

Enhancing Technical Vocabulary through Morphological Analysis Instruction for Biology-Majored Students

Kent-David Juen¹ Nhon Dang, M.A.

School of Humanities & Languages, Tan Tao University, Vietnam

ABSTRACT

This paper aims to investigate the effectiveness of morphological analysis instruction on grade ten biology-majored students in a high school in Vietnam, and to find out whether they can catch up with the level of university students majoring in natural science, in terms of science vocabulary performance. The research was conducted at a university and a high school in the Mekong Delta, Vietnam. The instruction selectively targeted technical multisyllabic words that occur frequently in the participants' corpus. Thirty-one students including eighteen Grade 10 biology students as the experimental group and thirteen university students as the control group participating in the study. For data collection, the pre-posttests were designed, validated and applied for the experimental and control group. Apart from the regular teaching method, the experimental group also received explicit morphemic analysis instruction, while the control group only received their regular teaching. The pretest to posttest results revealed that each group registered an increase in the respective means, however, the experimental group surpassed the control group up to 5.9 mean difference. Morphemic analysis confirms its effectiveness in boosting the students' vocabulary acquisition of multisyllabic terminologies that facilitates their learning. The paper ended with some pedagogical implications for teaching technical terms.

Keywords: technical vocabulary, biology, multisyllabic, acquisition, performance, morphological analysis

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I. INTRODUCTION

Educating students on how to identify thematic patterns of science to communicate meaning is the mission of science educators (Obniala, 2019). Today's subject-area teachers are encouraged to highlight literacy skills that are tailored to their respective field of study (Houseal, Gillis, Helmsing, & Hutchison, 2016) for the purpose of developing students' abilities to read, write, and speak as disciplinary apprentice (Shanahan & Shanahan, 2012). Undoubtedly, vocabulary plays a vital role in language learning. Without the adequate knowledge of the technical vocabulary in science, students cannot communicate and express what they learned practically during laboratory exercises and experiments.

Although each field of discipline has its own specific vocabulary requirements, the intricacy of science vocabulary, majority derived from Greek and Latin roots (Fang, 2006; Green, 2008), generally introduces significant barriers to student learning. As it happens, Wellington and Osborne (2001) wrote that the "language of science, rather than the content, is a major barrier to most pupils in learning science" (p. 2).

A promising approach to learning words that can be adapted to any content area is morphological instruction (Bowers, Kirby, & Deacon, 2010; Goodwin & Ahn, 2010; Kieffer & Lesaux, 2010; Reed, 2008). In this linguistic strategy, students are taught how to structure words by dissecting the morphemes (i.e., the smallest meaningful unit of a word) to help them spell, comprehend and acquire technical words they encounter while reading content-area written work. An efficient way to enhance students' decoding, spelling, reading comprehension and vocabulary skills is by concentrating morphological instruction (Bowers et al., 2010; Goodwin & Ahn, 2010; Reed, 2008).

1.1. Problem Statement and Context

Unlike other isolated languages such as Chinese and Thai, Vietnamese is written in extended Latin characters (Nguyen, et al., 2001), however, words in Vietnamese are often monosyllabic (Thompson, 1963). The monosyllabic of the Vietnamese language could be a challenging factor for Vietnamese students to learn multisyllabic words in English.

¹ Corresponding author: near.kent@gmail.com

In Vietnam, like many other countries, discipline-specific class discussion is completely dominated by syllabic-based approach where students are taught to utter each syllable of a multimorphemic word. For instance, phagocytosis has 5 syllables, 12 letters, and three morphemes (pronounced as pha-go-cy-to-sis). This strategy helps struggling adolescent readers to decode complex words (Bhattacharya & Ehri, 2004), however, this approach is less effective for students in accessing spelling patterns or the meaning of a word (Zoski, Nellenbach, & Erickson, 2018). The fact that syllabic-based approach focuses on the correct utterance of each phoneme in a syllable of a word, it is only effective to students at an early age with reading difficulties (Setyowati & Sukmawan, 2016).

Alternatively, students can parse and analyze parts of the words into meaningful and pronounceable fragments through morphemic analysis (i.e., phago-cyt-osis). This dissecting-strategy supports decoding and provides clues for identifying and memorizing the exact meaning of the word. *Phago-* derived from Greek that means “to eat”, *cyte* indicating a cell, and *-osis* denoting a process (i.e., phagocytosis means a process by which certain living cells called phagocytes ingest or engulf other cells or particles). Multi-morphemic science words can be thoroughly examined and employed using morphological instruction to support the recognition of familiar spelling patterns for students to improve their comprehension (Carlisle & Stone, 2005).

Another noticeable issue in discipline-specific fields is that Universities tend to reward research fame which forces professors to spend the vast majority of their time on laboratory research and less emphasis on effective teaching (Merrow et al., 2005). The common result is that neither the objectives nor the content of courses in the curriculum is concerned with the acquisition of technical vocabulary. Moreover, these technical words of science are transmitted directly without further dissecting and explaining its meaningful fragments. This approach is very similar to communicative language teaching where it has fewer concerns on word structure (Badawi, 2019), technical vocabularies and academic words related to science as the target specialized language, channeled instantly to students to produce meaningful communication. Therefore, students of science are not having the opportunity to benefit the pedagogical advantages of morphemic analysis which could potentially enhance their learning on technical words of science.

1.2. Questions and Assumptions

This study attempted to investigate the impact of explicit morphological analysis instruction on developing biology-majored students’ spelling and vocabulary performance at a high school and a university in Mekong Delta, Vietnam. Particularly, it sought to answer the following questions:

1. *What challenges do biology students in Vietnam face when they acquire technical vocabulary?*
2. *Are there any improvements in students’ vocabulary performance if morphological analysis instructions are used?*

This study has the following assumptions:

1. There is a significant difference between the control group and the experimental group in the pretest because naturally, University students are ahead and more exposed to technical terms compared to the grade ten high school students.
2. There is no significant relationship between the vocabulary performance of the experimental group and the respondents’ profile, including age and gender
3. There is a significant difference between the control group and the experimental group in pretest.
4. There is a significant difference between the pre/post-tests of the experimental group.

II. LITERATURE REVIEW

The use of morphological instruction has been studied extensively in research. Badawi (2019) designed a two-unit explicit morphology instruction program (EMIP), a morphological awareness test (MAT) and a reading comprehension test (RCT) to investigate its effect on developing secondary students’ EFL morphological awareness and reading comprehension. The explicit morphology instruction targeted two morphological skills namely, inflectional and derivational skills which basically applies to the majority of English words. Carlisle and Stone (2005), through a morphological approach, looked into decoding and familiarizing spelling patterns of multimorphemic science words will be convenient for students’ learning. Furthermore, Berninger et al., (2003) suggested that students can easily acquire the meaning of complex science words if they recognize these morphemic patterns.

Identifying and selecting morphemes are necessary for effective instruction. Zoski, Nellenbach and Erickson (2018) emphasized the need for vocabulary selection before instructing morphemic analysis to the target students; the content should include both discipline-specific words and general academic words related to science, also, the vocabularies should be linked to the core concepts of the curriculum so that students will encounter complex words during class lessons promoting high-utility science morpheme. Fang (2006) addressed

an additional challenge which is the frequent use of nominalization of technical vocabulary that transforms an adjective or verb into a noun. For example, the verb *amplify* can be transformed into a noun by adding the suffix *-ication*, resulting in *amplification*. This affixation may confuse students because suffixes like *-ication* do not provide any meaning-based information (Zoski, Nellenbach & Erickson, 2018). However, Bowers, Kirby, & Deacon, (2010) believe that these challenges can be addressed and solved through calculated, well-planned instruction.

“Morphological analysis which means breaking an unfamiliar word into parts and then recombining them into a meaningful whole is believed to help students to discover many new words and to use it.” (Eviyuliwati, Dzikrika & Hasibuan, 2018; p. 11-12). Nevertheless, morphological analysis is ineffective if the students lack the knowledge of the root words and affixes (White, Power, & White, 1989). For that reason, morphological instruction is essential in language literacy programs (McLeod & Apel, 2015). Objectively, Manyak, James and Manyak (2018) quote Carlise’s discovery about the four different objectives in research intervention applying morphological analysis: “(1) awareness of the morphological structure of words; (2) meanings of specific affixes and roots; (3) analysis of how a word’s morphemes contribute to its meaning, grammatical function, or spelling; and (4) strategies for using morphological analysis to infer word meanings.”(p.2). Although, our pre-posttest was designed to encapsulate these four objectives, it concentrates on selective morphemes that the students encounter in their science texts and class discussion, in other words, the researchers deliberately linked the technical vocabularies and related-academic terms to the content of the school’s curriculum.

Luong and Ha (2008) discuss the comparison between English and Vietnamese morpheme systems. Firstly, using the affixation. In Vietnamese, an affix can be added to a certain morpheme but the new word will consist of at least two unattached words. Unlike in English that when an affix is added it is still in a form of a single word. For instance, the word ‘*quên*’ means *forget* in English, and the by attaching a suffix ‘*quên lãng*’ is equivalent to the adjective *forgetful*. Secondly, the tonal alterations in Vietnamese. Vietnamese is commonly described as having six tones, and tonal ablaut are used grammatically, but it is not the case in English. This leads to a big difference when forming reduplicants, for example, *vàng* (yellow) can be formed as *vàng vàng* (yellowish).

III. METHODOLOGY

3.1. Research design

The study used an experimental and control group design where the participants are allocated to two different groups. This design will reveal the science vocabulary and spelling performance of the experimental group exposed to a given morphological awareness instruction, compared to the control group which will not be given an intervening variable except their usual classroom discussion, which the instructor is using a direct syllabic-based approach. Although the control group is academically advanced compared to the experimental group, the testing results after the intervention will be used to assess whether there is a significant difference between the performance of the two groups. Moreover, this study is mainly quantitative because it includes the scores of the experimental and control groups in the pretest and posttest, and these test results will correlate with their profiles.

3.2. Participants

The participants of this study were 18 grade ten students specializing in biology and 13 natural science students from a university and a high school in the Mekong Delta, Vietnam, conducted in October 2019. The participants were separated into two groups. The first group (n=18) which consisted of grade ten students selected as the experimental group, the remaining university participants (n=13) represented the control group. Morphemic analysis was taught explicitly on the experimental group in addition to their regular class discussion, the control group only received their regular class discussion where the instructor merely uses a syllabic-based approach. The respondents in the control group have already taken a few courses in their academic program. Meanwhile, the grade 10 students were currently investigating the structure and functions in living organisms.

3.3 Semi-Interview Structure Interview

For qualitative data, the researcher conducted semi-structured interview to each five grade-ten biology-majored students and eight students in natural science, primarily about their preference on laboratory practices or theoretical discussions in the class, and which of these two they like the most. List of questions were prepared (see Appendix E) but the researcher allowed the interviewees to bring new ideas during the interview to further expand and elaborate their concerns and attitude towards the questions given to them.

3.4. The intervention applied to experimental group

During the intervention, the topic of the biology class was narrowed down and the experimental group was taught only about cells, its organelles and their mechanisms to avoid information glut that may confuse the students. The topic of cells was chosen because it could serve as the basic building blocks of organisms. And by that, it is important to provide the grade 10 students basic inputs about the smallest unit of a living thing. Initially, the explicit instruction of morpheme analysis was applied in a much more general concept. Morpheme segmentation was used and displayed to students to identify the difference between Eukaryotic and Prokaryotic cells, the prefix *Eu-* derived from Greek which means “good”, and the prefix *Pro-* derived as well from Greek which means “before”. And the suffix *-karyotic* which both words have simply means “kernel” in Greek. The instructor intendedly taught prokaryotic as “good” or better cell in the sense that it has more organelles compared Prokaryotic cells, while the latter type of cell largely dominated by *bacterias* which can be harmful, so the term was introduced to the students similar to “before” the good, as what the corresponding prefix suggests. After explaining the differences of cell types, the researcher began to explain the organelles through morpheme dissection. For instance, phospholipid bilayer is segmented into 4 parts, *i.* phospho- representing phosphorus, *ii.* lipid- organic acid fatty compounds, *iii.* The prefix bi – pertaining to “having two”, and *iv.* Layer – arranged in layers (See illustration 1). Then the full meaning is introduced, a two-layered arrangement of phosphate and lipid molecules that form a cell membrane.

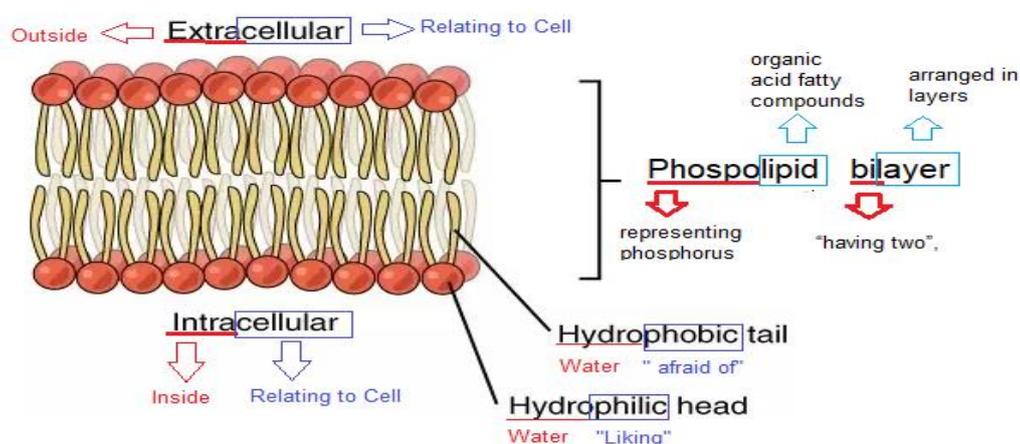


Figure 1: Dissecting the meaning of Phospholipid bilayer and its parts using morpheme segmentation
 [Source:<https://www.quora.com/What-is-the-definition-of-phospholipid-bilayer> (Edited)]

Through morpheme analysis, it is much easier to explain scientific terms to students by explaining each meaningful unit and combining their meaning afterwards. For instance, *extra-* a prefix meaning “outside”, *cellular* – an adjective relating to cell. Therefore, extracellular can be explained as “*outside of the cell*”. Another example, *hydro-* a prefix meaning water, *phobic* – an adjective involving “*fear or afraid of*”, there hydrophobic can be described as “*afraid or intolerant of water*”. The picture above is just one of the illustrations the researcher used to introduce morpheme analysis to the respondents of the experimental group.

3.5. Research instrument

This study will use a researcher pretest- posttest science vocabulary and spelling assessment. This pre-posttest science vocabulary and spelling has three parts: 1.) multiple choice, 2.) fill in the blanks, and 3.) spelling exercise where the researcher will dictate a word and the respondents will be asked to spell the word in written form. To avoid information glut that may confuse the respondents, the scope of this test will be limited to the topic about molecular and cellular biology. Other useful medical terms and morphemes will not be taught to limit the extent of the test.

Part 1 will be a science vocabulary test which is also a multiple-choice test where the respondents will be asked to encircle the letter that corresponds to the meaning. This part has 20 items and each number has four choices. The respondents will be asked to encircle the letter which they think has the correct answer. Part 2 will be fill-in-the-blanks. The students will be asked to complete a statement by adding information to a space that has left empty for them to fill their answers which they think is correct. This will be 10 items. Part 3 will be another spelling test where the researcher will dictate a multisyllabic scientific word and the respondents will be asked to spell the word in written form. There will be 10 items in this part.

3.6. Data collection procedure

This research examines whether Grade ten students specializing in biology can keep pace with the university students majoring in natural science, in terms of science vocabulary performance. And thus, a section biology in grade ten which composed of eighteen respondents was selected as the experimental group, and thirteen volunteers from natural science were selected as the control group where these samples did not receive any explicit morphology instruction like the first group. These two groups will be subjected to pre-test and post-test procedure. The scores from the pre-test and post-test will be collected and will be recorded by the researcher. The data gathering was done during the month of May to June 2020.

3.7. Statistical data analysis

The gathered data will be classified, counted and organized for quantitative analysis. Descriptive statistics will be used in this research such as mean, frequency and percentage. Inferential Statistics will also be used such as independent samples t-test, Spearman rho and Pearson correlation coefficient to determine the relationship and significant difference between the means of two groups.

For the first question, mean, frequency count, and percentage will be used to determine the number and percentage of respondents' profile in terms of gender and age. For the second question, the mean difference from the pretest to the posttest of each of the two groups was collected to determine the science vocabulary performance of both experimental and control groups. For the third question, t -test was used to determine the vocabulary level of the control and experimental group. This statistical tool will be used to assess if there is significant difference in the vocabulary level by analyzing the pretest results. The researcher will use SPSS version 26 and Microsoft Excel 2016 to accurately analyze the data.

IV. RESULTS AND DISCUSSION

Along age, one can infer that the respondents of the control and experimental group have a considerable age gap up to 4-5 years. The highest number of respondents were 16-year-olds.

Control Group			Experimental Group		
Age	Frequency	Percentage	Age	Frequency	Percentage
19	6	46.15	15	7	38.89
20	7	53.85	16	11	61.11
Total	13	100	Total	18	100

Table 1: *Distribution of respondents in the control and experimental group according to age.*

Meanwhile, results revealed that more than half of the respondents of the control and experimental groups were female. Table 2 shows the distribution of the respondents in the control and experimental group according to genders.

	Control Group		Experimental Group	
Gender	Frequency	Percentage	Frequency	Percentage
Male	7	53.85	8	44.44
Female	6	46.15	10	55.56
Total	13	100	18	100

Table 2: *Distribution of respondents in Control and Experimental group according to gender.*

The experimental group has 9.4% female respondents than the female respondents of the control group while the latter also has 9.4% more male respondents than the male respondents of the experimental group. And thus, along gender, one can infer again that the uncontrolled and controlled group are similar.

4.1. What challenges do biology students in Vietnam face when acquiring technical vocabulary?

Preference for Laboratory practices over theoretical discussion

For the semi-structured interview, four out of five grade ten biology-majored students chose laboratory experiments over class discussion. Because they find scientific demonstrations and investigations more exhilarating compared to classroom discussion. As one student describes it “*I can absorb and remember the knowledge more practically through experiments*”. Meanwhile, all eight students in natural science chose laboratory practice over theoretical discussion in the classroom. Similarly, their answers are related to “*directly experimenting the topic is far more interesting*”. The importance of theoretical discussion is often neglected by biology-majored students because it provides less excitement compared to their actual laboratory experiments, where they can work with the equipment, apparatus, sample tissue, cells, fungus and even microbes in a closed and controlled environment. Forgetting the fact that classroom discussion can also be exciting because it provides a setting where both instructors and students share views on a specific topic that develops students’ vocabulary and speaking skills.

The monosyllabicity of the Vietnamese Language provides challenges in remembering and pronouncing multisyllabic science words

Interestingly, all the respondents of the semi-structured interview have mentioned the monosyllabicity of their mother tongue poses great obstacles for them to comprehend and acquire multisyllabic technical terminologies. According to one of the interviewees named Tuấn,” because our native language is purely monolingual by nature, uttering multisyllabic science words is very difficult and thus, it’s also very hard to remember them. For instance, the word *DNA translation* means *DNA dịch* in Vietnamese, we’re not so used to pronouncing these long terms”. “Multisyllabic science terms are the complete opposite of the Vietnamese language, without laboratory practice, it could be really hard to apply these words”, said another interviewee. All of the thirteen respondents answered “YES” in question 3 of the semi-structured interview (See Appendix E). This can be implied that biology-majored students in Vietnam face obstacles when learning multisyllabic terms because of the monosyllabicity of their mother tongue.

4.2. Is there any improvement in students’ vocabulary performance if morphological analysis instructions are introduced?

Results revealed that both the control and experimental group have registered an increase in the respective means with and without intervention. The control group registered a mean difference of 4.38 while the experimental group registered a mean difference of 10.28. Although both results showed a promising improvement, the mean difference of the experimental group is 5.9 higher than the mean difference of the control group. This can be inferred that the intervention given to the experimental group is more effective than the regular class discussion of the control group.

Pretest

Pretest results revealed that there is a significant difference between the control group and experimental group. The mean difference of the pretest scores between the control and experimental group was found to be 7.07 which is a considerable difference. The comparability of the group was confirmed when an independent samples t-test was done. It was found that the absolute value of the calculated t at $p < 0.05$ is bigger than the critical value, which is $4.52 > 2.045$ (See Appendix A). Statistically, this would mean that the means of the two groups are significantly different which proves the initial assumption that the control group can perform better in the pretest compared to the experimental group because the respondents of the control group are academically advanced and they are exposed to science vocabularies compared to the grade ten respondents of the experimental group.

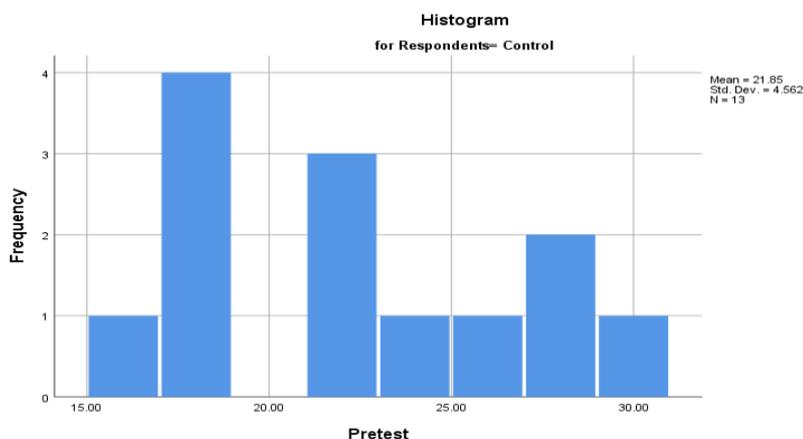


Table 3: Pretest results of the control group.

Eight students in the control group scored equal or more than 20 in the pretest which had 40 test items, and only five students scored less than 20. One student scored 30 which is 70% of the total test items and which is the highest among the 13 respondents.

Fifteen students scored below 20 in the pretest, and only three students scored above 20. This result shows that there is a big gap of the vocabulary level between the control and experimental group.

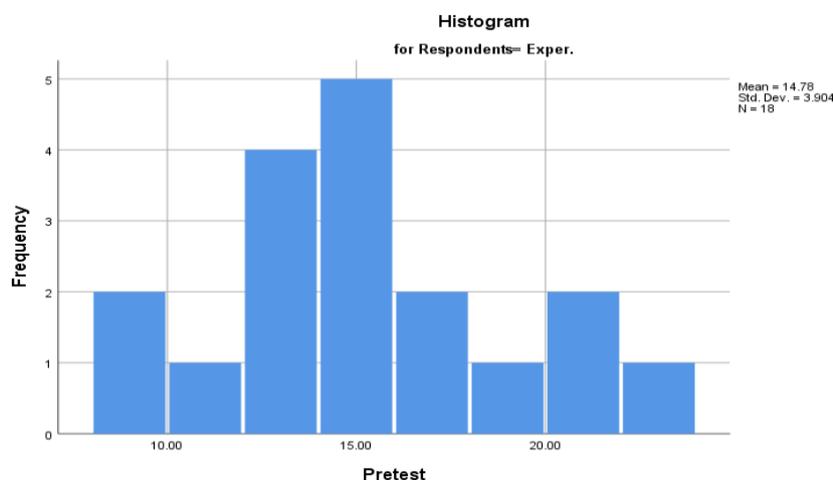
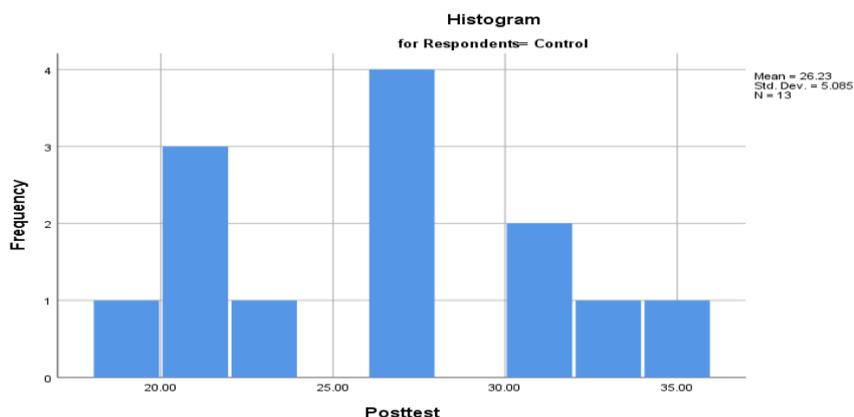


Table 4: Pretest results of the experimental group.

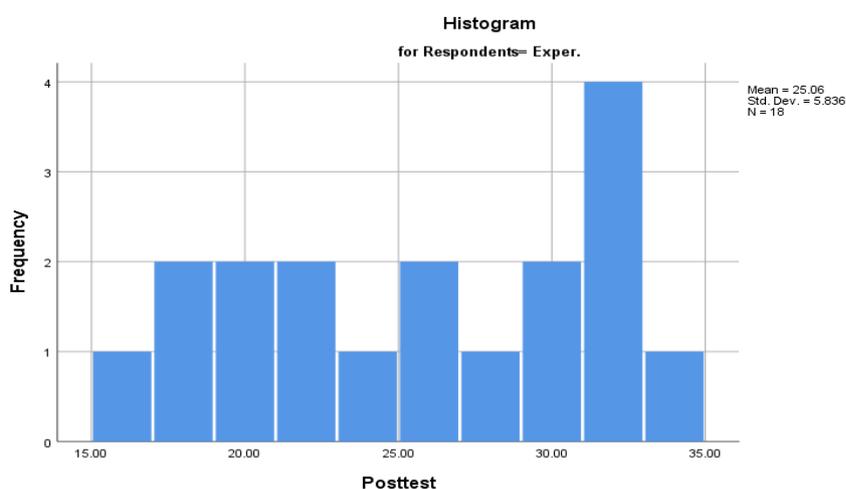
Posttest

The posttest scores of the experimental and control group were compared to prove whether or not the experimental group was able to catch up with the level of vocabulary performance of the control group. The t-test result to compare the posttest result of the experimental and control group revealed that that at $p < 0.05$, the calculated t is below the critical value, which is $.0596 > 2.045$ (See appendix D). Statistically, the means of the two groups were found significantly similar. This implies that the intervention applied to the experimental group

was effective to that point that the ten graders were able to catch up with the level of students in natural science, in terms of vocabulary performance.



The posttest results of the control group show an increase in the mean average up to 4.38. Twelve students scored above 20 and only one scored below. Four students scored above 30 (which is 75% of the total test items). We can infer that the usual classroom discussion where the instructor used a syllabic based approach is also effective in improving the vocabulary performance of the students in natural science.



The posttest results of the experimental group reveal a remarkable increase in the mean average up to 10.28. Unlike in the pretest where fifteen students scored below 20 and only 3 scored above, alternately, in the posttest only 3 students scored less than 20 and fifteen scored 20 and above, with five students scoring above 30 which is 75% of the total test item. These results display that the morphological analysis instruction given to the grade 10 biology-majored students was very effective in improving their vocabulary performance to the point that they could keep up with the same pace of those students in natural science.

V. CONCLUSIONS

In order to effectively comprehend the complex language of science, students and teachers must know the importance of vocabulary. Biology is a field where research fame is encouraged and less emphasis on vocabulary acquisition is mostly likely to blame. Furthermore, biology-majored students face difficulties in learning unfamiliar multisyllabic technical terms. These technical words of science are introduced to students directly without further dissecting and explaining its meaningful fragments. The syllabic-based approach is a good example where students are shown multisyllabic science words without fragmentations of meaningful units.

Based on the findings of this study, it was proven that the morphological analysis instruction was effective in enhancing the vocabulary performance of Grade 10 biology-majored students to the point that they slightly surpass the performance level of those college students majoring in natural science. The conclusion above is supported by the data which was analyzed by using IBM SPSS Statistics 26 and Microsoft Excel.

Initially, as expected, there was a significant difference in the vocabulary level of the experimental and control group. The comparability of the group was confirmed when an independent samples t-test was done. It was found that the absolute value of the calculated t at $p < 0.05$ is bigger than the critical value, which is $4.52 > 2.045$ (See Appendix A). Statistically, this would mean that the means of the two groups are significantly different which proves the initial assumption that the control group can perform better in the pretest compared to the experimental group. However, on the posttest, t-test to compare the posttest result of the experimental and control group revealed that at $p < 0.05$, the calculated t is below the critical value, which is $.0596 > 2.045$ (See appendix D). Statistically, the means of the two groups were found to be significantly similar. This result proves that through morphological analysis instruction, the grade ten biology-majored students were able to match their vocabulary level with the natural science college students.

The study is not yet comprehensive, but its preliminary result was positive. Therefore, some pedagogical implications can be withdrawn from the findings for teaching technical terms. Attention and effort must be given to students of science because the language of science is intricate and perplexing. It was suggested that teachers and researchers work together to apply various instructional strategies, including morphological instruction to help students improve their performance on comprehension, spelling, and vocabulary acquisition.

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APPENDICES

Appendix A

t-Test: Two-Sample Assuming Unequal Variances		
Comparing means of Pretests at p < 0.05		
	<i>Pretest Control</i>	<i>Pretest Experimental</i>
Mean	21.84615385	14.77777778
Variance	20.80769231	15.24183007
Respondents	13	18
df	29	
t Stat	4.518254755	
P(T<=t) two-tail	0.000154665	
t Critical two-tail	2.045	

Appendix B

t-Test: Two-Sample Assuming Unequal Variances		
Means of Control group at p < 0.05		
	<i>Posttest</i>	<i>Pretest</i>
Mean	26.23076923	21.84615385
Variance	25.85897436	20.80769231
Respondents	13	
df	11	
t Stat	2.314194137	
P(T<=t) two-tail	0.02953309	
t Critical two-tail	2.201	

Appendix C

t-Test: Two-Sample Assuming Unequal Variances		
Means of Experimental group at $p < 0.05$		
	Posttest	Pretest
Mean	25.05555556	14.77777778
Variance	34.05555556	15.24183007
Respondents	18	
df	16	
t Stat	6.210456609	
P(T<=t) two-tail	7.75384E-07	
t Critical two-tail	2.12	

Appendix D

t-Test: Two-Sample Assuming Unequal Variances		
Posttest score compared at $p < 0.05$		
	Control Group	Experimental Group
Mean	26.23076923	25.05555556
Variance	25.85897436	34.05555556
Respondents	13	18
df	29	
t Stat	0.596537705	
P(T<=t) two-tail	0.55560892	
t Critical two-tail	2.045	

Appendix E

SEMI-STRUCTURED INTERVIEW QUESTIONS SHEET

Student's name:
Major:
Year level:

Date of Interview:
Location:
Date:

1. What do you like about your major?
2. Do you prefer theory courses or laboratory practice? Why?
3. As a Vietnamese-native speaker, does your native language affect your learning in biology? If so, how?
4. What challenges do you encounter in acquiring technical vocabulary?
5. Are new multisyllabic-technical words in biology segmented when being introduced? Are they translated into Vietnamese?