Received 19/10/2562
Accepted 29/11/2562
Revised 20/11/2562

วารสารสวนสุนันทาวิชาการและวิจัย
Suan Sunandha Academic & Research Review

The Semantic Field of Technical Terms in Mathematics and Sciences for the 7th Grade English Program in Thailand

Teeraporn Plailek[1], Achara Wongsothorn[2], Suphat Sukamolson[3], Cholthicha Sudmuk[4]
The Graduate School, Suan Sunandha Rajabhat University[1,2,3,4]
E-mail: teeraporn.pl@ssru.ac.th

ABSTRACT

The aims of this study are 1) to analyze the semantic field of technical terms in Mathematics and Sciences in the relation of hyponymy; 2) to create the MS Word Net on the smartphone application for Thai grade 7 English program students; and 3) to evaluate the MS Word Net on the smartphone application. The research procedures consist of analyzing the semantic features of the technical terms by using Componential Analysis and classifying the technical terms based on the Semantic Field Theory in the relation of hyponymy.

The results revealed that the semantic field of mathematics technical terms was divided into eight main groups: Arithmetic, Algebra, Geometry, Statistics, binary operation, property rule, Mathematical symbol, and variable. The semantic field of Sciences technical terms was divided into four main groups: Chemistry, Physics, Earth Science, and Biology. Each group was further divided into several subgroups. According to the semantic feature analysis, the technical terms that had common semantic features were classified under the same concept to form a semantic field (Ullmann, 1977). Furthermore, the technical terms' meanings in the same sematic field were related and they had at least one different semantic feature. Consequently, the analysis of the technical terms' meanings by Componential Analysis assisted to classify them into the semantic fields.

The findings of the evaluation of the MS Word Net on the smartphone application usage revealed that the items with highest average were the "systematic data linking" on the MS Word Net application and the "benefits on the learners" of the MS Word Net ($\bar{X}$ = 4.54, S.D. = 0.62), followed by the "appropriate graphics" on the MS Word Net application ($\bar{X}$ = 4.53, S.D. = 0.74) and the "increases in the learners' memory of the technical terms" using the MS Word Net ($\bar{X}$ = 4.48, S.D. = 0.62).

Keywords: Semantic field, Technical terms, Mathematics and Sciences, English program

Introduction

According to the policy of the Ministry of Education, which developed the English program (EP) in Thai curriculum, EP students must learn all subjects in English except Thai language, Thai law, culture and tradition (The Office of the Basic Education Commission, 2005). This stipulation means that the numerous vocabulary including technical terms have been learned and practiced by Thai EP students, especially for the grade 7 who are the first year students of EP and non-native speakers who lack English lexicon. According to research studies concerning vocabulary learning problem (Anderson & Freebody, 1979; Bright and McGregor, 1970; Mezynski, 1983; Oxford and Crookall, 1990; Qian, 2002), the research results illustrated that a large number of new lexical items, especially long or infrequent vocabulary, caused problems for the learners to learn and remember. Moreover, one of the problems in vocabulary learning was related to the textbooks (Pimporn Wattanakamolkul, 2019). In accordance with the aforementioned studies, EP students have to confront the trouble and the difficulty in remembering the technical terms and the meanings from textbooks that they are not familiar with, especially in Mathematics and Sciences which are the main subjects for the students to study in the 21st century.

In studying the vocabulary's meanings, it was found that the meanings of groups of words are closely interrelated (Zhou, 1997). This is known as a "semantic field." The Semantic Field Theory was developed by J. Trier (1934). The concepts are that some words could form a semantic field under a common concept and the meanings of words in the same semantic field are interdependent (Ullmann, 1977). For instance, "rational number" and "irrational number" have some common semantic feature of "real number." Thus, they could form a semantic field under the concept of "real number." Furthermore, the words in the semantic field have some related meanings in order to construct the larger semantic fields or divide into many subgroups. For example, to "rational number," the following words: "integer," "fraction," "mixed number," "and decimal" share common semantic features and they could form a semantic field under the concept of "rational number."

In this study, hyponymy, one of the Semantic Field Theory relations, is considered to indicate the hierarchy of semantic field. Hyponymy indicates the relationship between a generic term (hypernym or superordinate) and a specific term (hyponym). The basic level can be divided into more specific levels. A hypernym is the word located at a higher level of hyponyms while hyponyms have some semantic features under the concept of hypernym (Gao and Xu, 2013). For example, "real number" can be divided into "rational number" and "irrational number." And "rational number" can be further divided to integer, fraction, mixed number, and decimal. In this relation, to "real number," "rational number" and "irrational number" are the hyponyms. They have some common semantic features under the concept of "real number" and they are

located at a lower level of "real number." On the other hand, "rational number" is the hypernym and it locates at a higher level of hyponyms "integer," "fraction," "mixed number," and "decimal." These hyponyms have some common semantic features under the concept of hypernym "rational number." According to the characteristic mentioned above, the students could learn new words more easily by studying the hypernyms or hyponyms in order to obtain the meanings of the words and remember them systematically.

To classify the semantic fields of words, the study of the words' meanings and the comparison of the similarity and the differences of the words' meanings are very important. Componential Analysis is a method that describes the relations between the words' meanings by breaking down each word into semantic features which are absolutely minimal for its reference (Carter, 1987). Moreover, Componential Analysis distinguishes the meaning of words that are semantically related or in the same semantic field (Saeed, 2009). However, the semantic feature differs from the definition. The definition refers to the statement giving the meaning of a word or expression while the semantic feature represents the basic conceptual components of meaning (Palmer, 1976). For example, the definition of irrational number is "a number that can be expressed as an infinite decimal with no set of consecutive digits repeating itself indefinitely and that cannot be expressed as the quotient of two integers." From the definition above, to find the semantic features of irrational number, the semantic properties or the components of meanings are considered. In this case, "infinite decimal," "no digits repeating," and "cannot be expressed as the ratio of two integers" are the semantic features of irrational number. Thus, Componential Analysis assists the meanings of the words prominent and the relationship between the words' meanings will be clearer (Lyons, 1995). As a result, the technical terms can be accurately classified into the semantic field.

In this study, eventually, the Word Net that is derived from the semantic field of Mathematics and Sciences technical terms (hereafter MS Word Net) has been proposed. This MS Word Net is beneficial to Thai students based on the fact that it can enlarge Thai grade 7 EP students' memory of technical terms and to deepen their understanding of technical terms, since they will systematically learn the terms under the same concept.

Objectives

1. To analyze the semantic field of technical terms in Mathematics and Sciences in the relation of hyponymy
2. To create the MS Word Net on the smartphone application for Thai grade 7 English program students
3. To evaluate the MS Word Net on the smartphone application for Thai grade 7 English program students

Methodology

The methodology is divided into the following steps:

1. Collecting the technical terms

1.1 Select the textbooks

The 14 textbooks from 5 publishers were selected to be the sources for listing the technical terms. Seven mathematics textbooks and 7 science textbooks from 5 publishers were prescribed by the Office of the Basic Education Commission, Ministry of Education of Thailand. The alignment of contents of Mathematics and Sciences was checked to the strands and the learning standards of the newly revised curriculum of B.E. 2560 (A.D.2017).

1.2 Select the technical terms

The technical terms were taken from the textbooks based on the followings criteria written by Gutiérrez Rodilla (1998).

1.2.1 “Precision” means the meaning of terms has only one meaning and cannot be altered to introduce the feeling, expressivity, and creativity.

1.2.2 “Emotional neutrality” means the use of terms has to be free of affective, personal or subjective components.

1.2.3 “Stability” means the validity of a term with its concept of meaning does not change.

The criteria were a tool to determine that which words were technical terms. In this study, the technical terms consist of 2,800 technical terms: 889 technical mathematics terms and 1,911 technical sciences terms.

1.3 Select the repeated and non-repeated technical terms

The repeated and non-repeated technical terms were the sample groups of this study. For the repeated technical terms, the same technical terms that occur more than once are counted as one word. Thus, the sample groups of words consisted of 686 technical terms; 274 technical mathematics terms and 412 technical science terms.

Technical mathematics terms and technical science terms were selected by the Systematic Random Sampling Technique with a 95% confidence level and a 5% confidence interval. The first step is that, all technical terms were calculated for the optimum sample sizes and then selected the non-repeated technical terms. It appeared that the number of the obtained non-repeated technical terms was larger than the optimum sample sizes which reduced the sampling errors.

2. Classifying the technical terms by using the Semantic Field Theory

2.1 Analyze the technical terms by using the Componential Analysis

The Componential Analysis was used based on Nida's (1975) 6 procedural steps used to analyze the semantic features of a related set of words' meanings. However, the discovered information increased in some steps of this study. They were as follows:

2.1.1 Finding the definitions of technical terms that form a relatively well-defined semantic domain by sharing a number of common features.

In this step, Mathematics Encyclopedia and Science and Technology Encyclopedia were used to find the Mathematics and Science technical terms' definitions. In case of not finding the definitions of technical terms from the abovementioned dictionaries, the following dictionaries were considered:

Mathematics

1. Mathematics Encyclopedia
2. Glossary of Mathematical terms & definition
3. Collins COBUILD Advanced Dictionary

Sciences

1. Science and Technology Encyclopedia
2. Oxford Dictionary of Chemistry
3. Oxford Dictionary of Biology
4. Campbell Biology Book
5. Collins COBUILD Advanced Dictionary

All of the above mention provided the technical terms' definitions in specific fields except Collins COBUILD Advanced Dictionary which provides both general and specific meanings. However, Collins COBUILD Advanced Dictionary was chosen to use more than other dictionaries since it distinguished itself by providing definitions in full sentences rather than excerpted phrases and example sentences are given for almost every meaning of every word, drawn from a large corpus of actual usage (Szynalski, 1987). Thus, Collins COBUILD Advanced Dictionary was another one of all sources for finding the technical terms' definitions.

Moreover, to make it even clearer for technical terms' definitions, dictionaries of Thai language from the following were considered:

1. Thai word repository of the Institute for the Promotion of Teaching Science and Technology
2. Lexitron Thai - English Electronic Dictionary of National Science and Technology Development Agency
3. Terminology of Office of the Royal Society

2.1.2 Finding semantic features of each technical term that belong to the semantic domain.

This step is designed to find the semantic features of technical terms that have related meanings under the same semantic field. For example, “zero” and “natural number” are the components of “whole number;” therefore, both components have some common semantic features under the same semantic field of “whole number.”

2.1.3 Determining the common component that is shared by all the technical terms in the same semantic field. For example, “whole number” is the common component that is shared by “zero” and “natural number” in the semantic domain or semantic field.

2.1.4 Determining the diagnostic component to distinguish the meaning from others in the same domain. For example, in the same semantic domain or semantic field, “zero” and “natural number” are distinguished by the number between −1 and 1, number 1 and any number more than 1 as the diagnostic component. 2.1.5 Verifying the technical terms’ features.

In analyzing the semantic features, the different markers were used to indicate the different features. These are [+] when a word possesses a feature and [-] when a word does not possess a feature (McCarthy, 1990). Sometimes three markers are used such as [±] is used when a word cannot be distinguished by the feature (Newmark, 1995)

An example to explain the steps above is provided by the technical terms “zero” and “natural number.” These technical terms all belong to the semantic field of “whole number”

zero [+ whole number]
[+ the number between −1 and 1]
[- number 1 and any number more than 1]

natural number
[+ whole number]
[– the number between −1 and 1]
[+ number 1 and any number more than 1]

From the example above, the hyponyms “zero” and “natural number” have some common semantic features of the hypernym “whole number” and the hypernym “whole number locates at a higher level of them.

However, in Componential Analysis, the meanings of hyponyms that related to the meaning of hyperym have to be analyzed. In this study, for examples, “type” and “component” are the meaning concepts that illustrate the semantic relations between hyponyms and hypernym. “Type” is the meaning concept that illustrates the semantic relation between the hypernym “integer” and hyponym “whole number” while

"component" is the meaning concept that expresses the semantic relation between the hypernym "whole number" and hyponyms "zero" and "natural number."

2.1.6 Describing the data systematically.

After analyzing the technical terms' features, the data were presented in the tables. For example,

The semantic features of "whole number:"

Hyponym	Semantic features	
	type of integer	positive integer
whole number	+	+

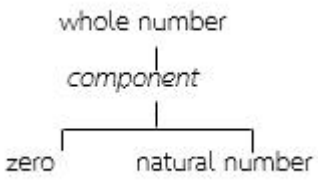
The semantic features of "zero" and "natural number"

Hyponyms	Semantic features		
	component of whole number	the number between −1 and 1	number 1 and any number more than 1
zero	+	+	−
natural number	+	−	+

From the table above, the technical terms were described as follows: whole number is a type of nonnegative integer. A zero is a component of a whole number. It is the number between −1 and 1. It is not number 1 or any number more than 1. A natural number is a component of a whole number. It is number 1 and any number more than 1.

2.2 Classify the semantic field of technical terms

The technical terms were classified based on the Semantic Field Theory in the relation of hyponymy and appeared in the diagram of hyponym relation. That means the related meanings of technical terms were classified into the same semantic field. In the diagram, it consisted of the technical terms, the meaning concept (italic letters) to indicate the relationships between the hypernym and the hyponyms, and the underlined words which were not the data of this study but they were added to complete the semantic field. Below is the diagram of hyponym relation



3. Creating the MS Word Net on the smartphone application for Thai grade 7 EP students

The semantic field of Mathematics and Sciences technical terms that classified based on the Semantic Field Theory in the relation of hyponymy was created into the MS Word Net on the smartphone application. The process was created in the following steps:

3.1 Plan

3.1.1 Define the objective of the construction

3.1.2 Select the users or the target groups

3.2 Design

3.2.1 Conceptualize the main features and approximate layouts and structures of the application

3.2.2 Design the User Interface (UI)

3.3 Construct the prototype and the functions in each menu of the application

3.4 Develop the MS Word Net on the smartphone application by using Mobi Roller App Maker program

3.5 Test the MS Word Net on the smartphone application

3.6 Deploy the MS Word Net on the smartphone application

4. Evaluating the MS Word Net on the smartphone application for Thai grade 7 EP students

The evaluation of the MS Word Net on the smartphone application usage for Thai grade 7 EP students was presented in the following steps:

4.1 The questionnaires of the MS Word Net on the smartphone application usage for Thai grade 7 EP students were given to 5 experts to check the Item Content Validity Index (I-CVI) which the value of I-CVI = 1.

4.2 The questionnaires were given to 120 English program students from 4 schools (30 students per school): Demonstration School of Suan Sunandha Rajabhat University in Bangkok, Yupparaj Wittayalai School in Chiang Mai, Kuchinarai School in Kalasin, and Benjamarachutit School in Nakhon Si Thammarat which were derived from the cluster random sampling.

4.3 The obtained data were collected and analyzed by the application of mean and standard deviation.

Results

The results of this study were presented following the research objectives.

1. The technical terms were analyzed based on the Semantic Field Theory in relation to hyponymy. The semantic field of technical mathematics terms was divided into eight main groups: Arithmetic, Algebra, Geometry, Statistics, binary operation, property rule, Mathematical symbol, and variable, and the semantic field of technical science terms were divided into four main groups: Chemistry, Physics, Earth Science, and Biology. These main groups were as follows:

1.1 The semantic field of Mathematics

1.1.1 Arithmetic

1.1.2 Algebra

1.1.3 Geometry

1.1.4 Statistics

1.1.5 Binary operation

1.1.6 Property rule

1.1.7 Mathematical Symbol

1.1.8 Variable

1.2. The semantic field of Sciences

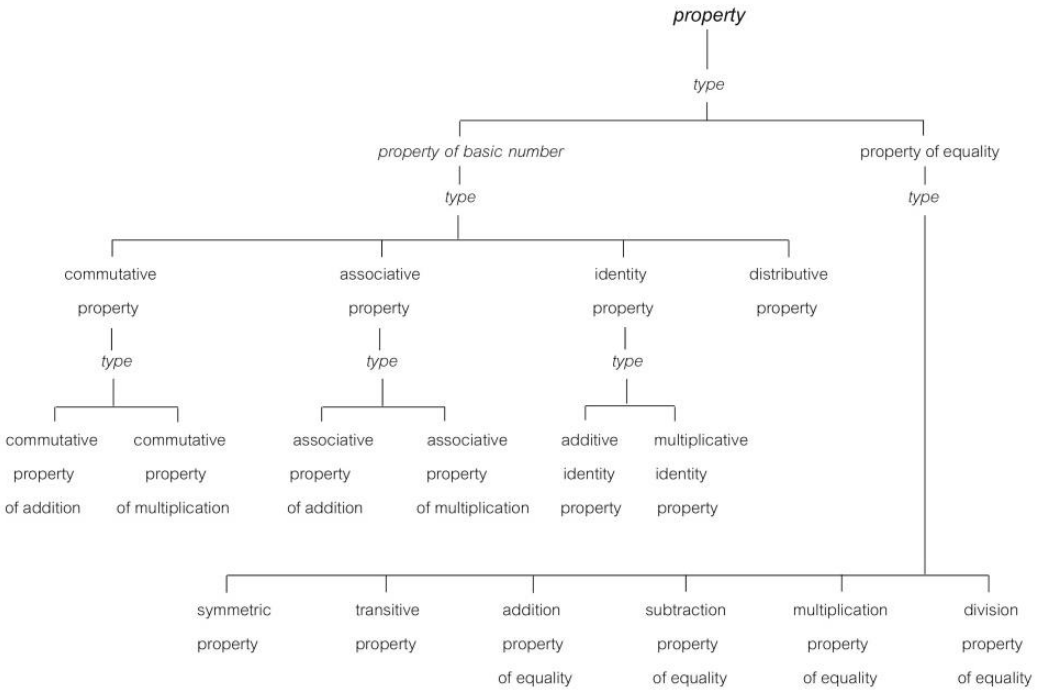
2.1.1 Chemistry

2.1.2 Physics

2.1.3 Earth Science

2.1.4 Biology

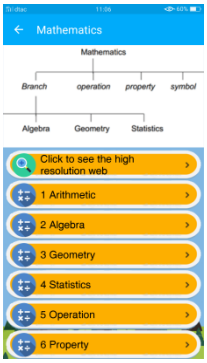
Below is an example of the semantic field of Mathematics technical terms in the group of "property rule"

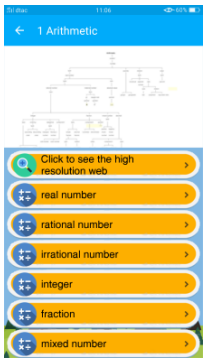


The semantic field of property rule

1. Property of basic number
    a. type
        1.1 commutative property
            a. type
                1.1.1 commutative property of addition
                1.1.2 commutative property of multiplication
        1.2 associative property
            a. type
                1.2.1 associative property of addition
                1.2.2 associative property of multiplication
        1.3 identity property
            a. type
                1.3.1 additive identity property
                1.3.2 multiplicative identity property
        1.4 distributive property
2. Property of equality
    a. type
        2.1 symmetric property
        2.2 transitive property
        2.3 addition property of equality
        2.4 subtraction property of equality
        2.5 multiplication property of equality
        2.6 division property of equality

2. The MS Word Net on the smartphone application for Thai grade 7 EP students derived from the semantic fields of Mathematics and Sciences technical terms was classified based on the Semantic Field Theory in relation to hyponymy. The Mathematics and Sciences technical terms were grouped into the sets of the conceptual-semantic relations providing technical terms'definitions and meanings. Below is the illustration part of the MS Word Net on the smartphone application.





3. The evaluation of the MS Word Net on the smartphone application usage.

Table 1 Mean and Standard Deviation of the MS Word Net on the smartphone application usage

(n = 120)

Statements	$\bar{X}$	S.D.	Order	Meaning
The design of the MS Word Net application				
1. There is a systematic data linking on the MS Word Net application.	4.54	0.62	1	Highest
2. The graphics on the MS Word Net application are appropriate.	4.53	0.74	2	Highest
3. The sizes of the letters are appropriate.	4.31	0.92	3	High
4. The MS Word Net application is interesting.	4.31	0.83	3	High
The accession of the MS Word Net application				
5. The instruction of using the MS Word Net application is clear.	4.37	0.73	1	High
6. The MS Word Net application can be accessed rapidly.	4.22	0.99	2	High
The content of the MS Word Net application				
7. The technical terms are appropriate for the level of the students	4.47	0.62	1	High
8. The definitions of technical terms are clear.	4.46	0.72	2	High
The usage of the MS Word Net application				
9. The MS Word Net application can be self-taught.	4.47	0.72	1	High

Statements	$\bar{X}$	S.D.	Order	Meaning
10. The MS Word Net application is practical.	4.43	0.64	2	High
The advantage of the MS Word Net application				
11. The MS Word Net is beneficial to the learners.	4.54	0.62	1	Highest
12. The MS Word Net increases the learners' memory of the technical terms.	4.48	0.62	2	High
13. The MS Word Net assists the learners to study the technical terms systematically.	4.40	0.78	3	High
Total	**4.42**	**0.55**		**High**

The findings revealed that the average evaluation of the MS Word Net on the smartphone application usage was high ($\bar{X}$ = 4.42, S.D. = 0.55). The averages that were at the highest level and high level were: "there is a systematic data linking on the MS Word Net application" and "the MS Word Net is beneficial to the learners" ($\bar{X}$ = 4.54, S.D. = 0.62); next was "the graphics on the MS Word Net application are appropriate" ($\bar{X}$ = 4.53, S.D. = 0.74), followed by "the MS Word Net increases the learners' memory of the technical terms" ($\bar{X}$ = 4.48, S.D. = 0.62) respectively.

To further analyze each item, the findings are as follows: For the design of the MS Word Net application, the most average was "there is a systematic data linking on the MS Word Net application" ($\bar{X}$ = 4.54, S.D. = 0.62). For the accession of the MS Word Net application, the most average was "the instruction of using the MS Word Net application is clear" ($\bar{X}$ = 4.37, S.D. = 0.73). For the content of the MS Word Net application, the most average was "the technical terms are appropriate for the level of the students" ($\bar{X}$ = 4.47, S.D. = 0.62). For the usage of the MS Word Net application, the most average was "The MS Word Net application can be self-taught" ($\bar{X}$ = 4.47, S.D. = 0.72). And for the advantage of the MS Word Net application, the most average was "The MS Word Net is beneficial to the learners" ($\bar{X}$ = 4.54, S.D. = 0.62).

Conclusion and Discussion

The study aims to analyze the semantic field of technical terms in the area of Mathematics and Sciences in relation to hyponymy, to develop the MS Word Net on the smartphone application for Thai grade 7 English program students, and to evaluate the MS Word Net on the smartphone application.

To analyze the semantic field of technical terms in the area of Mathematics and Sciences in relation to hyponymy, the results revealed that the semantic field of technical mathematics terms could be divided into eight main groups, which were Arithmetic, Algebra, Geometry, Statistics, binary operation, property rule,

Mathematical symbol, and variable, and the semantic field of Sciences technical terms could be divided into four main groups which were Chemistry, Physics, Earth Science, and Biology. Furthermore, each group was further divided into many subgroups. According to the Semantic Field Theory, technical terms could form a semantic field under a common concept. Moreover, the meanings of the technical terms in the same semantic field were interdependent. The technical terms in each semantic field had some related meanings in order to construct the larger semantic fields. Consequently, the semantic fields of Mathematics technical terms and Sciences technical terms illustrated the concepts of technical terms' meanings. Therefore, these semantic fields helped EP students to acquire vocabulary knowledge systematically, which can lead them to more easily remember a large number of technical terms especially Mathematics and Sciences technical terms that they are not familiar with. It is consistent with Wangru's (2016) statement which indicated that words, according to Semantic Field Theory, are self-systematic, although the number is very large. In addition, (Gao and Xu, 2013) stated that Semantic Field Theory plays a remarkable role in learning English vocabulary effectively and systematically and appropriate use of Semantic Field Theory will make learning English vocabulary much easier.

The results of the MS Word Net on the smartphone application usage revealed that the highest averages were "there is a systematic data linking on the MS Word Net application" and "the MS Word Net is beneficial to the learners." Next was "the graphics on the MS Word Net application are appropriate" and followed by "the MS Word Net increases the learners' memory of the technical terms." The results are consistent with those of Wangru (2016) and Guo (2010), who stated that the semantic field benefits the students in learning vocabulary because it can help them improve their vocabulary acquisition and enlarge their vocabulary by constructing relations of new items, as well as deepening their mastery of vocabulary. Moreover, the technical terms in the MS Word Net were classified based on the Semantic Field Theory in the relation of hyponymy. Thus, the MS Word Net increased the learners' memory of the technical terms. The abovementioned is consistent with Wangru's (2016) statement, which was that hyponymy is the study of the relationship between a series of words in a certain group or common concept. The students are able to enlarge their vocabulary and strengthen memory, which can lead to in-depth understanding of the lexical meanings. Furthermore, a systematic data linking and the graphic on the MS Word Net application increased the students' interest in learning technical terms. This is in an agreement to Sirinya Laten and Seree Chadcham (2017)'s statement which claimed that systematic and well-designed smartphone applications can result in better students' learning outcome.

The evaluation of this novel approach to the MS Word Net derived from the analyses of the Semantic Field Theory in the relation of hyponymy by Thai grade 7 EP students revealed that the students thought that the MS Word Net systematically increased their memorization skills and deepened their understanding of Mathematics and Sciences technical terms and meanings. It would heighten their conceptual thinking in vocabulary learning, which would lead to enlargement of their vocabulary knowledge and improvement of their usage.

Suggestions

1. The semantic field of technical terms in the area of Mathematics and Sciences in the relation of hyponymy for Thai grade 7 EP students was analyzed and classified to illustrate the relationship of the technical terms' meanings in terms of the similarities and the differences. For individuals who are interested in studying the words' meanings, the study of Semantic Field Theory to analyze the technical terms in other learning areas is recommended.

2. The semantic field of technical terms in terms of the MS Word Net on the smartphone application benefits Thai grade 7 EP students in a way that it acts as a guideline in acquiring vocabulary knowledge systematically, to increase the students' memory of the related groups of technical terms, and to deepen the understanding of technical terms and their meanings.

3. The semantic field of technical terms in terms of the MS Word Net could be a guideline for EP teachers to teach vocabulary systematically.

4. It is also beneficial to other students in regular program who are interested to study technical terms.

References

Anderson, R. C. & Freebody, P. (1979). *Vocabulary Knowledge*. Urbana: University of Illinois Center for the Study of Reading Technical Report No. 136.

Bright, J.A. & McGregor, G.P. (1970). *Teaching English as a Second Language: Theory and Techniques for the Secondary Stage*. London: Longman.

Carter, R. (1987). *Vocabulary: Applied Linguistics Perspectives*. London: Allen & Unwin.

Collins COBUILD Advanced Dictionary (1987).Glasgow:HarperCollins Publishers.Retrieved June,2019, from https://www.collinsdi ctionary.com/dictionary /english/

Gao, C. and Xu, B. (2013). The Application of Semantic Field Theory to English Vocabulary Learning. *Journal of Theory and Practice in Language Studies*, 3(11), 2030-2035.

Glossary of Mathematical Terms &Definition, from https://www.storyofmathematics.com/glossary.html

Guo, C. (2010). The Application of the Semantic Field Theory in College EnglishVocabulary Instruction. *Chinese Journal of Applied Linguistics (Bimonthly)*, 33(3), 50-62.

Gutiérrez Rodilla. B.M. (1998). *La cienciaempieza en la palabra.* Capellades, Ediciones Peninsula, S.A. Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky,

Robert B. Jackson. (2013). *Campbell Biology*. United State: Pearson Education.

Laten, S. and Chadcham, S. (2017). Mobile Applications Design Based on Bloom's Revised Taxonomy**.** *Research Methodology & Cognitive Science*, 15(2), 1-11.

Lexitron Thai –English Electronic Dictionary.2009). Bangkok: National Science and Technology Development Agency. Retrieved January, 2019, from https://lexitron.nectec.or.th/2009_1/

Lyons, J. (1995). *Linguistic semantics: An introduction*. Cambridge, England: Cambridge University Press

Mathematic Encyclopedia. (2019). Oxford: Oxford University Press. Retrieved June, 2019, from https://www.encyclopedia.com/science-and-technology/mathematics/

Mathematic Encyclopedia. (2019). Oxford : Oxford University Press. Retrieved June, 2019, from https://www.encyclopedia.com/science- and-technology/mathematics/.

Mezynski, K. (1983). Issue Concerning the Acquisition of Knowledge: Effects of Vocabulary Training on Reading Comprehension. *SAGE Journal*, June 1.

Ministryof Education. (2017). *Basic Education Core Curriculum B.E. 2551 (The newly revised curriculum of B.E.2560 (A.D.2017).* Bangkok.

Newmark, P. (1995). *Approaches to translation*. Hempstead [UK]: Phoenix ELT.

Nida, E. A. (1975). *Componential Analysis of Meaning*. The Hague: Mouton.

Office of the Basic Education Commission. (2005). *English Program*. Ministry of Education. Bangkok.

Oxford Dictionary of Biology. (2014). Oxford: Oxford University Press. Retrieved July, 2019, from https://www.oxfordreference.com/view/10.1093/acref/9780199204625.001.0001/acref-9780199204625

Oxford Dictionary of Chemistry. (2008). Oxford: Oxford University Press. Retrieved July, 2019, fromhttps://www.oxfordreference.com/view/10.1093/acref/9780199204632.001.0001/acref-9780199204632

Oxford, R. & Crookall, D. (1990). Vocabulary Learning: Critical Analysis of Techniques. *TESL Canada Journal/Revue TESL Du Canada*, 7, 9-30.

Palmer,F.R. (1976). *Semantics: A new Outline*. Cambridge: Cambridge University Press.

Pimporn Wattanakamolkul. (2019). The Study of Potentials for Learning Chinese Vocabulary and Chinese Language Proficiency of Chinese Major Students at Rajamangala University of Technology Rattanakosin. *Suan Sunandha Academic & Research Review*, 13, 2 (July – December).

Quan, D.D. (2002). Investigating the Relationship between Vocabulary Knowledge and Academic Reading Performance: An Assessment Perspective. *Language Learning*, 52(3), 513-536.

Saeed, J I. (2009). *Semantics*. 3rd ed. United Kingdom: Wiley Blackwell.

Science and Technology Encyclopedia. (2019). Oxford: Oxford University Press. Retrieved July, 2019, from https://www.encyclopedia.com/science- and-technology/mathematics/

Szynalski, Tomasz P. (1987). *Review of the Collins COBUILD Advanced Learner's English Dictionary*. Antimoon.com. Retrieved 1 February 2011.

Terminology. (2019). Bangkok: Office of the Royal Society.Retrieved January, 2019, from http://www.royin.go.th/coined_word/

Thai word repository. (2009). Bangkok: The Institute for the Promotion of Teaching Science and Technology. Retrieved January, 2019, from http://www.thaiglossary.com/groups/ipst-vocab/browse/published/

Trier, J. (1934). *Das Sprachliche Feld. EineAuseinandersetzung*.NeveJahrbucher fur Wissenschaft und Jungenbildung, 10, 428-449

Ullmann, S. (1977). *Semantics: An Introduction to the Science of Meaning*. Oxford: Basil Blackwell.

Wangru, C. (2016). Vocabulary Teaching based on Sematic-Field. *Journal of Education and Learning*, 5 (3), 64-71.

Zhou, Weijie. (1997). A Research on English Semantic Field. *Shandong Foreign Language Journal*, 68, 21-23