Knowledge of English Affixes in Thai EFL Learners of Science and Language Programs

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Abstract

This study investigated the knowledge of affixes on vocabulary development among English as a Foreign Language (EFL) learners, focusing on the differentiation between students studying science and those studying the language. Affix knowledge, encompassing both prefixes and suffixes, is essential for expanding word family knowledge, serving as a cognitive bridge to proliferate word family members. To explore this, 111 secondary school students from a semi-urban Thai school, split into 53 science and 58 language program students, were assessed through receptive and productive affix knowledge tests. The findings reveal that science program students outperformed their language counterparts in receptive affix knowledge tests. Additionally, results indicated a learning continuum in affix acquisition, with students showing better average performance on receptive tests compared to more complex productive tasks. Notably, affix knowledge concerning prefixes was superior to that of suffixes across both test types. Moreover, the correlational analysis revealed a medium to strong relationship between English affix knowledge and vocabulary knowledge. The findings also suggest that suffix knowledge has a greater impact on productive vocabulary than on receptive vocabulary. Regression analysis supports the correlation results, highlighting that a deeper understanding of affixes is linked to stronger vocabulary knowledge in both comprehension and usage. These results suggest a structured progression in affix learning, from recognition to production, and underline the significance of affix knowledge in vocabulary expansion for EFL learners. The study emphasizes the need for further research into the mechanisms of affix acquisition and its role in language learning curricula.

Keywords: affix, receptive affix knowledge, productive affix knowledge, word family, EFL learner, prefix, suffix

1. Introduction

Affix knowledge is increasingly recognized as a cornerstone for accelerating and enriching vocabulary acquisition, a sentiment echoed by recent studies in addition to foundational works (Laufer & Goldstein, 2004; Nation, 2022; Thorndike et al., 1941). This form of knowledge encompasses a learner's proficiency in identifying and modifying the structural components of morphologically dense words, enhancing both their lexical understanding and linguistic agility (Aitchison, 2012; Lieber, 2010). By dissecting affixed words into their morphological constituents, learners can more easily grasp the meanings of unfamiliar terms in both their written and spoken forms. This morphological awareness facilitates the generation of new words through the application of derivational suffixes or the invention of novel suffixed words to fulfill communicative needs. For instance, appending "-ion" to a verb transitions it to a noun ("predict" to "prediction"), whereas "-ive" modifies a verb into an adjective ("predict" to "predictive"), playing a pivotal role in linguistic expression and comprehension.

Moreover, a profound understanding of affixes ignites an awareness among learners that numerous words consist of smaller, affixed units. This realization aids in extracting comprehensive meanings from entire words and their familial links (Kieffer & Lesaux, 2012; Nagy et al., 2014). Recognizing the structure of word families, constructed from a base word and its inflected and derived forms, significantly simplifies the learning process, preventing the necessity of memorizing isolated forms. This methodology supports learners intuiting the meanings of words like "unbreakable" by leveraging their foundational knowledge of "break," thus illustrating the critical nature of affix-related lexical segmentation. The conceptual framework of word families has also been pivotal in crafting vocabulary lists to refine educational methodologies and assess textual vocabulary coverage to gauge an individual's lexical proficiency and ascertain vocabulary size.

Corpus-based research reaffirms that EFL learners expand their vocabulary breadth through enhanced affix knowledge by employing word families, suggesting an even more substantial lexicon than previously estimated (Cobb & Laufer, 2021; Dang et al., 2017; Goulden et al., 1990; Hirsh, 2018). These insights highlight the significance of affixation in textual comprehension and the structural analysis of complex words.

Studies underscore a robust correlation between affix knowledge and vocabulary size among EFL learners, revealing a consistent trend despite the historical scarcity of research in this area. Initial investigations by Schmitt and Meara (1997) identified a moderate correlation, with later research solidifying the connection across various affix types, indicating a potential pathway for accelerated vocabulary

development (Dang et al., 2017; Danilović et al., 2013; Hayashi & Murphy, 2011; Hirsh, 2018; Mochizuki & Aizawa, 2000; Sukying, 2018; 2022; Sumalee & Sukying, 2024). These findings suggest that a surge in morphological awareness could significantly expedite both receptive and productive vocabulary expansion.

Instructional strategies targeting the enhancement of affix mastery through word-part analysis have been validated by empirical evidence, showcasing significant linguistic benefits. This approach has proven fruitful not only among native speakers but also among EFL learners, indicating that affix knowledge plays an indispensable role in vocabulary growth (Bubchaiya & Sukying, 2022; Dang et al., 2017; Matwangsaeng & Sukying, 2023; McBride–Chang et al., 2005; Nagy & Herman, 1987; Nagy et al., 1993; Schmitt & Meara, 1997; Sumalee & Sukying, 2024; Tyler & Nagy, 1989). Despite a relative paucity of longitudinal studies on second language affix acquisition, educational practices emphasizing morphological training are strongly advocated (Milton, 2009; Nation, 2022; Sasao & Webb, 2017; Schmitt & Zimmerman, 2002).

Highlighting the importance of affix knowledge underscores its utility in new vocabulary acquisition and elucidating word family connections. Learners can significantly bolster their vocabulary through tailored instructional techniques focusing on English affix manipulation. Given the symbiotic relationship between vocabulary size and affix knowledge, this study examined how affix knowledge interplays with vocabulary knowledge, particularly for Thai high school learners. The current study also attempted to investigate the knowledge of English affixes of high school students from Science and Language Programs. Understanding their knowledge of English affixes would cast light on pedagogical implications and fruitful information for practitioners. Two research questions were formulated to guide the study in achieving these research objectives.

1) To what extent do Thai high school learners of Science and Language Programs know English affixes?

2) What is the relationship between English affix knowledge and vocabulary knowledge in Thai high school learners?

2. Affix Knowledge and Its Relationship to Vocabulary Expansion

The understanding of affixes, encompassing both prefixes and suffixes, plays a crucial role in the linguistic competency of identifying and adjusting the internal structure of complex words, which is essential for mastering morphologically complex vocabulary (Carlisle, 2003; Claravall, 2016; Fromkin et al., 2014; Lieber, 2010; Singleton, 2016). This proficiency enables learners to dissect affixed words into more digestible morphological units, enhancing their comprehension and use in both written and oral communication. By leveraging affixes, learners can more efficiently acquire new vocabulary by linking new words to already known base forms, thereby expanding their linguistic repertoire. Moreover, an adept understanding of affixes facilitates the recognition of relationships within word families and the creation of new words to meet communicative needs, such as forming nouns from verbs by adding "-er" or adjectives by appending "-able."

Affix knowledge spans the understanding of both inflectional and derivational affixes. Inflectional affixes, which focus on slight modifications to a word that carry significant syntactic implications without altering the word's category, contrast with derivational affixes that contribute to the creation of new words and may change the syntactic category of the base word. The derivation process, involving bound morphemes, thus plays a crucial role in word formation and syntactic categorization, exemplified by the transformation of "eat" to "eatable" or "happy" to "happiness."

The concept of affix knowledge intertwines with form and meaning, involving syntactic properties and semantic information. This dual aspect of affix knowledge highlights the complexity of morphological acquisition, which is guided by principles such as selectional restriction and morphological ordering. Theoretical frameworks like the 'Mirror Principle' (Baker, 1985) suggest that grammatical knowledge is mirrored in derivational affixes, implying a deep interconnection between syntax and morphology.

Psycholinguistically, affix order and acquisition are influenced by factors of parsability, which include phonology, productivity, and semantic transparency, among others. This parsability affects how affixes are organized, suggesting a hierarchy where more passable affixes precede less passable ones for cognitive ease. Such organizational principles not only guide the processing of morphologically complex words but also inform instructional strategies for teaching affixes and word families.

The study of word families, as outlined by Bauer and Nation (1993), provides a framework for understanding how knowledge of a base word facilitates the learning of its morphological variants with minimal additional effort. This theory underscores the importance of rule-based learning, particularly for inflectional affixes, and highlights the later acquisition of more complex derivational affixes. The classification of affixes into seven levels based on criteria like frequency and productivity offers a structured approach to teaching and learning morphologically complex words, though the relative importance of these criteria remains an area for further exploration.

Research underscores the significance of affix knowledge in vocabulary acquisition, suggesting that understanding the acquisition patterns of affixes can illuminate effective strategies for vocabulary learning. However, investigations into the specific processes of affix acquisition remain limited. By delving into the nature of affix acquisition, educators can better tailor their instructional approaches, focusing on the affixes most beneficial for students and designing learning activities and assessments that support morphological awareness and vocabulary expansion.

3. Research Methods

3.1 Participants

The present study employed convenience sampling, involving 111 Thai high school EFL (English as a Foreign Language) learners,

spanning two distinct academic programs: Science and Language. The cohort comprised 53 students from the Science Program, which emphasizes the study of scientific disciplines, including physics, chemistry, biology, mathematics, and other science-related subjects. The remaining 58 participants were enrolled in the Language Program, with a curriculum focused on social sciences and languages and studying multiple languages such as English, French, and Chinese. Despite their specialized areas of study, both groups participated in a set of required courses as prescribed by the Thai national curriculum, ensuring a balanced educational foundation.

All participants were within the age range of 16 to 17 years, indicating that they were at a similar stage of adolescent development. They had been exposed to English language education for approximately ten years through formal schooling, suggesting a substantial duration of language acquisition experience. However, the variability in their English proficiency levels was noted, attributed to differing degrees of engagement and exposure to the English language outside the formal classroom environment.

During the data collection period, each participant enrolled in eight courses, reflecting a comprehensive academic schedule. Among these, the students received an average of five hours of English language instruction per week, a component of their broader educational experience, totaling 35 hours of study each week for the Science and Language Program students. This structured approach to language learning, combined with their varied exposure to English outside of school, provided a rich context for examining the effects of affix knowledge on vocabulary acquisition among Thai high school EFL learners.

3.2 Research Instruments

This study's methodology for assessing affix knowledge was inspired by Sukying's (2018) comprehensive approach, incorporating three distinct tasks designed to evaluate varying degrees of affix proficiency among participants. These tasks included the Receptive Affix Knowledge (RAK) assessment, the More-Controlled Productive Affix Knowledge (MPAK) task, and the Less-Controlled Productive Affix Knowledge (LPAK) task. The RAK assessment employed a multiple-choice format featuring 60 items that cleverly integrated pseudowords with actual affixes. The use of pseudowords aimed to minimize the advantage that participants might gain from their familiarity with real words, thus providing a more equitable measure of their ability to recognize affixes.

The MPAK task was divided into two segments to gauge the participant's ability to actively employ affixes in a somewhat restricted setting. The first segment presented a word as a stimulus, prompting participants to generate suitable affixes. The subsequent segment challenged participants to use these affixes correctly within the context of a sentence completion task. The materials for this task were meticulously selected from a substantial corpus comprising 2,762,195 tokens across 58,768-word types found in 74 English textbooks utilized in Thai secondary education, ensuring relevance and applicability to the student's learning environment.

In the production test, participants were tasked with identifying all permissible affixes for each given target word and completing each sentence with the appropriate word. The correct answer consisted of a single specific word, though the number of acceptable affixes that could be applied varied with the given prompt words. Participant answers were evaluated against the comprehensive set of possible correct responses identified within a word family, as catalogued in the British National Corpus (BNC) word lists (Nation, 2022). For affixes not listed within the specified word family, their suitability was assessed by two native English-speaking EFL teachers based in Thailand. Each valid affix provided by a participant was awarded one point, while blanks received no points. Supplying an incorrect affix resulted in a deduction of one point. Participants were instructed to read sentences attentively to grasp their meanings fully and to craft coherent sentences by employing the appropriate prefixes and/or suffixes. Correct word forms were credited with one point each. No penalty was imposed for incorrect word forms to account for instances where participants demonstrated a partial understanding of the word but failed to deliver the exact required form.

Similarly, the LPAK task aimed to evaluate participants' productive use of affixes in a more open-ended format, albeit within a structured framework similar to that of the MPAK. Participants first recalled an affix based on its meaning and then crafted sentences employing any suitable affix identified in the initial part. This design, chosen for its practicality given time and budget limitations, eschewed a fully unguided productive task in favor of this more structured approach, which nonetheless offered valuable insights into the students' affix usage in creative sentence formation.

Participants were tasked with identifying and writing down suitable affixes for each target and then creating a sentence utilizing these affixes. Consequently, the volume of responses each participant provided varied. To guide this process, a reference list of affixes along with their definitions was provided (Nation, 2022). In the initial part of the exercise, Xa, each correctly identified and written affix earned the participant one point, while points were not awarded for incorrect or incomplete affixes. To discourage random guessing, a penalty of one point was applied for every incorrect affix submitted. The effectiveness of the participants' sentences was evaluated by two proficient native speakers, both English EFL teachers in Thailand. A sentence incorporating a correctly used affix was given one point; if the affix was also used in the correct word form, an additional point was awarded, making two points in total (Paribakht & Wesche, 1997, p. 181). Sentences that demonstrated semantic accuracy received three points, and those that also exhibited grammatical precision, in addition to the correct use of affixes and semantic accuracy, were awarded four points. Minor spelling mistakes were overlooked, and no penalty was issued for sentences deemed incorrect overall, as such errors were interpreted as indicative of a learner's partial comprehension of the affixes in question.

It was also noteworthy that this study used the RAK, MPAK, and LPAK from Sukying's (2018) research. The reliability of internal consistency for the RAK, MPAK, and LPAK were .80, .92, and .84, respectively.

To complement the affix knowledge assessment, the study also incorporated two established vocabulary tests to examine the breadth of the participants' lexical knowledge: The Vocabulary Size Test (VST) by Nation and Beglar (2007) and the Productive Vocabulary Levels Test (PVLT) by Laufer and Nation (1999). The VST, assessing receptive vocabulary size, consisted of 50 lexical items drawn from the top five English word frequency levels. The PVLT, on the other hand, estimated productive vocabulary size across three frequency levels—2,000, 3,000, and 5,000—comprising a total of 54 items, with 18 items per frequency level. Together, these tools provided a nuanced understanding of the relationship between affix knowledge and vocabulary size, encompassing both the receptive and productive dimensions of lexical knowledge.

3.3 Data Collection Procedure

In the initial week of the study, participants undertook two vocabulary size assessments on the same day. The subsequent week was dedicated to evaluating their affix knowledge, with both the receptive and productive affix tasks conducted concurrently a week after the vocabulary tests. To mitigate any potential bias, the productive vocabulary test was administered before the receptive one, preventing participants from inferring spellings or connections from the receptive to the productive test. Similarly, the productive affix tests were carried out before the receptive affix test to limit the likelihood of participants correlating the productive affix tasks with their receptive counterparts. Each testing session included a 10-minute break to alleviate any fatigue among the participants. Comprehensive instructions were provided in Thai, the participants' mother tongue, complemented by illustrative examples of the tasks, ensuring clarity and understanding before commencement. Additionally, two filtering criteria were applied to the data collection process: responses were excluded if participants left all questions unanswered or repeated the same answer for ten consecutive questions to ensure the validity of the data analyzed.

The research purposes were fully explained to the participants, emphasizing that the tests were an evaluation of their language skills and would not impact their academic grades, ensuring that participation was voluntary. Permission for the study was obtained from the school in Thailand and approved by the school director prior to data collection. After obtaining school approval, the researchers introduced the study and extended an open invitation to participate during English classes. Informed consent was obtained from the guardians and classroom advisors of all participants under the age of 18 to ensure voluntary participation. The consent form and Participant Information Statement were translated into Thai by a certified English-Thai translator and distributed to potential participants before data collection. Moreover, participants' identity and information would keep confidential and anonymous in any dissemination of results, whether in the context of a conference, journal article, or report.

3.4 Data Analysis

Descriptive statistical analyses were utilized to characterize the participants' performance on the affix knowledge and vocabulary size tests, encompassing calculations of means, and standard deviations. The mean scores represent the average performance, while standard deviations detail the variability of scores around this average, as noted by Gass and colleagues (2005).

Statistical tests were employed to delve deeper into the data for inferential analysis. The use of an independent t-test facilitated the comparison between the mean scores of two distinct groups to determine if their differences were statistically significant.

The multiple regression analysis was also conducted to create a model that explains the variance observed and predicts vocabulary knowledge. The coefficient of determination (R^2) and other related statistics provided insights into the statistical significance and relevance of the regression model in capturing the relationships within the data.

4. Results

4.1 Affix knowledge in EFL Learners of Science and Language Programs

Table 1 presents statistical data across three categories of knowledge prefixes: RAK, MPAK, and LPAK, each evaluated within two distinct streams. These categories likely represent different datasets or types of knowledge being analyzed. The statistical measures include the mean, standard deviation, minimum, and maximum values for each stream and knowledge prefix, offering insights into the central tendency, variability, and range of the data.

For the RAK category, Stream 1 exhibits a mean of 63.34 with a standard deviation of 13.08, indicating a moderate level of variability around a relatively high average. The values in this stream range from a minimum of 30.43 to a maximum of 91.30. Stream 2, on the other hand, shows a higher mean of 69.98 and a slightly lower standard deviation of 11.98, suggesting a tighter clustering of values around a higher average, extending from 43.48 to 95.65. This indicates that for the RAK category, Stream 2 generally performs better than Stream 1 regarding average performance and consistency.

In the MPAK category, both streams demonstrate lower mean values than RAK, with Stream 1 having a mean of 17.09 and Stream 2 slightly higher at 17.58. The standard deviations are relatively close, at 9.94 for Stream 1 and 10.51 for Stream 2, reflecting a similar level of variability. Notably, Stream 1 includes a negative minimum value of -19.15, highlighting values representing a loss or deficit, whereas Stream 2's minimum and maximum range from -2.13 to 44.68, suggesting a broader spread of data points.

Lastly, the LPAK category shows Stream 1 with a mean of 23.59 and a standard deviation of 12.34, indicating a reasonably widespread around the mean. The values range from 0.00 to 66.67. Stream 2 improves upon these figures with a mean of 30.64 and a standard deviation of 14.59, and its range is slightly narrower from 5.83 to 65.83, implying a higher average performance with increased

variability.

Table 1. A summary of prefix knowledge

Prefix knowledge	Program	M	S.D.	Minimum	Maximum	*t*-value
RAK	1	63.34	13.08	30.43	91.30	2.78**
	2	69.98	11.98	43.48	95.65	
MPAK	1	17.09	9.94	-19.15	3.30	.25
	2	17.58	10.51	-2.13	44.68	
LPAK	1	23.59	12.34	0.00	66.67	2.73**
	2	30.64	14.59	5.83	65.83	

Note: 1 = Language Program, 2 = Science Program, **significant at the 0.01 level ($p < .01$)

An independent samples t-test was performed to compare the scores between different learning streams. The findings indicated that science students outperformed language students on the RAK test ($t(109) = 2.78$, $p < .01$). Similarly, science students achieved higher scores on the LPAK test compared to language students ($t(109) = 2.73$, $p < .01$). However, there were no significant differences between the two programs on the MPAK test.

Together, Table 1 provides a comparative analysis of the performance across two streams for each knowledge prefix. RAK shows the highest mean values, indicating the best overall performance, while MPAK and LPAK exhibit lower averages with significant variability. The differences between streams within each category suggest variations in performance, with Stream 2 generally showing improved or more consistent results than Stream 1, except for the broader range of values in MPAK Stream 2. This analysis highlights the nuances in data performance across different categories and conditions, offering valuable insights for further investigation or decision-making.

The data presented in Table 2 summarizes the findings on suffix knowledge across different streams, revealing insightful trends in the mean scores, standard deviations, and range values (minimum and maximum scores) for each category of suffix knowledge: RAK, MPAK, and LPAK. For RAK, the mean scores indicate that participants in stream 2 (M = 52.93, SD = 10.46) exhibited a higher level of knowledge compared to those in stream 1 (M = 47.90, SD = 11.46), suggesting that learners in stream two may have had more effective exposure or instruction related to regular suffixes. The range of scores also shows a wide variation in RAK within each stream, from 21.62 to 75.68 in stream one and from 29.73 to 72.97 in stream 2, indicating a significant diversity in suffix knowledge among the participants.

In the category of MPAK, both streams demonstrated relatively lower mean scores than in RAK, with stream 1 participants achieving a mean of 22.47 (SD = 9.95) and stream 2 participants having a slightly higher mean of 24.98 (SD = 11.18). The minimum and maximum scores reveal a broader range in MPAK compared to RAK, especially in stream 2, where scores ranged from 6.50 to 53.00. This variation might reflect learners' nuanced challenges in grasping morpho-phonemic rules applied in suffixation, which can significantly differ from the more straightforward applications seen in regular affixation patterns.

The LPAK scores were the lowest among the three categories for both streams, with stream 1 having a mean of 10.12 (SD = 6.23) and stream two a mean of 12.05 (SD = 8.20). Negative values in the minimum scores for stream 2 (minimum = -.30) could suggest data recording errors or represent learners' misconceptions about affixed forms, which could negatively impact their scores. The maximum scores (23.88 for stream 1 and 34.63 for stream 2) indicate that some learners were significantly more proficient in LPAK, though overall knowledge remains limited compared to RAK and MPAK.

These findings suggest a gradient of suffix knowledge proficiency among the participants, with the greatest proficiency observed in RAK and the least in LPAK. This trend underscores the complexity of acquiring affixed knowledge, especially concerning the phonemic and lexical intricacies of the English language. The data highlights the necessity for targeted educational interventions that address the specific challenges posed by affixation rules of MPAK and LPAK to enhance overall suffix knowledge among learners.

Table 2. A summary of suffix knowledge

Suffix knowledge	Program	M	S.D.	Minimum	Maximum	*t*-value
RAK	1	47.90	11.46	21.62	75.68	2.41*
	2	52.93	10.46	29.73	72.97	
MPAK	1	22.47	9.95	1.00	45.50	1.24
	2	24.98	11.18	6.50	53.00	
LPAK	1	10.12	6.23	0.00	23.88	1.39
	2	12.05	8.20	-.30	34.63	

Note: 1 = Language Program, 2 = Science Program, *significant at the 0.05 level ($p < .05$)

An independent samples t-test was conducted to compare the scores between different learning programs. The results indicated that science students scored significantly higher on the RAK test compared to their language counterparts ($t(109) = 2.41$, $p < .05$). However, no significant differences were found between science and language programs on the MPAK and LPAK tests.

Table 3 summarizes affix knowledge between science and language students. The results demonstrated that science students (M = 69.98, S.D. = 11.98) outperformed language students (M = 63.34, S.D. = 13.08) on the receptive prefix knowledge test. Similarly, science students (M = 52.93, S.D. = 10.46) scored higher on the receptive suffix knowledge test compared to language students (M = 47.90, S.D. = 11.46). Differences were also observed in the productive prefix knowledge test, with science students (M = 26.97, S.D. = 12.04) outperforming

language students (M = 21.76, S.D. = 10.54). However, differences in productive suffix knowledge tests between science students (M = 16.90, S.D. = 6.12) and language students (M = 14.74, S.D. = 6.68) were not significant.

An independent samples t-test was also conducted to determine if differences existed between the two programs. The analysis revealed significant differences in receptive prefix knowledge ($t(109) = 2.78$, $p < .05$) and receptive suffix knowledge ($t(109) = 2.41$, $p < .05$). While there were significant differences in productive prefix knowledge ($t(109) = 2.41$, $p < .05$), no significant differences were observed in productive suffix knowledge.

Table 3. A summary of affix knowledge

Affix	Program	M	S.D.	*t*-value
Receptive prefix	1	63.34	13.08	2.78*
	2	69.98	11.98	
Receptive suffix	1	47.90	11.46	2.41*
	2	52.93	10.46	
Productive prefix	1	21.76	10.54	2.43*
	2	26.97	12.04	
Productive suffix	1	14.74	6.68	1.52
	2	16.90	6.12	

Notes: 1 = Language Program, 2 = Science Program, *$p < .05$ (two-tailed)

4.2 Relationship between vocabulary knowledge and affix knowledge in EFL learners

Table 4 reveals the performance of Thai high school students on two key vocabulary tests: the Vocabulary Size Test (VST) and the Productive Vocabulary Levels Test (PVLT), with scores reported for 111 participants. The total scores from both vocabulary assessments were converted into percentage terms to facilitate comparison. This approach provides a clearer perspective on the overall test outcomes and participant proficiency across different frequency levels.

For the VST, which assesses the learners' receptive vocabulary size, participants achieved a mean score of 61.14% with a standard deviation of 9.89. This suggests a moderately high level of understanding of the vocabulary items tested, with a somewhat tight distribution indicating that most students performed similarly across the board. The mean scores for individual frequency levels within the VST were 71.35% for the 2000 frequency level (SD = 10.81), 65.05% for the 3000 frequency level (SD = 14.95), and 48.96% for the 5000 frequency level (SD = 12.78). The decreasing mean scores with increasing frequency levels indicate that students were more familiar with lower frequency (more common) words and less so with higher frequency (less common) words, a trend that is expected in vocabulary acquisition.

In contrast, the PVLT, which evaluates the learners' productive vocabulary size, showed lower mean scores. The total mean percentage score on the PVLT was significantly lower at 24.61%, with a standard deviation of 12.04. This wide variation suggests a more significant disparity in the ability of participants to use the vocabulary actively. For individual frequency levels, the mean scores were 42.24% for the 2000 frequency level (SD = 16.67), markedly decreasing to 17.37% for the 3000 level (SD = 14.78) and further to 14.21% for the 5000 level (SD = 9.79). These results illustrate a distinct drop in the ability to produce fewer common words as the frequency level increases, highlighting a significant challenge in moving from recognition to production in vocabulary knowledge.

The disparity between the receptive vocabulary size, as indicated by the VST scores and the productive vocabulary size, as shown by the PVLT scores, underscores a critical aspect of language acquisition. It suggests that while Thai high school students may recognize and understand a relatively wide range of English words, their ability to actively use them in productive ways is substantially lower. This gap between receptive and productive vocabulary knowledge highlights the need for targeted instructional strategies to enhance active vocabulary usage among EFL learners, particularly at higher frequency levels where the challenge appears to be greater.

Table 4. Means and standard deviations for scores on the VST and PVLT

	VST (N =111)		PVLT (N = 111)	
Frequency levels	Mean	S.D.	Mean	S.D.
2000	71.35	10.81	42.24	16.67
3000	65.05	14.95	17.37	14.78
5000	48.96	12.78	14.21	9.79
Total (%)	61.14	9.89	24.61	12.04

As shown in Table 5, the results of the correlation of all aspects of affix knowledge and vocabulary size are positively linear, which is consistent with previous studies (Danilović et al., 2013; Hayashi & Murphy, 2011; Mochizuki & Aizawa, 2000; Sukying, 2018; Sumalee & Sukying, 2024). Further, all correlation coefficients are statistically significant at $p < .001$ (two-tailed). In general, the magnitude of correlations between vocabulary knowledge and affix knowledge is between 0.56 and 0.72, a moderate to large association (Cohen, 1988). Specifically, according to Hasson, Ahmad, and Boon (2019), correlations of .01 to .50 are considered weak, .51 to .70 are medium, and .71 or above are strong.

The correlation coefficients between VST and all aspects of affix knowledge are moderate, according to Cohen (1988). The highest association is between overall affix knowledge and combined vocabulary knowledge ($r = 0.72$, $r^2 = 0.52$). This relationship aligns with Sukying's (2018) finding ($r = 0.70$, $r^2 = 0.49$). The prefix knowledge is positively associated with vocabulary size ($r = 0.61$, $r^2 = 0.37$), productive vocabulary ($r = 0.56$, $r^2 = 0.31$), and vocabulary knowledge ($r = 0.62$, $r^2 = 0.39$). Furthermore, a similar linear association exists

between suffix knowledge and vocabulary size and productive vocabulary (r = 0.63, r^2 = 0.40). The relationship between knowledge of suffixes and vocabulary knowledge is also moderate (r = 0.67, r^2 = 0.45). The results also suggest moderate positive linear correlations between affix knowledge and all aspects of vocabulary knowledge. Indeed, affix knowledge has strong positive correlations with knowledge of prefixes (r = 0.87, r^2 = 0.76) and suffixes (r = 0.96, r^2 = 0.92). In summary, all aspects of affix knowledge have a moderate relationship with vocabulary knowledge in Thai EFL high school participants.

Table 5. Correlations between affix knowledge and vocabulary knowledge

	1	2	3	4	5	6
Vocabulary size (1)	**					
Productive vocabulary (2)	.75	**				
Vocabulary knowledge (3)	.92	.95	**			
Prefix (4)	.61	.56	.62	**		
Suffix (5)	.63	.63	.67	.71	**	
Affix (6)	.68	.67	.72	.87	.96	**

Note: ** significant at 0.01

A multiple regression analysis was conducted to assess how well aspects of affix knowledge, specifically knowledge of prefixes and suffixes, could predict receptive and productive vocabulary knowledge. Through a Forced Entry method, these predictors were incorporated into the model. The analysis revealed that affix knowledge accounted for 45% of the variability in receptive vocabulary knowledge and 42% of the variability in productive vocabulary knowledge among Thai high school students. Furthermore, affix knowledge predictors explained 51.5% of the overall variance in the student's vocabulary knowledge. These findings are shown in Table 6. The analysis also indicated that suffix knowledge mainly had a more substantial impact on the students' receptive and productive vocabulary knowledge.

Additionally, suffix knowledge had a notably larger effect on productive vocabulary than receptive vocabulary knowledge. This regression analysis corroborates the correlation results, highlighting that a deeper understanding of affixes is linked to stronger vocabulary knowledge, both in understanding and use. These results align with prior research (Hayashi & Murphy, 2011; Sukying, 2018; 2020; Sumalee & Sukying, 2024) reinforcing the connection between affix knowledge and vocabulary proficiency in both receptive and productive capacities.

Table 6. Predictive roles of affix knowledge in vocabulary knowledge

Affix types	**B**	**SD**	***β***	***t-value***	**R^2**
Predicting VST					**.450*** **
Prefixes	.285	.09	.317	3.13	
Suffixes	.546	.14	.407	4.01	
Predicting PVLT					**.420*** **
Prefixes	.256	.11	.234	2.25	
Suffixes	.752	.17	.460	4.42	
Predicting vocabulary knowledge					**.515*** **
Affixes	.937	.09	.718	10.76	

Notes: For VST, F (2,108) = 44.122, p < .001; for PVLT, F (2,108) = 39.046, p < .001; for vocabulary knowledge F (1,109) = 115.817, p < .001. ***p < .001 (two-tailed)

5. Discussion

5.1 Affix knowledge in EFL Learners of Science and Language Programs

This study exploring affix knowledge among Thai EFL learners, particularly within Science and Language Programs, sheds light on how different educational pathways influence morphological understanding and its subsequent impact on vocabulary acquisition. Drawing on insights from Claravall (2016) and Fromkin and colleagues (2014) regarding the significance of morphological awareness, and integrating findings from Hayashi and Murphy (2011) on the role of morphological knowledge, this research methodically analyzes prefix and suffix knowledge. It highlights notable disparities in morphological competencies between students from varying academic backgrounds. Consistent with Carlisle (2000) and Lieber (2010), who underscore the foundational role of morphemes in language learning, Science Program students were found to have superior proficiency in prefix and suffix knowledge compared to their Language Program peers. Owing to the fact that the discipline of science is inherently complicated and calls for profound and abstract thoughts (Affandy et al., 2014; Angell et al., 2004; McWilliam et al., 2008), this suggests that the analytical rigor of science education may inadvertently foster greater morphological awareness, aligning with McBride-Chang and colleagues (2005) and Nation's (2022) assertions on the crucial role of affix knowledge in vocabulary development.

The research delineates a hierarchy of affix knowledge comprehension, with RAK (Receptive Affix Knowledge) scores topping the charts, followed by MPAK (More-controlled Productive Affix Knowledge) scores, and LPAK (Less-controlled Productive Affix Knowledge) scores trailing with the lowest mean scores. This tiered understanding, resonating with Sasao and Webb's (2017) exploration of morphological complexity, underscores the necessity for pedagogical strategies tailored to the distinct challenges learners face at different levels of affix comprehension. The study advocates for an inclusive approach to affix instruction that accommodates the spectrum of difficulty inherent in affix rules. Therefore, affixes should be taught in the order of acquisition. These findings align with Sukying's (2022) study, which identified five stages of affix acquisition: starting with inflections, followed by derivational affixes, prefixes, verbs, nouns,

adjectives, and adverbs.

The use of pseudonyms like the RAK (Sukying, 2018) aims to reduce cognitive load by avoiding the introduction of new semantic concepts for each question (Mitchell & Brady, 2014). However, the superior performance of Science Program students in affix knowledge tasks might reflect their consistent engagement with analytical and structured learning exercises, potentially enhancing cognitive strategies for managing language processing's inherent cognitive load. This efficiency in cognitive handling might underpin their adeptness at affix knowledge acquisition, thereby bolstering vocabulary growth. Conversely, Language Program students, who primarily focus on linguistic subjects, may develop the same cognitive strategies due to their lack of exposure to similar content. This could result in a higher extraneous cognitive load when grappling with affix details, leading to lower affix knowledge proficiency (Nation, 2022, Schmitt & Meara, 1997; Sukying, 2022; Sumalee & Sukying, 2024).

Drawing upon Tyler and Nagy's (1989) and Nation's (2022) conceptualization of multidimensional word knowledge, the study interprets the observed affix understanding gradient—where proficiency dips from RAK to MPAK and LPAK—through the prism of vocabulary knowledge's multifaceted nature. The complexity introduced by each affix knowledge category likely escalates the cognitive load tied to morphological processing, challenging learners to integrate these new elements into their linguistic repertoire.

The capacity of learners to tackle the cognitive demands posed by various affix types is pivotal for fostering comprehensive word knowledge. As posited by Singleton (2016), RAK, being the most accessible form of affix knowledge, exerts minimal cognitive load, thereby easing its integration into learners' vocabularies. In contrast, MPAK and LPAK, encapsulating more intricate rules and exceptions, necessitate deeper cognitive engagement, thereby consuming a more significant portion of their finite working memory capacity.

By integrating cognitive load theory with insights into multidimensional word knowledge, this study highlights the need for instructional designs that balance the cognitive demands of language tasks with the complex nature of vocabulary knowledge. Effective language instruction should gradually build on learners' existing knowledge and cognitive strategies through strategic scaffolding. Morphological interventions have positively impacted various aspects of vocabulary knowledge in academic words, as shown by Yuan and Tang (2023). Additionally, using storybooks in instruction has been proven to enhance multidimensional word knowledge, including the breadth and depth of vocabulary knowledge, as indicated by Dickinson et al. (2019). Such pedagogical strategies not only facilitate the mastery of complex affix knowledge but also foster comprehensive development of multidimensional word knowledge, leading to improved vocabulary comprehension and usage.

In sum, the disparities in affix knowledge proficiency among Thai EFL learners unveil the interplay between the cognitive load induced by diverse affix knowledge types and word knowledge's multidimensional facets. This nuanced understanding champions instructional methodologies that are attuned to learners' cognitive limits and the intricacies of language acquisition, advocating for systematic affix knowledge cultivation within an expansive vocabulary learning framework.

5.2 Relationship between Vocabulary Knowledge and Affix Knowledge in EFL Learners

The current study examined the relationship between affix knowledge and vocabulary knowledge among Thai high school EFL learners, illuminating a significant correlation that reinforces and elaborates on previous findings in linguistic research. Through a comprehensive analysis encompassing receptive (VST) and productive (PVLT) vocabulary tests, the study clearly depicts the learners' proficiency across varying frequency levels, revealing a stark disparity between their ability to recognize and actively use vocabulary. The correlation and regression analyses further quantify the influence of affix knowledge on vocabulary acquisition, offering insights into the cognitive underpinnings of language learning.

The moderate to strong correlations between affix knowledge (including both prefixes and suffixes) and all aspects of vocabulary knowledge underscore the foundational role of morphological awareness in language acquisition. Specifically, the present findings, which reveal that affix knowledge accounts for 45% of the variability in receptive vocabulary knowledge and 42% in productive vocabulary knowledge, highlight the significant predictive power of affix knowledge on vocabulary proficiency. This not only corroborates but also significantly builds upon previous studies (Danilović et al., 2013; Hayashi & Murphy, 2011; Mochizuki & Aizawa, 2000; Sukying, 2018; Sumalee & Sukying, 2024), suggesting that a deep understanding of morphological structures is crucial for both understanding and producing language.

Interestingly, the analysis also points to the particularly substantial impact of suffix knowledge over prefix knowledge on both receptive and productive vocabulary skills, with an even more pronounced effect on the latter. This distinction suggests that the ability to manipulate suffixes feasibly due to their frequent role in indicating grammatical functions, such as tense, aspect, mood, and voice, may offer learners a strategic advantage in actively constructing and understanding complex language uses. Such findings enrich the understanding of multidimensional word knowledge by emphasizing the differential impact of specific morphological components on language proficiency.

6. Conclusion

The study meticulously explored the proficiency in English affix knowledge among Thai high school learners within Science and Language Programs, alongside examining the intricate relationship between English affix knowledge and vocabulary knowledge. The findings provide nuanced answers to the research questions, offering significant insights into morphological understanding and its impact on vocabulary acquisition among this learner cohort.

Regarding the extent of English affix knowledge among Thai high school learners, the study reveals that students from both Science and Language Programs possess varying degrees of morphological awareness, with noticeable differences between the two groups. Science Program learners demonstrated a higher proficiency in understanding and using English affixes, as evidenced by their performance across different categories of affix knowledge, including the RAK, the MPAK, and the LPAK. This suggests that the analytical and structured learning environment of the Science Program may inadvertently contribute to enhanced morphological awareness, thereby facilitating a better grasp of English affixes compared to their peers in the Language Program.

The study unequivocally establishes a positive and statistically significant relationship between English affix knowledge and vocabulary knowledge among Thai high school learners. The correlation and regression analyses indicate that a substantial portion of the variance in both receptive and productive vocabulary knowledge can be explained by learners' proficiency in English affixes. Specifically, suffix knowledge emerges as a particularly potent predictor of vocabulary proficiency, exerting a more substantial impact on vocabulary knowledge than prefix knowledge. This underscores the critical role of morphological awareness, especially an understanding of suffixes, in facilitating the recognition and active use of a wide range of vocabulary among EFL learners.

In conclusion, the study provides compelling evidence that Thai high school learners of Science and Language Programs exhibit a significant level of English affix knowledge, with Science Program students showing a relatively higher proficiency. Moreover, the research confirms a strong relationship between English affix knowledge and vocabulary knowledge, highlighting the importance of morphological awareness in language acquisition. These findings suggest that enhancing affix knowledge, mainly through focused instructional strategies, could significantly bolster vocabulary development among Thai high school EFL learners. Therefore, integrating explicit morphological instruction into the EFL curriculum represents a promising avenue for improving language proficiency, offering learners a solid foundation for understanding and actively using English in diverse contexts.

7. Implications of the Study

The study on English affix knowledge among Thai high school learners and its correlation with vocabulary knowledge presents valuable insights with significant implications for pedagogy and linguistic theory. These findings illuminate the critical role of morphological awareness in language acquisition, emphasizing the need for targeted instructional strategies and offering a new perspective on cognitive processes involved in learning a second language.

The revelation that students in Science Programs exhibit a higher proficiency in affix knowledge suggests an interdisciplinary approach to language learning could be beneficial. This indicates that integrating structured and analytical learning experiences, commonly found in science education, into language programs may enhance learners' morphological awareness and, by extension, their vocabulary knowledge. Consequently, curriculum designers are encouraged to develop EFL curricula that include focused morphological instruction, explicitly addressing the function and usage of affixes. Such an approach would not only aid in the direct teaching of vocabulary but also empower students to decode and construct new words independently, significantly enriching their language learning experience.

Furthermore, the study advocates for creating instructional materials that cater to the varying levels of affix understanding—from the more straightforward receptive affix knowledge to the complex affix knowledge. These materials should be designed to progressively challenge students, thus accommodating and stimulating learners at different proficiency levels. Additionally, implementing regular assessments can provide educators and learners with essential feedback on morphological skills development, allowing for the timely adjustment of instructional strategies to address identified gaps.

From a theoretical standpoint, this study reinforces the significance of morphological awareness in the broader framework of language acquisition theories. It suggests that a deeper exploration into the cognitive processes underpinning morphological analysis could yield valuable insights into how language learners acquire, store, and retrieve linguistic information. Moreover, the findings support that cognitive strategies developed through structured learning in disciplines outside of language studies can positively impact language learning. This points towards the potential of interdisciplinary learning theories that explore synergies between cognitive development in various academic domains and language acquisition.

The relationship between affix knowledge and vocabulary acquisition highlighted by this research underscores the necessity for second language acquisition (SLA) models to incorporate morphological awareness as a pivotal component. Such inclusion could provide a more nuanced understanding of the multifaceted nature of language learning, accounting for the interplay between cognitive load management and linguistic proficiency. This alignment with cognitive load theory emphasizes the importance of designing language teaching strategies that effectively manage learners' cognitive resources, facilitating more efficient and successful language acquisition.

In conclusion, the current findings on the pivotal role of affix knowledge in vocabulary development among Thai high school EFL learners offer a compelling case for integrating explicit morphological instruction into language education. By leveraging these insights, educators can enhance instructional strategies, and theorists can deepen the understanding of language acquisition processes. The study contributes to the pedagogical field by providing actionable strategies for language instruction. It enriches theoretical discussions on the cognitive underpinnings of learning a second language, marking a significant step forward in improving language education.

8. Limitations and Suggestions for Future Studies

While providing substantial insights, the research on the relationship between English affix knowledge and vocabulary knowledge among Thai high school learners is subject to certain limitations that highlight areas for further investigation. The study's focus on Thai high school

students enrolled in Science and Language Programs limits its generalizability. The unique cultural and educational milieu of Thailand may impart specific influences on affix and vocabulary acquisition that might not directly translate to learners in varied global contexts or different educational settings. This specificity suggests a need for caution when applying the study's findings beyond the immediate sample and context.

Moreover, the scope of affix knowledge explored in this research was concentrated on prefixes and suffixes, without an extensive examination of other morphological structures, such as infixes or a detailed exploration of the complex role's affixes play in advanced word formation. This narrowed focus restricts the study's ability to capture the full breadth of morphological knowledge that could potentially impact vocabulary development. Additionally, while yielding significant correlations between affix knowledge and vocabulary proficiency, this quantitative approach may not fully encapsulate the qualitative dimensions of language learning. Learners' personal strategies, cognitive processes, and attitudes towards learning English morphology remain primarily unexplored yet are crucial for a comprehensive understanding of language acquisition dynamics.

Furthermore, the absence of an examination into the effectiveness of specific instructional strategies or interventions on affix knowledge and vocabulary learning represents a missed opportunity. Understanding the pedagogical implications of various teaching methods could provide valuable guidance for EFL educators seeking to enhance morphological instruction in their classrooms.

Given these limitations, future studies should broaden their scope by including a more diverse sample of learners from different linguistic backgrounds and educational systems. Such expansion would enable a more comprehensive understanding of how affix knowledge influences vocabulary acquisition across various learner populations. Delving deeper into the complexities of morphological structures beyond prefixes and suffixes could uncover additional layers of influence on language proficiency. Incorporating qualitative research methods could also shed light on the subjective experiences of learners, offering richer insights into the cognitive and affective facets of learning English morphology. Finally, experimental studies focused on pedagogical interventions would be invaluable in identifying effective strategies for teaching affixes, directly informing instructional practices, and potentially enhancing vocabulary development among EFL learners.

By addressing these areas, future research can build upon the current findings, offering more nuanced insights into the role of morphological knowledge in language learning and providing empirical evidence to support innovative teaching approaches in the EFL context.

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Authors' contributions

Dr. Apisak Sukying was responsible for the study design and data analysis. Pasara Namsaeng, Aummaraporn Nooyod, and Rangsawoot Matwangsaeng primarily managed the literature review and data collection. Dr. Apisak Sukying provided ongoing guidance and consultation throughout the research process. All authors collaboratively analyzed the data, interpreted, and discussed the findings. Apisak Sukying and Pasara Namsaeng drafted the manuscript, and Dr. Apisak Sukying revised it. Pasara Namsaeng, Aummaraporn Nooyod, and Rangsawoot Matwangsaeng checked and updated the citations and references. All authors read and approved the final manuscript, and each contributed equally to the study.

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