together occur 311 times which covers 0.23% of the text coverage in the EPTC. Perhaps they should start with *exercise, body, energy, muscle, blood, training, fat, oxygen, heart,* and *physical* because they are words specific to exercise physiology. Also, if learners do not know these words well, it is difficult for them to learn the combinations in the texts and they occur 1,512, 827, 722, 609, 584, 493, 470, 463, 357, and 332 times, respectively. This is a total of 6,369 times which is 4.7% of the text coverage in the EPTC. The second set of words should be prioritized because they have higher text coverage in exercise physiology texts.

Consequently, it can be said that the BNC HFWL may be not suitable for sports science graduate students because learners do not know which words should be prioritized. Moreover, BNC fails to deal with the issue of technicality.

5.2.3 The Exercise Physiology List (EPL)

The new vocabulary syllabus from this study is the Exercise Physiology List (EPL).

There are 2,208 word types in the EPL. The words from this exercise physiology vocabulary syllabus are all technical which means that the meanings of the word types are specific to exercise physiology. Clearly, the exercise physiology vocabulary syllabus is needed by sports science learners because the words contained in it are from exercise physiology reading materials for graduate sports science students. The syllabus is useful because:

1. It is representative since the corpora come from an exercise physiology textbook and research articles which are the texts the students use. Therefore, they can be very representative of the texts in exercise physiology while sports science graduate students use as academic reading materials. They come from the EPTC and EPRAC which have exercise physiology technical words. The EPTCL comes from an exercise physiology textbook while the EPRACL comes from the text of exercise physiology research articles.

2. It is comprehensive because the EPL comes directly from authentic Exercise physiology texts which sports science graduate students have to read. There are 2,208 word types which include 65,077 tokens. Therefore, all the words in the EPL appear in the texts. The proportion of the word tokens of the EPL in the EPTC is 48.33%. The proportion of word tokens of the EPL in the EPRAC is 48.55%. EPL also

covers high text coverage in other texts in the field of exercise physiology which is OEPTC. It covers 47.40% of the word tokens in OEPTC. This means that it has validity and it is useful to use in the other texts in the field of exercise physiology.

3. It is efficient because the EPL contains only technical words. The technical words in the field of exercise physiology convey the main content of the discipline and unnecessary words are cut out of the EPL. Technical words will help learners to understand the content of exercise physiology well. Learning technical words, which are directly relevant to learners, can grasp their attention and motivate them to learn. It is better than learning starting with the GSL and then the AWL which are irrelevant. From this study, some of the GSL and AWL which seem to play a role in both general and academic texts, such as *actor, ideology, ignorant,* and *immigrate* do not occur in exercise physiology texts. Therefore, it is more efficient to focus on only necessary words.

4. It is practical because there are 2,208 word types which is not too many words for sports science graduate students to learn. The words in EPL are counted as word types while in NP and BNC HFWL are counted as word family. We can see the difference clearly if the same counting unit is employed. 2,208 word types in EPL may come up with the lower number if word family is used. In EPL, *exercise, exercisers, exercising,* and *exercises* come from a word family.

Laufer (2010) proposed that academic reading comprehension requires 95% of the text coverage. The text coverage among the vocabulary syllabi is as follows.

In order to cover 95% of text coverage in the EPTC, we have 64.49% from the GSL plus 11.81% from the AWL plus 18.70% from technical running words. This means that exercise physiology textbook readers need 1,938 word families (from the

GSL plus AWL) plus 18.70% word families from technical words in EPTC. They do not need 1,936 word families (from the GSL plus AWL) plus 18.70% word families from the EPTC list because 571 word families from the GSL and 63 word families from the AWL do not occur in the EPTC. That means 634 word families in NP are unnecessary for the exercise physiology textbook reading.

Actually, the text coverage needed for reading varies according to text types and the desired level of comprehension (Dang & Webb, 2014).

In the same way, to cover 95% of text coverage in the EPRAC, we have 67.72% from the GSL plus 11.17% from the AWL plus 16.11% from technical running words. That means 1,660 word families (from the GSL and AWL) plus 16.11% of word families from the technical list in EPTC are needed for the reading research article. Learners do not need 2,570 word families (from the GSL and AWL) plus 16.11% of word families from the technical list in the EPRAC because 814 word families from the GSL and 96 word families from the AWL do not occur in the EPRAC. That means 910 word families in NP are unnecessary for reading exercise physiology research article.

Therefore, in a comparison between NP, the BNC HFWL and the EPL, the EPL seems to be a more useful vocabulary syllabus than NP and the BNC HFWL for sports science graduate students. The reasons are that EPL: 1) comes directly from exercise physiology texts, 2) covers nearly 50% of the text coverage in the two corpora, 3) contains the technical words which convey the main content of the exercise physiology discipline, and 4) contains 2,208 word types which are not too many to learn.

5.3 Differences of word types in the EPTC and EPRAC

5.3.1 Distinctions between the tokens and types of the two corpora

Comparing the two corpora, the numbers of tokens are similar but they are different in terms of types. The types of words in the EPTC are around two thousand more than the word types in the EPRAC. *Exercise* occurred the most often in both corpora. *Study*, which means a research article, occurs frequently (579 times) in the EPRAC but not in the EPTC.

Table 5.9: Distinctions between the word lists from the two corpora

Corpus	**No. of Tokens**	**No. of Types**
EPTC	134,633	10,868
EPRAC	134,029	8,787
DIFFERENCES	**604**	**2,081**

From the table, it can be seen that the EPTC contains 604 more tokens and 2,081 more types than the EPRAC. Even though the difference in tokens between the two corpora is 604, the EPTC uses 2,081 types more than the EPRAC. So, there is more variety of word types used in the EPTC, while the EPRAC uses fewer types of words than EPTC. This may depend on the genre and subject discipline. The EPTC is a textbook genre in the exercise physiology discipline. This textbook writing is divided into chapters for different topics which use different words. Moreover, the discipline of exercise physiology is based on multi-disciplines, such as sports, science, and medicine, and, therefore, words are used in various ways. The EPRAC is a research article genre for the exercise physiology discipline. Research article writing follows a set structure: the Abstract, Introduction, Materials and Methods, Results, and Discussion. Specific

words are employed to serve the purpose of each section of the research article and, as these follow the same structure, the same words are employed to serve the purpose, structure, and constraint of the genre. Moreover, the same words are used repeatedly to show the conduct of the same procedures in the research, e.g. *aim* (31 times), *study* (579 times), *significantly* (277 times), *subjects* (370 times), *sampling* (28 times), and *results* (321 times).

5.3.2 Text coverage of words in the EPTC and EPRAC compared with NP

The text coverage of the AWL in the EPTC is similar to the text coverage of the AWL in the EPRAC at approximately 11%. On the other hand, the text coverage of the GSL and technical and low frequency words is different. The text coverage of the GSL in the EPRAC is 3.23% greater than the text coverage of the GSL in the EPTC (EPRAC=67.72%, EPTC=64.49%). The text coverage of technical and rare words in the EPTC is 2.59% higher in the EPRAC (EPTC= 23.70%, EPRAC =21.11%).

The interesting findings from the comparison are: 1) technical and low frequency words are significantly different from the estimate in NP (Nation, 2001) which is 11-13% higher. This difference may come from the nature of the corpora. These two corpora are technical and, therefore, a large number of technical words are employed. 2) There are more single words in the EPTC than in the EPRAC. The EPTC tends to use a greater variety of single word types because a textbook aims to present a body of knowledge (Swale, 1995). A textbook is divided into chapters which contain various topics and various topics bring about a greater variety of words. The purpose of writing textbooks is to present the subject to students and scholars, and so writers have to make explanations so that students understand. Research articles aim to describe original research or experiments (Carter & Skates, 1996), and, therefore, the same style

of writing is used in every research articles. Their components are the same: Abstract, Introduction, Materials and Methods, and Results. The structure of each one is the same, so the word types are used repeatedly. 3) More non-technical single words occur than technical words in both the EPTC and EPRAC. There are 64.28% of non-technical words in EPTC and 70.66% of non-technical words in EPRAC.

5.3.3 Distinctions between word types in the EPTCL and EPRACL

There are 1,739 word types in the EPTCL and 1,104 word types in the EPRACL. There are some overlapping word types in the EPTCL and EPRACL. The examples are *exercise, body, energy,* and *muscle.* Both textbook and research articles share the same word types because they both contain exercise physiology content.

5.4 Differences between Noun-Noun Combinations in the EPTC and the EPRAC

There are some differences in the use of NNCs in the EPTC and EPRAC and the differences are shown below.

Table 5.10: Proportion of technical noun-noun combinations (NNCs) in the EPTC

Step	**Number of NNCs**		**Percentage**		**Classification**
1	469		13.76%		Non-technical NNCs 13.76%
2	2,828	2, 941	82.93%	86.24%	Technical NNCs 86.24%
3	113		3.31%		
Total	**3,410**		**100%**		**100%**

There are 3,410 noun-noun combinations that occur in the EPTC, of which 469 or 13.76% are non-technical NNCs, and 2,941 or 86.24% are technical NNCs. The examples of technical NNCs in the EPTC are *muscle performance,* and *endurance activities*. The examples of non-technical NNCs in the EPTC are *sea level*, and *age group.* More technical NNCs occur than non-technical NNCs in the EPTC.

Table 5.11: Proportion of technical noun-noun combinations (NNCs) in the EPRAC

Step	**Number of NNCs**		**Percentage**		**Classification**
1	487		24.23%		Non-technical NNCs 24.23%
2	1,451	1,523	72.19%	75.77%	Technical NNCs 75.77%
3	72		3.58%		
Total	**2,010**		**100%**		**100%**

There are 2,010 noun-noun combinations in the EPRAC; 487 NNCs or 24.23% of all NNCs in the EPRAC are non-technical NNCs and 1,523 NNCs or 75.77% of all NNCs in the EPRAC are technical NNCs. The examples of technical NNCs in the EPRAC are *exercise intensity,* and *agility performance.* The examples of non-technical NNCs in the EPRAC are *control group,* and *standard deviation.* More technical NNCs occur than non-technical NNCs in the EPRAC.

NNCs appear often in both the EPTC and EPRAC. This is in the same result as other studies which found that NNCs are used in large numbers in any academic discourse (Arnaud & Savignon, 1997; Biber & Barbieri, 2007; Biber & Gray, 2010: Hyland, 2008; Linh, 2010; Schmitt & Carter, 2004; Ward, 2007; Wasuntarasophit,

2008). NNCs in the EPTC and EPRAC largely occur because the EPTC and EPRAC are in a specialized disciple in an academic discourse. NNCs occur often in specialized texts because they have special meanings and have more significance than single units (Laufer, 1990). They convey specific meanings which are used as technical terms, because when two words are combined, they convey the compact meaning of nouns (Pueyo & val, 1996).

The EPTC contains more NNCs than the EPRAC because of the nature of the textbook and research articles (a difference of 1,400 NNCs). NNCs convey special meanings in their content. The EPTC contains more variety of NNCs and more technical NNCs. A textbook aims to present the body of knowledge (Swales, 1995) and textbook is divided into chapters which contain various topics which, in various turn, produce more variety in use of NNCs.

5.5 Summary of Discussion

From this discussion chapter, it can be stated that words in Exercise Physiology List (EPL) and noun-noun combinations in Exercise Physiology Noun-Noun Combination List (EPNNL) are suitable for sports science graduate students as evidence shown in Chapter 4 and 5. They are worth learning, therefore teaching implications are suggested in the next chapter.

CHAPTER 6

IMPLICATIONS AND RECOMMENDATIONS

6.1 Teaching Implications

Lexical profiling was employed to assess the usefulness of the existing vocabulary and exercise physiology lists. The results show that the Exercise Physiology Vocabulary Syllabus seems to be more useful than the existing vocabulary lists for exercise physiology learners, as mentioned earlier. Therefore, the exercise physiology vocabulary syllabus is worth learning.

The preliminary interview shows that exercise physiology learners have to read English texts specific to their discipline, but that they encounter some difficulties. One of their difficulties comes from English vocabulary. They want to learn more English vocabulary to expand their vocabulary for text comprehension. As exercise physiology learners have to read texts specific to their field, technical vocabulary is a central focus. Technical vocabulary is useful for specific purpose learners (Nation, 2001, 2008) because its meanings are specific to the area of study. The EPL comes from technical word types from the exercise physiology corpora.

The EPL and EPNNL should be prioritized for teaching because they have regularly occurring vocabulary (Moon, 1997; Nation, 2001; Sinclair & Renouf, 1988) and contain the subject area content of exercise physiology. Therefore, they should be learned. Examples of single words and NNCs are *endurance* and *fitness* (in the EPTC), *tolerance* and *strength* (in the EPRAC), *competition performance* (in the EPTC),

endurance test and *performance response* (in the EPRAC). These words and NNCs show the content of exercise physiology clearly and allow readers to understand what the discipline is about. NNCs in the EPNNL should be studied as well because they occur very often and convey special meanings specific to exercise physiology. Learning NNCs is a practical way for learners to understand specialized meanings more easily and achieve native-like language use (Nation, 2001). Words from the syllabus which occur frequently should be taught explicitly to exercise physiology learners. Pre-sessional course could help exercise physiology graduate students before taking the exercise physiology course, or an in-sessional course also could support their course learning.

The tasks and activities for teaching the vocabulary (Richards, 2001) can be: 1) word matching, 2) identifying NNCs from the context, and 3) connecting the two halves of a sentence to make a true statement.

1) Examples of tasks for exercise physiology vocabulary teaching

Instruction: Match the word and its meaning

Words	***Meanings***
1) exercise	*a) human movements and physical activities which involve the use of large muscle groups rather than highly specific relatively non-taxing movements of small muscle groups*
2) energy	*b) the capacity for doing work*
3) fitness	*c) the ability of an individual to live a happy and well-balanced life.*
4) intensity	*d) The quantitative as contrasted with qualitative aspect of stimulation or experience, the magnitude or amplitude of sound- waves as*

	distinguished from their frequency.
5) performance	*e) the manner or quality of carrying out an activity, including a sporting activity.*

Instruction: Match the noun-noun combination and its meaning

Noun-noun Combinations	***Meanings***
1) oxygen consumption	*a) the volume of oxygen used for metabolism by the human body in a given period of time.*
2) exercise intensity	*b) how much energy is expended when exercising*
3) energy expenditure	*c) the energy cost of body activities.*
4) body mass	*d) the mass of the human body measured to the tenth of a kg when the subject is nude, or with clothing of a known mass so that a correction to nude mass can be made*
5) heart rate	*e) number of heart beats per minute*

Instruction: Identify NNCs from the context, and give the meanings of the NNCs

1) Exercise

-Nutrition and <u>exercise physiology</u> share a natural linkage.

-With this knowledge and perspective, the <u>exercise specialist</u> can critically evaluate claims about special nutritional supplements, including dietary modifications to enhance physical performance.

-Endurance capacity during cycling exercise varied considerably, depending on what diet was consumed for 3 days before the <u>exercise test</u>.

2) *Performance*

-Too often, individuals devote considerable time and effort striving to optimize exercise performance, only to fall short owing to inadequate, counterproductive, and sometimes harmful nutritional practices.

-The high-carbohydrate diet improved endurance performance by more than three times that of the high-fat diet.

3) *Intensity*

-Progressively increasing exercise intensity promotes continued bone deposition.

-The magnitude of heart rate acceleration relates directly to physical activity intensity and duration.

4) *Damage*

-Regular but excessive vitamin D consumption can cause kidney damage.

-The addition of protein to the carbohydrate-containing beverage (4:1 ratio of carbohydrate to protein) may delay fatigue and reduce muscle damage compared with supplementation during exercise with carbohydrate only.

-As discussed in Chapter 31,electrocardiography furnishes a vital diagnostic tool to uncover abnormalities in heart function, particularly abnormalities related to cardiac rhythm, electrical conduction, myocardial oxygenation, and tissue damage.

5) *Training*

-Alterations in bone's geometric configuration to long-term exercise training enhance its mechanical properties.

-Successful nonpharmacologic treatment of athletic amenorrhea uses a four-phase behavioral approach plus diet and training interventions.

- If additional research verifies these findings, and if changes in the hormonal milieu actually diminish training responsiveness and tissue synthesis, a low-fat intake may be contraindicated for optimal resistance training responses.

Instruction: Connect the two halves of the sentence to make a true statement.

1) Carbon, hydrogen, oxygen, and nitrogen represent

a) the basic structural units for most of the body's bioactive substances.

2) Depleting carbohydrate reserves increases

b) protein catabolism during exercise

3) Elite sport performance success requires

c) optimization of muscle fiber distribution

4) Type 2 diabetes results when the pancreas cannot

d) produce sufficient insulin to regulate blood glucose, causing it to rise

5). Patients with existing heart disease improve

e) coronary blood flow (reducing myocardial ischemia during daily life) within 6 months by aggressively using drug and diet therapy that lower total blood cholesterol and LDL cholesterol.

These three kinds of tasks are recommended by Hutchinson and Waters (1987) and are suitable for English for Specific Purposes learners.

Differences between the two genres, textbook and research articles, in terms of single words and NNCs should be learned to understand the characteristics of each genre. The EPTC contains more technical word types and NNCs than in the EPRAC, as presented in Chapter 4. The EPRAC contains more words related to the processes of conducting research and writing research articles. The differences in vocabulary use between a textbook and research articles are mentioned so that the characteristics of these two types of reading materials can be seen which would help readers of exercise physiology textbooks and research articles to understand the vocabulary use.

Sports science graduate students need to read exercise physiology textbooks and exercise physiology research articles for the exercise physiology course and to conduct research.

The EPL and EPNNL can help not only graduate students but also undergraduate students to expand their vocabulary and improve their reading comprehension. The syllabi also can provide guidelines for an exercise physiology course or vocabulary syllabus and for those who teach.

6.2 Limitations of the study

The EPL and EPNNL come directly from the corpora which are directly related to exercise physiology. Hence, the words and NNCs contained are worth learning. However, there are some limitations of the textbook and the sub- discipline included in the corpora. Moreover, in this study, the multi- words units are limited to only Noun-Noun Combinations

6.2.1 Limitations of the corpus

The EPTC comes from only one exercise physiology textbook Although it is recommended because of the detailed and in-depth knowledge provided, it is only one textbook, therefore, further research should be conducted from more exercise physiology textbooks.

6.2.2 Limitations of the field

Both the EPTC and EPRAC were created from one sub-discipline of sports science which is exercise physiology. Even though exercise physiology is a core branch of sports science, it is just one sub-discipline of at least three main sub-disciplines of sports science. As a result, it may be not a perfectly representative of the overall sports

science discipline. Further study can include two more sub-disciplines of sports science which are psychology and biomechanics.

6.2.3 Limitations of the combinations

There are many kinds of multi word units, however, only NNCs were included in this study. Cases of more than two nouns or combinations of other kinds of words are not within the scope of this study. Other kinds of multi word units are interesting and they also occur highly in exercise physiology texts. In addition, more than two nouns co-occurred frequently as well. Future studies should take them into consideration.

6.3 Suggestions

Conducting research on a larger scale of this study by collecting data from all the sub-disciplines of sports science can be undertaken in a similar manner. The sports science sub-discipline of psychology and biomechanics should be included to build the better representative corpus of sports science discipline.

Studying single words and NNCs in other specialized areas can be done in future studies. For English for Specific Purposes learners, vocabulary specific to their fields are significant to learn, therefore technical vocabulary specific to particular disciplines should be created.

Using other kinds of approaches for classifying vocabulary into categories can be replicated in future research. Besides using the Range program comparing with the baseword lists and the rating scale to identify technical vocabulary, other approaches such as statistical approach can be employed in future research.

6.4 Conclusion

The two corpora in this study were created from an exercise physiology textbook and exercise physiology research articles. From the two corpora, the exercise physiology vocabulary list was created. The corpora were created in order to compare with the existing vocabulary lists to see which one is useful for sports science learners. Vocabulary in the corpora was compared with the well-known NP and the BNC HFWL. It is of interest that the results reveal that words in the GSL of NP occur less in the EPTC and EPRAC than estimated in NP, and that words in the AWL of NP occur closely to NP's estimation whereas technical words occur higher than NP's estimation. This may result from the characteristics of the genres (textbook and research articles), and the characteristics of the subject discipline (exercise physiology as a sub-discipline of sports science). Textbook and research articles are written genres in the academic field, hence the AWL has much of the same text coverage as in the academic fields. Because these two genres are used for academic writing in the field of exercise physiology technical words provide high text coverage, just as in other specialized fields. The GSL text coverage is lower than NP's estimation as the EPTC and EPRAC are from specialized academic written texts which contain specialized words to a large degree. There are fewer general words than general texts.

Not only technical single words but also technical NNCs occur often in both the EPTC and EPRAC. Because of the significant role of multi word units in all disciplines, multi word units in these corpora were identified. NNCs, which are a kind of multi word unit, convey the key content of the texts. The findings reveal that both the EPTC and EPRAC contain a high proportion of NNCs. The high proportion of NNCs shows the

technicality of exercise physiology because most of the NNCs have meanings which are related or are specific to exercise physiology.

Nation's Paradigm (NP) proposed by Nation (2001) may not be suitable for English for Specific Purposes learners, especially for sports science learners, to study as vocabulary with respect to general words, academic words, and technical words. The reasons are: first, NP has a large number of words but it does not cover all vocabulary needed for sports science learners, secondly, NP does not contain noun phrases or word combinations which convey the specialized meanings in specialized texts; and thirdly, the proportions of the technical vocabulary claimed in NP and that to be found in the EPTC and EPRAC are outstandingly different. The claim of NP is 5%, while it is 35.72% of the running words in the EPTC and 29.34% of the running words in the EPRAC. That means that the roles of the technical vocabulary in NP and the field of exercise physiology are very different.

BNC HFWL may be not suitable for learners in exercise physiology field because they are based on frequency only. They fail to address the usefulness of technicality.

Vocabulary for teaching sports science learners should come directly from their sports science discipline in order to fit the learners' needs. The vocabulary should come from a representative corpus of that sports science field in order to cover the threshold vocabulary text coverage for sports science material reading comprehension. The sports science vocabulary lists created here from the representative corpora are practical for learners. In addition, learners do not need irrelevant vocabulary; everything that they learn is relevant. Something relevant can motivate them to learn.

The exercise physiology vocabulary lists from the two corpora are useful for language teachers who teach sports science learners and for those who teach vocabulary for sports science learners. Moreover, the lists are practical for both graduate and undergraduate students who study sports science.

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APPENDIX A

The Exercise Physiology List (EPL)

exercise3342
body1220
energy1124
muscle959
training956
blood889
physical784
performance760
heart665
activity646
fat620
oxygen571
intensity546
aerobic532
weight484
protein436
mass433
running417
vo372
risk370
strength343
recovery314
carbohydrate301
water296
fitness290
performed279
resistance273
expenditure266
rate265
disease261
endurance260
athletes240
players240
glucose236
rest234
health231
anaerobic230
lactate225
response223
sports214
fatigue212
diet207
cardiovascular205
cardiac203
patients203
treadmill200
air193
acid189
glycogen189
kcal188
cell184
conditions184
analysis183
intake183
metabolic183
concentration182
food182
balance181
hr180
heat179
cholesterol176
tissue170
trained167
stress161
muscular160
sport159
based158
composition158
cells157
metabolism157
active156
physiologic156
cho155
insulin155
pulmonary154
fibers152
dietary149
fluid148
run148
sedentary147
activities146
acids145
temperature143
treatment143
bone141
force140
responses139
resting139
induced138
muscles138
fatty136
cycling135
plasma131
arm129
determined124
symptoms122
condition121
gas121
intense121
healthy120
determine119

exercises119
fiber117
pressure117
arterial115
velocity115
adults114
carbon114
pr112
speed112
lipid111
power108
acute106
dna106
respiratory106
ventilation106
synthesis105
calcium104
density104
serum103
sprint103
diets100
nutrition100
paa100
bmi98
protocol98
medicine96
supplementation96
oxidation95
tissues95
soreness94
lung93
leg92
skeletal92
cancer91
obesity91
breathing90
creatine90
content89
obese89
children88
brain87
dioxide87
amino85
caffeine85
coronary85
hb85
hormone85
physiology85
mood84
chemical83
diabetes83
growth83
hdl82
laboratory82
rehabilitation82
eeg81
intensities81
proteins81
stroke81
chronic79
eccentric79
swimming79
rpe78
transfer78
ventilatory78
lean77
myocardial77
walking77
adaptations76
bout76
vitamin76
waist76
clinical75
activation74
diving74
game74
concentrations73
gene73
analyses72
molecule72
placebo71
atp69
enzyme69
death68
tennis68
hg67
peripheral67
stride67
adolescents66
artery66
bp66
exertion66
foods66
injury66
liver66
mouth66
play66
ball65
intakes65
physiological65
runners65
hemoglobin64
medical64
release64
vitamins63
adaptation62
beta62
cardiorespiratory62
ergogenic62
science62
cellular61
ffm61
molecules61
movement61
action60
tournament60
component59
nitrogen59
soccer59
aging58
competition58
components58
interaction58
supplements58
dose57
nutritional57

overweight57
reactions57
alcohol56
patient56
adult55
enzymes55
systolic55
workload55
boxing54
breath54
exercising54
ie54
tg54
cortical53
genetic53
gsh53
intervention53
molecular53
nervous53
supplement53
adaptive52
base52
competitive52
epoc52
hypertension52
jump52
mortality52
oxidative52
vascular52
alveolar51
circuit51
ergometer51
exhaustion51
physically51
carbohydrates50
chf50
cvd50
dehydration50
diseases50
hand50
neural50
severe50
sympathetic50
basketball49
ldl49
reaction49
athlete48
behavior48
biologic48
fatiguing48
perform48
po48
salivary48
shooters48
skin48
circumference47
med47
neurons47
ambient46
back46
diastolic46
football46
games46
intermittent46
lipids46
minerals46
player46
sodium46
triacylglycerol46
venous46
ventricular46
ingestion45
rm45
sbp45
cortisol44
iron44
skinfold44
syndrome44
beats43
cyclists43
knee43
lungs43
mmhg43
mmol43
playing43
strenuous43
chromium42
hydrogen42
lt42
mineral42
pain42
risks42
strong42
testosterone42
abdominal41
chest41
ck41
induce41
lipoprotein41
membrane41
menopausal41
spinal41
agility40
dhea40
fit40
rates40
chd39
external39
immune39
ph39
rinse39
saliva39
sensitivity39
structure39
anthropometric38
antioxidant38
canoeists38
cord38
dbp38
hormones38
isokinetic38
motion38
restriction38
wi38
adipose37
bicycle37

calories37
cardiopulmonary37
inspired37
macronutrient37
movements37
nerve37
postexercise37
psychological37
pyruvate37
la36
nerves36
pregnancy36
sci36
teams36
tolerance36
accumulation35
adiposity35
chromosome35
peh35
prescription35
sportsmen35
vessels35
weighing35
females34
sensory34
transition34
caloric33
identical33
neuromuscular33
preexercise33
secretion33
exerc32
female32
genes32
hormonal32
joint32
kinase32
nutrient32
pace32
saturation32
stimulates32
adolescent31
dyspnea31
ingested31
nutrients31
sdi31
strain31
therapy31
tra31
tract31
bouts30
catabolism30
es30
prevalence30
race30
receptors30
scientific30
absorption29
actions29
circulation29
cls29
ess29
exerts29
gases29
glycemic29
isometric29
parasympathetic29
physiol29
reserves29
rtg29
stimulation29
structural29
untrained29
aip28
athletic28
bcl28
calorimetry28
cmj28
co28
cs28
eimd28
field28
hydrostatic28
limb28
osi28
osteoporosis28
pco28
smoking28
step28
steroid28
stimulate28
swim28
weights28
anabolic27
arteries27
biochemical27
capillary27
dae27
exogenous27
fatness27
forced27
formation27
glycerol27
legs27
pse27
rda27
reserve27
caspase26
divers26
foot26
identify26
league26
nausea26
pcr26
phosphate26
renal26
rpp26
rq26
saturated26
sciences26
thermal26
veins26
abnormal25
adls25
arms25
combustion25

compounds25
contraction25
dcorr25
footballers25
handball25
kidney25
protocols25
residual25
treatments25
uric25
activated24
bpm24
cavity24
copd24
diver24
enzymatic24
estrogen24
hypotension24
liquid24
mitochondria24
mitochondrial24
subcutaneous24
tumor24
wall24
bax23
circulatory23
contractile23
cortex23
determining23
disorders23
drugs23
dynamometer23
eo23
extension23
fats23
fluids23
identified23
intramuscular23
kidneys23
motivational23
oral23
postural23
potassium23
runs23
stable23
superoxide23
surgery23
train23
urine23
vr23
warm23
abnormalities22
apoptosis22
biology22
breast22
calorie22
determination22
drug22
dysfunction22
fold22
gh22
organs22
plyometric22
sod22
stature22
appetite21
ec21
flexibility21
inactivity21
infection21
internal21
intracellular21
judo21
marathon21
menopause21
mrna21
mvc21
polypeptide21
radicals21
rna21
sed21
sleep21
swimmers21
symptom21
thoracic21
anxiety20
attack20
biodex20
cpk20
excretion20
exert20
extended20
ffa20
gt20
infarction20
intensive20
memory20
menstrual20
performing20
pulse20
released20
structures20
substrate20
adapted19
assay19
atoms19
calibrated19
calorimeter19
contractions19
disorder19
electron19
glutamine19
hypertrophy19
illness19
injuries19
inspiratory19
motivation19
polyunsaturated19
rfd19
slalom19
stretch19
substances19
sugar19
triceps19
activate18
analyzer18

circulating18
cn18
dizziness18
exhaustive18
glycolytic18
heavy18
hydration18
judokas18
jumping18
lipoproteins18
myocardium18
myoglobin18
phosphorus18
psychologic18
psychology18
ray18
reflex18
releases18
rg18
scuba18
sensitive18
shots18
skinfolds18
spirometry18
team18
ve18
winners18
aldosterone17
binding17
capillaries17
compound17
concentric17
doms17
glu17
head17
helium17
hippocampus17
inflammatory17
intestine17
kinetics17
neuronal17
nucleotide17
obla17
performances17
physiologist17
plays17
push17
quadriceps17
rhythm17
sense17
stability17
tension17
ut17
weightlifting17
airflow16
anatomic16
apoptotic16
arousal16
dentate16
diabetic16
ei16
endogenous16
face16
feet16
fructose16
genome16
glutathione16
gxt16
gyrus16
hydrolysis16
ingesting16
interventions16
jumps16
macronutrients16
medulla16
mod16
moves16
neuron16
oets16
pool16
reactivity16
scientists16
shape16
swimmer16
trial16
aids15
binds15
citric15
coaches15
codon15
dehydrogenase15
elderly15
exercised15
exp15
flexion15
habits15
hemodynamic15
hip15
hyperhydration15
hypertensive15
hyperventilation15
hypothalamus15
induces15
induction15
ldh15
oz15
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APPENDIX B

The Exercise Physiology Noun NounCombination List (EPNNL)

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CURRICULUM VITAE

Miss Ratchanee Singkhachan was born in Maha Sarakham on December 10, 1975. She received a Bachelor of Arts in English from Mahasarakham University in 1998 and a Master of Education in English from the same university in 2005. Her research interests include English for Specific Purposes, English for Academic Purposes, and vocabulary teaching.