Research Article

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Analytic relations versus syntagmatic and paradigmatic relations of vocabulary depth knowledge: Their correlation and prediction to academic reading comprehension of EFL learners

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Abstract: The aims of the study were to examine the correlation and prediction of different dimensions of vocabulary depth knowledge to academic reading comprehension. Students were instructed to take part in four English-language proficiency tests voluntarily. The research was carried out, administering four instruments, word associates test, morphological knowledge test, and analytic relations test to measure the depth of vocabulary knowledge. In addition, a reading comprehension test that consisted of three reading passages by Longman Test of English as a Foreign Language was adopted and administered for the current study. The results highlighted that the analytic (part—whole) relations, which represented the depth of vocabulary knowledge had the highest correlation with academic reading comprehension in comparison with morphological knowledge and combined syntagmatic and paradigmatic relations, which represented word associates test. Of all the three independent variables, analytical relations made the most statistically significant unique contribution to the prediction of the outcome variable compared to word associates test and morphological knowledge. The present study suggests that the depth of vocabulary knowledge would have practical use for students and English teachers at tertiary level and further implications for lexical researchers.

Keywords: paradigmatic relation, syntagmatic relation, analytic relations, academic reading comprehension

1 Introduction

Vocabulary aspect of language learning and teaching has received significant attention among vocabulary researchers, and the dimension of vocabulary in terms of language teaching and learning has been substantially researched in second language (L2) assessment, acquisition, and instruction (Schmitt 2010; Zhang and Yang 2016). Vocabulary knowledge plays a significant role in L2 learning and teaching, and this has been well-documented (Nation 1983; Schmitt 2008; Zhang et al. 2017; Choi and Zhang 2018). In addition, there exists a close association between vocabulary and reading comprehension (Qian 1999, 2002; Nation 2001) or "the ability to read well" (Read 2000: 74), and a well-developed meaning of vocabulary is a prerequisite for fluent reading (Joshi 2005).

Moreover, L2/foreign language (FL) vocabulary researchers (e.g., Richards 1976; Read 1989, 1993, 1998, 2000; Nation 1990, 2001; Wesche and Paribakhat 1996; Chapelle 1998; Qian 1998, 1999, 2002; Henriksen 1999; Haastrup and Henriksen 2000; Bogaards and Laufer 2004; Milton 2009; Zhang 2012; Li and Kirby 2015; Zhang and

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Koda 2017) have proposed that vocabulary knowledge has various aspects. Vocabulary depth knowledge includes different constituents, such as meaning, spelling, register, pronunciation, frequency, and morphological and syntactic attributes (Qian 1998, 1999).

Additionally, vocabulary knowledge comprises minimally two features, namely, the breadth of vocabulary knowledge and the depth of vocabulary knowledge. The breadth of vocabulary knowledge refers to the number of words a learner knows; on the other hand, the depth of vocabulary knowledge signifies how well or deeply a word is known (Qian and Schedl 2004; Qian 2005). Moreover, most of the vocabulary researchers (i.e. Na and Nation 1985; Laufer 1992, 1996; Milton 2013; Jeon and Yamashita 2014) have focused mainly on the crucial role played by vocabulary breadth in reading comprehension. Few empirical studies (de Bot et al. 1997; Qian 1998, 1999) have investigated different components of the depth of vocabulary knowledge, namely, word associates, morphological knowledge, and analytic relations as indispensable parts of the depth of vocabulary knowledge and their correlation and prediction to reading comprehension (Hasan and Shabdin 2017).

2 Literature review

2.1 Theory-relating vocabulary comprehension

Researchers and language teachers are perplexed by the way of determining the exact nature of vocabulary knowledge (Schmitt 2014); furthermore, the nature of vocabulary knowledge is not clearly identified and defined (Li and Kirby 2015). Moreover, many overlapping ways show their existence, and the depth of vocabulary knowledge can be conceptualized in those ways (Schmitt 2014). Consequently, the difference in conceptualizing vocabulary depth knowledge makes it unfathomable to comprehend the ways to approach depth "from a theoretical perspective" (Schmitt 2014: 915). In addition, the lack of definition manifests that the definition is "clearly theory-driven" (Li and Kirby 2015: 614). Thus, this research deliberates on the prevalent, important, and relevant hypothesis (instrumental) and approach (dimension) regarding vocabulary and reading comprehension for the current study, and more of the hypothesis and approach are discussed in Section 5.

2.2 Knowledge gap

It has been mentioned earlier that other facets of vocabulary depth knowledge encompass pronunciation, spelling, meaning, frequency, register, morphological, and syntactical attributes. However, vocabulary researchers have predominantly emphasized on three primary relationships that prevail between target words and associations, and the associations are paradigmatic (synonyms and superordinates), syntagmatic (collocations), and analytic relations (items of vocabulary, i.e., words that correspond to an indispensable part of the meaning of the target word) (Read 2004). Examples of syntagmatic relation are *abstract – concept*, edit - film, team - sport, and occur - phenomenon; and examples of paradigmatic relation encompass adjust - modify, edit - revise, assent - agreement, abstract - summary, and edit - revise. Moreover, examples of analytic relations are edit – publishing, team – together, electron – tiny, and export – overseas (as cited in Choi 2013: 426-427).

Qian (2002) claims that both the depth and the breadth aspects of vocabulary knowledge merit equal attention while examining the important role vocabulary knowledge plays in reading comprehension. Consequently, measures that have the capability of evaluating vocabulary depth knowledge efficaciously are crucially pursued. The rationale behind this is that so far L2/FL research have presented "a clear imbalance" (p. 699) concerning its multidimensionality, especially with respect to vocabulary depth knowledge (Zhang and Yang 2016).

Furthermore, concerning the relationship between vocabulary depth knowledge and reading comprehension, considerable number of vocabulary knowledge researchers (i.e. Rashidi and Khosravi 2010; Chen 2011; Farvardin and Koosha 2011; Mehrpour et al. 2011; Atai and Nikuinezhad 2012; Moinzadeh and Moslehpour 2012; Choi 2013; Kameli et al. 2013; Rouhi and Negari 2013; Kezhen 2015; Li and Kirby 2015) has focused only on syntagmatic relations and paradigmatic relations as aspects of vocabulary depth knowledge and their correlations and prediction to reading comprehension. Most significantly, little is known about empirical investigation that includes the four components, such as analytic relations, syntagmatic and paradigmatic relations, and morphological knowledge all together as essential dimensions of vocabulary depth knowledge and their correlations and prediction to reading comprehension. According to Ma and Lin (2015), consequently, taking a study into consideration along the refereed research gap requires to be examined.

As far as morphological knowledge and its research gap in literature are concerned, some of the studies (Tyler and Nagy 1990; Deacon and Kirby 2004) that comprise the relationship regarding morphological knowledge and reading comprehension are longitudinal in nature. The focus of the most psycholinguistic research was on investigating morphological learning and processing under laboratory conditions (Schmitt and Zimmerman 2002). Besides, the participants (i.e., English-speaking students) of the mentioned studies encompass learners from second to fifth grade (Deacon and Kirby 2004), learners from sixth grade (Kieffer and Lesaux 2012), and students from fourth to fifth grade (Kieffer and Lesaux 2008). The abovementioned studies did not deal with morphological knowledge dimension and its correlation and prediction to reading comprehension and also did not include participants from tertiary level. As a result, morphological knowledge aspect as an integral dimension of vocabulary depth knowledge is included for investigation in the present study. Furthermore, employing quantitative approach, little is known about empirical research, which dealt with the correlations and prediction of manifold aspects of analytic relations as inseparable constituents of the depth of vocabulary knowledge to reading comprehension in any context of English as a foreign language (EFL). Analytic relations is also known as an important type of sematic relation (Winston et al., 1987). Schmitt and Meara (1997) claim the importance of word association in the field of language learning. Thus, analytic relations have been reckoned as one of the important aspects of the depth of vocabulary knowledge in the present study. Hasan and Shabdin (2016) provided rationales for assessing various components of depth of vocabulary knowledge (i.e., paradigmatic relation represented by synonyms, syntagmatic relation represented by collocations, analytic relations represented by part-whole relationship, and morphological knowledge represented by the four major derivative word forms) as essential parts of vocabulary depth knowledge regarding examination of "their correlation and prediction to academic reading comprehension" (Hasan and Shabdin 2016: 235).

Considerable number of empirical studies have been conducted by lexical researchers who mostly have focused on the issues and association among the breadth and depth of vocabulary knowledge and reading comprehension. Of the mentioned studies, many researchers (Akbarian 2010; Rashidi and Khosravi 2010; Farvardin and Koosha 2011; Mehrpour et al. 2011; Moinzadeh and Moslehpour 2012; Choi 2013; Kameli et al. 2013; Rouhi and Negari 2013; Kezhen 2015) found that vocabulary breadth and depth knowledge and reading comprehension had positive and significant associations with each other. The results of the study of Atai and Nikuinezhad (2012) showed that both vocabulary scores and syntactic knowledge (grammar) were positively correlated with reading comprehension scores. The study of Choi (2013) revealed that the strength of correlation between the depth of vocabulary knowledge and reading comprehension was greater than the strength of correlation between the breadth of vocabulary knowledge and reading comprehension.

Of the abovementioned studies, several studies showcased the association between the breadth of vocabulary knowledge and vocabulary depth knowledge. One of the findings of the study by Akbarian (2010) was that positively, vocabulary level test (i.e., breadth of vocabulary knowledge test) and word associates test had high, significant, and positive correlation with each other for both high- and low-proficient groups. The study of Li and Kirby (2015) revealed that vocabulary breadth knowledge and vocabulary depth knowledge were moderately associated with each other. In addition, other studies (i.e., Farvardin and

Koosha 2011; Mehrpour et al. 2011; Wang 2014) confirmed that both vocabulary breadth knowledge and vocabulary depth knowledge were positively correlated with each other.

The related studies that have been conducted on vocabulary in the context of Bangladesh have mainly focused on the challenges that EFL teachers face while they teach vocabulary; and the students learn vocabulary in EFL classrooms (Jahan and Jahan 2011; Siddigua 2016), vocabulary learning strategies (Ashraf 2015; Bristi 2016), and the prevalent vocabulary teaching practice (Hasan 2014), which are the responsible reasons for making vocabulary-related tasks ineffective (Arju 2011). In the context of Bangladesh, vocabulary-related other studies have encompassed different dimensions, such as English writing skill of the students (Afrin 2016) and the effect of preschool dialogic reading on vocabulary (Opel et al. 2009). However, the above-mentioned studies have not focused on vocabulary depth knowledge and its different parts, particularly their correlations to academic reading comprehension skill of the students at the tertiary level in Bangladesh. Thus, filling the research gap, the current study attempted to investigate the different dimensions of vocabulary depth knowledge and their correlations and prediction to academic reading comprehension among Bangladeshi EFL learners.

In view of the abovementioned discussion, the present study has attempted to examine the degree to which different parts of vocabulary depth knowledge are better predictors of academic reading comprehension. It also seeks to determine the degree to which dissimilar aspects of vocabulary depth knowledge, such as paradigmatic relation (synonyms, antonyms, and hyponyms), syntagmatic relation (collocation), analytic relations (meronymy), and morphological knowledge (derivative word classes) as essential dimensions of the depth of vocabulary knowledge have more effect on EFL learners' academic reading comprehension. To this end, employing two independent variables, morphological knowledge and analytical relations with paradigmatic and syntagmatic relations, which represented word associates test, the present study has examined three dimensions of the depth of vocabulary knowledge of Bangladeshi EFL learners and their correlation and prediction to academic reading comprehension.

2.3 Prevalent research studies on different dimensions of vocabulary depth knowledge

Current views or existing thinking in the field of vocabulary knowledge imply that vocabulary knowledge is multidimensional (Nation 1990, 2001; Qian 1998, 1999; Schmitt 2014; Zhang and Koda 2017). In addition, previous studies show that morphological structure of words encompasses multidimensional competence (Zhang and Koda 2013). The results of Schmitt and Zimmerman (2002) study suggested that for learners, it was comparatively not common to know either of all four forms of words or none of the four word classes of a particular given prompt word. In addition, their study (i.e., Schmitt and Zimmerman 2002) examined the capability of producing proper derivatives in the four major word classes among non-native English-speaking graduate and undergraduate students. However, their study did not investigate the correlations of the major derivative word classes (i.e., noun, verb, adjective, and adverb) to academic reading comprehension.

Greidanus and Nienhuis (2001) conducted a study on three types of associations, namely, syntagmatic, paradigmatic, and analytic relations, and they found that for both higher proficiency learners and lower proficiency learners, the scores for paradigmatic association and analytic association were significantly higher than those for syntagmatic association. Their study included 54 learners of French from two Dutchspeaking universities, without considering learners from English as a second language (ESL)/EFL context; on the contrary, the present study has considered analytic relations as a part of vocabulary depth knowledge from an EFL perspective. Concerning the study of Horiba (2012), it can be mentioned that her study investigated a depth of test for types of associations (i.e. paradigmatic, syntagmatic, and analytic relations); however, her study has not included morphological knowledge and different dimensions of analytic relations as essential parts of vocabulary depth knowledge. In addition, her study has not encompassed all four combined aspects (i.e. syntagmatic, paradigmatic, morphological, and analytical relations) of vocabulary depth knowledge and their correlations and prediction to academic reading comprehension.

Kieffer and Lesaux (2008) propound that EFL learners face difficulties in comprehending reading passage, so it becomes important to investigate reading comprehension difficulties among EFL learners since morphological knowledge has close relationship with word reading (Zhang 2017; Zhang et al. 2016). The underlying reason for choosing knowledge of derivational suffixes for the current study is that derivational suffixes express more depth of vocabulary knowledge, and the acquisition of FL derivations affects positively reading comprehension of the students (Schmitt and Zimmerman 2002). Li and Kibry (2015) assert that an investigation of only one constituent of depth of vocabulary knowledge cannot represent all constituents of vocabulary depth knowledge. Thus, the present study attempted to evaluate the multidimensional nature of vocabulary depth knowledge, which fails to get evaluated by FL/L2 lexical researchers so far.

In order to address the research gap on the basis of earlier research work in the above literature review, the following research questions were formulated:

- 1. To what extent do scores of the three aspects of vocabulary depth knowledge (i.e., syntagmatic and paradigmatic relations, which represented word associates test; the four major derivative forms of morphological knowledge test, namely, noun, verb, adjective, and adverb; and six dimensions of analytic relations test) correlate with each other?
- 2. To what extent are the three aspects of vocabulary depth knowledge (i.e., syntagmatic and paradigmatic relations, which represented word associates test; the four major derivative forms of morphological knowledge test, namely, noun, verb, adjective, and adverb; and six dimensions of analytic relations test) related to academic reading comprehension?
- 3. Which one of the three aspects of vocabulary depth does predict the most in comparison with the other two aspects of vocabulary depth knowledge? In addition, to what degree do the scores of the three aspects of vocabulary depth knowledge affect EFL learners' academic reading comprehension performance?

3 Methods

3.1 Participants

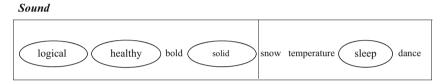
The participants in the study were a sample of 155 Bangladeshi EFL students (five classes/sections) in the first year of their graduation from a top-ranked private university in Dhaka, Bangladesh. The native language of the learners of the study was Bengali (from one language background), and the students of the study used EFL. The participants of the study had at least 12 years of learning English, i.e., all the students who participated in the study had an average of 12 years' exposure to English learning. Out of the participated students, 84 were male (54.2%) and 71 were female (45.8%) who were majoring in different subjects, like economics, finance and accounting under business school (three sections), and in electrical and electronic engineering and computer science and engineering under engineering school (two sections). The average age of the male and female participants was 20 years and half.

3.2 Measures

The participants also completed three vocabulary instruments, namely, a word associates test, a morphological knowledge test, and an analytical relations test and a reading comprehension task that consisted of three multiple-choice passages.

3.3 Word associates test

The word associates test measure which was administered in the current study was partly the version of word associates test (Read 2004). In other words, version 4 of the word associates test and the depth of vocabulary test used by Qian and Schedl's (2004) study were adapted and employed in order to assess the depth of vocabulary knowledge of the current study. The word associates test was considered as a reliable test to assess several paradigmatic and syntagmatic characteristics of vocabulary knowledge (Qian 2000). The word associates test comprised 40 items, and it proposed to evaluate two constituents of vocabulary depth knowledge; they were paradigmatic (meaning/synonyms) and syntagmatic (collocation) relations of words. Under each item, there were two groups, and each group contained words. Each different column had four words; and of the eight words, four words were associates to the stimulus words, whereas the other four words worked as distractors. An incorrect selection of the answer was given 0; as a result, the maximum achievable score of the word associates test was 4 × 40 = 160. For word associates test, selecting the target words was based on the criterion that the target word asked and the associates would possess two fundamental relations, and one of them bore synonymous relationship, and the other one had collocational relationship in a sentence. A sample of the test item is given in the following.



3.4 Analytic relations test

The analytic relations test for the current study was adapted on the basis of the idea about part-whole relations propagated by Winston et al. (1987), and the aim of the test was to measure the part-whole relations of words. The analytic relations test consisted of 30 blanks, and the testees were required to write/fill either part or whole meaning of the words in the blanks. In scoring analytic relations test, one point was given for each appropriate answer, so the highest score for the test was 30. The selection criterion of the target words for analytic relations test was that the target word and the associates measured the part-whole relations of the words. A sample of the test item is provided below.

The head is a part of the ___ _____. Answer: body

3.5 Morphological knowledge test

Morphological knowledge test of the present study was executed by checking the learners' productive knowledge of the derivative forms of a word family, particularly the word classes of noun, verb, adjective, and adverb. The students were asked to jot down the correct derivative forms of the target word in each of the provided blanks. If the learners believed that no derivative form existed, they simply placed an X in the blank. As the main focus was on derivational, the researchers of the present study disregarded any attached inflections. For the current study, the structure of the morphological test was adopted on the basis of the test deigned by Schmitt and Zimmerman (2002). In scoring for the morphological knowledge test, one point was awarded to the learners for their correct answers. An incorrect answer provided 0 point. The morphological test had 30 blanks, so the maximum possible score for the test was 30. The selection criterion of the target words for morphological knowledge was to check the learners' productive knowledge of the derivative forms of a word family, namely, noun, verb, adjective, and adverb. An example of the test item is given in the following (Figure 1).

Assume		
Noun:	He made anassumption	that she likes
meat.		
Verb:	He can assume	that she likes meat.
Adjective:	He had anassumed/assumable	idea that she
likes meat.		
Adverb:	He decided X	that she likes
meat.		

Figure 1: An example of the test items of morphological knowledge.

3.6 Reading comprehension test

Reading comprehension test of the study was a standard multiple-choice academic reading comprehension test, and this test was adopted from Longman Test of English as a Foreign Language (Philips 2006: 343–5). Of the several passages, three texts were selected for the current study, and the total number of multiple-choice questions was 20. The maximum possible score for the reading comprehension test was 20 as there was a total of 20 questions.

3.7 Research design and data collection procedures

The present study followed regression analysis of correlation design (Creswell 2014) under quantitative research. In other words, the quantitative approach was selected, and regression analysis was used to describe the potential predictions of the independent variables to dependent variable. Before administering the four instruments, namely, word associates test, morphological knowledge test, analytic relations, and academic reading comprehension test, a printed "letter of informed consent" and a "background questionnaire" were provided to the students. In the letter of informed consent, there was an option (tick $\sqrt{\text{or} \times}$) where the students were asked whether they would participate or not. The participation of the students for the tests measure was voluntary.

One reading comprehension test and an analytic relations test were administered in one session, and syntagmatic and paradigmatic relations, which represented word associates test and morphological knowledge test, were administered in another session, i.e., the four tests were conducted in two successive sessions to the students in their regular English classes. The time assigned for word associates test was 40 and 30 min for morphological knowledge test. In another class, reading comprehension and analytic relations tests were conducted. The students were provided 25 min to answer the reading comprehension test and another 30 min to perform the analytic relations test.

In order to find out the level of intercorrelations among word associates test, analytic relations, morphological knowledge, and reading comprehension, the two-tailed Pearson Correlation was used for analyzing the data. To determine the predictors of reading comprehension, multiple regression analysis was carried out. In other words, multiple regression analysis (stepwise) was applied to find out the important role played by the depth of vocabulary knowledge in explaining academic reading comprehension. Generally, researchers are guided to employ stepwise multiple regression when they find after initial checking that the data set does not possess normal distribution. In order to address the data set that were not normally distributed and to have successful multiple regression analysis, stepwise multiple regression analysis was conducted for the present study. SPSS version 24 (Statistical Package for Social Studies) was exercised as the key statistical program for analyzing the data.

4 Results

For investigating the first two research questions, the quantitative data, i.e., scores of four language tests, namely, word associates test, morphological knowledge, analytic relations, and academic reading comprehension were employed. A two-tailed Pearson correlation analysis was run to examine the associations between the three dimensions of vocabulary depth knowledge and academic reading comprehension. The Pearson correlation values of all the variables are given in Table 1.

The first research question relates: "to what extent do scores of three aspects of vocabulary depth (i.e., syntagmatic and paradigmatic relations represented word associates test; the four major derivative forms of morphological knowledge test, namely, noun, verb, adjective, and adverb; and six dimensions of analytic relations test) correlate with each other?" To answer the first question, as Table 1 showcases, the intercorrelations among the scores of the three language tests were both positive and statistically significant at the level of 0.01. The relationship between morphological knowledge and combined syntagmatic and paradigmatic relations, which represented word associates test score (r = 0.414) was higher than the correlation between word associates test and analytic relations (r = 0.299). The correlation between morphological knowledge and analytic relations (r = 0.435) was the highest.

The second research question alludes: "to what extent are three aspects of vocabulary depth knowledge (i.e. syntagmatic and paradigmatic relations which represented word associates test; the four major derivative forms of morphological knowledge test, namely, noun, verb, adjective, and adverb; and six dimensions of analytic relations test) related to academic reading comprehension?" From Table 1, it can be observed that intercorrelations between the scores of the three language tests and academic reading comprehension were statistically significant at the level of 0.01. Analytic (part-whole) relations part of the depth of vocabulary knowledge had the highest correlation with academic reading comprehension (r = 0.509; p < 0.01) in comparison with morphological knowledge (r = 0.385; p < 0.01) and combined syntagmatic and paradigmatic relations, which represented word associates test score (r = 0.351; p < 0.01). According to Cohen (1988), the value r, multiple correlation coefficient, close to 0.50 shows strong correlation between the variables. The fact that analytic relations had a higher correlation with academic reading comprehension is not surprising, since Winston et al. (1987) mentioned that analytic relations was an essential part of the depth of vocabulary knowledge.

In order to investigate the last research question, the quantitative data, i.e., the scores of four language tests, namely, word associates, morphological knowledge, analytic relations, and academic reading comprehension, were used. In order to address the third research question and to examine which one of the three dimensions of depth of vocabulary knowledge had the strongest prediction to academic reading comprehension, the researchers conducted multiple regression analysis (stepwise). To this end, the scores of word associates test, morphological knowledge, and analytic relations were taken as predictor (independent) variables and the scores of academic reading comprehension as the criterion or dependent variable.

Table 1: Correlations among the Scores of word associates test, morphological knowledge, analytic relations, and reading comprehension (N = 155)

Test	RC	WAT	МК	AR
RC	_	0.351**	0.385**	0.509**
WAT	0.351**	_	0.414**	0.299**
MK	0.385**	0.414**	_	0.435**
AR	0.509**	0.299**	0.435**	_

^{**}Correlation is significant at the 0.01 level (two tailed).

WAT = word associates test; MK = morphological knowledge test; AR = analytic relations test; RC = reading comprehension test.

From Table 2, it can be observed that one of the independent variables, analytic relations, was selected to be entered first in the regression process as a part of run regression. The R^2 implies the proportion of the total variance in the dependent variable (in this case, the range of academic reading comprehension) accounted for by the independent variables (analytic relations and syntagmatic and paradigmatic relations which represented parts of the depth of vocabulary knowledge). In addition, the adjusted R is an estimation of the population size value. On the other hand, R^2 change indicates the difference between a R^2 value of the foregoing independent variable and a R^2 value of the independent variable being entered. In other words, it showcases the extent of the prediction of a variable at the point where it is joined into regression equation.

The first section of Table 2 (labeled A) shows that the analytic relations of vocabulary depth knowledge was entered first into the equation and then combined paradigmatic and syntagmatic parts, which represented word associates test followed by analytic relations. It can be noticed that at this step, both R^2 value and the adjusted R^2 value were 0.259 and 0.254, respectively. This means that the analytical relations part of depth of vocabulary knowledge accounted for 25.4% ($R^2 = 0.254$) of the variance in the dependent variable, academic reading success. Evidently, the analytical part of depth of vocabulary knowledge as an independent variable explained a significant amount of success in academic reading comprehension.

When the combined part of syntagmatic relation and paradigmatic relation, which represented word associates test variable, was added into regression analysis at the second step, the value of R^2 and the value of adjusted R^2 changed to 0.303 and 0.293, respectively. Jointly, analytic relations and word associates test accounted for 30.3% ($R^2 = 30.3$) of the total variance in academic reading success. Moreover, the introduction of paradigmatic and syntagmatic relations represented word associates test did not contribute significantly in addition to analytic relations (R^2 change = 0.043). The introduction of word associates test at the second step contributed only an extra 4.3% of the variability of academic reading success.

In order to examine further the contribution made by combined paradigmatic and syntagmatic relations part of word associates test, the researchers administered another regression analysis. The second division of Table 2 (labeled B) exhibits the results when the combined paradigmatic and syntagmatic relations parts, represented word associates test, was entered in the regression equation first, and later the analytic relations of vocabulary depth knowledge followed the combined paradigmatic and syntagmatic relations parts, which represented word associates test. At that stage of regression equation, the value of R^2 was 0.123, and this signifies that the combined paradigmatic and syntagmatic relations parts, which represented word associates test alone, explained 12.3% of the variance in academic reading comprehension. In the following step, when the analytic relations part of depth of vocabulary knowledge was incorporated into the regression equation, the value of R^2 mounted up to 0.303 (R^2 change = 0.180). This means that analytic relations part of the depth of vocabulary knowledge explained an additional 18% of the variability of academic reading success.

The second part of research question 3 relates: "to what degree do the scores of three aspects of vocabulary depth knowledge affect EFL learners' academic reading comprehension performance?" The β values of run regression model answers the second part of research question 3, and the β values of all the variables are given in Table 3.

Table 2: Multiple regression analysis of depth of vocabulary knowledge and academic reading comprehension

Step	Independent variable(s) involved	R ²	Adjusted R ²	R ² change
(A)				
1	AR	0.259**	0.254**	0.043
2	AR, WAT	0.303**	0.293**	
(B)				
1	WAT	0.123**	0.117**	0.180
2	ARs	0.303**	0.293**	

^{**}Correlation is significant at the 0.01 level; AR = analytic relations; WAT = word associates test.

Table 3: Beta and coefficients of all variables

	Standardized coefficients	t	Sig	Correlations		Collinearity statistics	
	β			Partial	Part	Tolerance	VIF
WAT	0.218	2.983	0.003	0.242	0.208	0.911	1.098
AR	0.444	6.068	0.000	0.453	0.424	0.911	1.098
MK	0.141	1.724	0.087	0.143	_	0.722	1.385

WAT = word associates test; AR = analytic relations; MK = morphological knowledge.

As shown in Table 3, β values under standardized coefficients show that the β value of analytic relations was the largest (β = 0.444; p < 0.000). In terms of β value discussion, it is known that a large t-value paired with small significance value suggests how much the predictor value (independent value) has impact on the criterion or dependent value.

The largest β values of predictor variable help to infer that analytical relations (β = 0.444; t = 6.068, p = 0.000 (significant) (p < 0.001)) made the largest effect on explaining the outcome variable, reading comprehension, when the variance was explained jointly by all the other variables. The β value of other independent variable, namely, word associates test informs that combined paradigmatic and syntagmatic relations (β = 0.218, t = 2.983, p = 0.003 (significant at the 0.05 level) (p < 0.05)) part of depth of vocabulary knowledge made less effect on the outcome variable, reading comprehension, than analytic relations part of the depth of vocabulary knowledge.

Of all the three independent variables, analytical relations made statistically and significantly the largest contribution to the prediction (at the 0.000 level) of the outcome in the model as the "sig" or p value of analytic relations was less than 0.001 (p < 0.000); and of two other variables, word associates test also made statistically significant unique contribution to the prediction (at the 0.01 level) since the "sig" or p value of word associates test was less than 0.01 (p < 0.01).

The other independent variable, namely, morphological knowledge did not make any statistically significant effect on the prediction (at the 0.05 level) of the outcome as the "sig" or p value was more than 0.05 (t = 1.724; p = 0.087). From the above result discussed, it can be said that only two independent variables made statistically significant effect on the prediction of the outcome.

As shown in Table 3, the column "part" which is also known as semi-partial correlation coefficient in the literature can be looked into. When each of the values of the part correlation is squared, it provides an indication of the contribution of that/each individual variable to the total R^2 . In other words, it tells how much of the total variance in the outcome is uniquely explained by that variable. Squaring the value $(0.424)^2$ means that analytical relations uniquely explained about 18% (17.997) of the variance in the total reading comprehension score. On the other hand, squaring the part coefficient value $(0.208)^2$ indicates that word associates test uniquely explained about 4.5% (4.3264) of the variance in the total reading comprehension score.

In addition, squaring the partial value of $(0.242)^2$ means that word associates test had 5.8564% shared variance with two other independent variables in academic reading comprehension. On the other hand, squaring the partial value of analytic relations, i.e., $(0.453)^2$, informs that analytic relations had 20.5209% shared variance with two other independent variables in academic reading comprehension.

5 Discussion

From the intercorrelations between the three predictor variables and academic reading comprehension (as shown in Table 1), it is observed that those students who had more of analytic relations (meronymy) and morphological knowledge (the major four derivative forms of words) performed better in academic reading comprehension than combined syntagmatic and paradigmatic relations aspects of vocabulary depth knowledge. In the present study, morphological knowledge was found to have significant correlation with reading

comprehension than paradigmatic and syntagmatic relations, which represented word associates test. The findings of the present study failed to corroborate the findings of Qian (1998, 1999, 2002). In his studies, it was found that the syntagmatic and paradigmatic relations part of the depth of vocabulary knowledge test (i.e., word associates test) had stronger correlation with reading comprehension than other aspects of vocabulary depth knowledge and reading comprehension. This suggests that a combination of analytic relations and morphological knowledge correlates better with academic reading performance.

The possible reasons resulting in the differences between this study and other studies are given in the following. Qian (1998) probably would find strong correlations between morphological knowledge and academic reading comprehension if he increased the sample size (the sample size of his study was 74) of his study. In addition, in terms of designing the test items of morphological knowledge, morphological knowledge aspect of the current study is different from the study of Qian (1998). Morphological knowledge test of the current study encompassed words that were required to change different parts of speech (e.g., noun, verb, adjective, and adverb) by the learners. On the other hand, the morphological test in Qian's (1998) study included words which comprised affixes that were to be identified to discern whether there was any change or not in parts of speech.

Both aspects of the depth of vocabulary knowledge, measured by paradigmatic relation and syntagmatic relation, and analytical relations jointly and significantly contributed to the dependent variable, academic reading comprehension. The result of the present study corroborated other previous findings of L2 learners of English (e.g., Qian 1998, 1999, 2002; Li and Kirby 2015; Zhang and Yang 2016) even though the cited studies did not include morphological knowledge and analytical relations under the depth of vocabulary knowledge test. On the other hand, analytical relations of the depth of vocabulary knowledge contributed the most to explain the variance in academic reading comprehension than other parts of depth of vocabulary knowledge represented by both syntagmatic and paradigmatic relations and morphological knowledge. Morphological knowledge was the least contributor to explaining the outcome. The least contribution by morphological knowledge substantiated the previous studies (e.g., Qian 1998, 1999, 2002). On the other hand, Zhang (2017) found that derivational awareness, i.e., morphological awareness directly and significantly predicted to reading comprehension of ESL learners. The probable reason for the difference can be because of the different context and participants.

Moreover, further analysis showcased that when analytic relations part of vocabulary depth knowledge alone explained about 26% (25.9) of the variance in academic reading success, combined syntagmatic and paradigmatic relations, which represented word associates test accounted for merely 12.3% of the variance. Combined syntagmatic and paradigmatic relations, which represented word associates test and analytic relations of vocabulary depth knowledge jointly accounted for 30.3% of the variance in academic reading comprehension. Evidently, the results demonstrated the significant role that two dimensions of depth of vocabulary knowledge played in academic reading comprehension success. The findings of the current study also suggest that analytic relations of vocabulary depth is the strongest predictor of academic success through reading.

In the present study, analytic relations also made the most statistically significant unique contribution to the prediction. As analytical relations is considered an important aspect (e.g., Winston et al. 1987) of vocabulary depth knowledge, the significant part played by analytical relations is not surprising. This is the new finding of the current research, and this aspect of inclusion of analytical relations under vocabulary depth knowledge and its contribution to academic reading comprehension in the present study is a contribution to lexical knowledge domain. Greidanus and Nienhuis (2001) conducted a study on three types of associations among paradigmatic, syntagmatic, and analytic (defining characteristics, such as those used in dictionary definitions) relations, and they found that for both higher proficiency learners and lower proficiency learners, the scores for both paradigmatic association and analytic association were significantly higher than those for syntagmatic association. Also, their study investigated only association among paradigmatic, syntagmatic, and analytic relations, considering neither correlation nor prediction between paradigmatic, syntagmatic, and analytic relations and academic reading comprehension. In a similar vein, it can be said that Horiba (2012) investigated a depth test for types of association (i.e., paradigmatic, syntagmatic, and analytic). Her study conducted an investigation on association and prediction among paradigmatic, syntagmatic, and analytic relations, and no

correlation or prediction between paradigmatic, syntagmatic, and analytic relations; and academic reading comprehension in an EFL context was explored. The study of Horiba (2012) found no unique and significant effect of depth of vocabulary knowledge on reading comprehension. The findings of her study support the findings of the current research work.

The results of the study showed that for EFL learners, different dimensions of depth of vocabulary knowledge played a significant role in performing in academic reading comprehension, and evidence in support of the "dimension" approach is affirmed since a "dimensional" approach contends that the depth of vocabulary knowledge encompasses different aspects of word knowledge. On the contrary, the results of the current study substantiate "instrumental" hypothesis, which indicates knowledge of a word's meaning directly affects the reading comprehension of a learner. This statement is supported by the obtained significant and positive correlations between academic reading comprehension and three dimensions of vocabulary depth knowledge, and students' knowledge of three dimensions of vocabulary depth knowledge directly affected their performance in academic reading comprehension.

6 Conclusion and pedagogical implications

The current study presents empirical evidence to corroborate the important associations between different dimensions of depth of vocabulary knowledge and academic reading comprehension. The present research aimed to investigate the extent of word associates, morphological knowledge, analytic relations relate to academic reading comprehension, and their strength of correlations that existed among word associates test, morphological knowledge, and analytic relations, and which one of the three aspects of depth of vocabulary knowledge was the strongest predictor of academic reading comprehension of EFL learners. This study could be of considerable help to provide insights to the teachers of English to identify the lack of vocabulary knowledge of the students in English as a significant problem.

In terms of implications, since the current study corroborated the significance of three components of vocabulary depth knowledge and their correlations with reading comprehension, the findings of the current research work will have meaningful implications for future researchers to work on FL reading comprehension and vocabulary knowledge, curriculum/syllabus designers, and instructional practices for EFL classrooms. Concerning the strengths of the study, since the four tests conducted underwent pilot study and indicated accepted level of reliability, the administered instruments can be replicated in other EFL context as well. In addition, the current study contributed to reduce the research gap, investigating varied aspects of vocabulary depth knowledge and their correction with academic reading comprehension. The current study would enable teachers of English to teach vocabulary knowledge of L2/EFL students effectively; as a result, students would be able to improve their reading comprehension of academic texts.

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