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## **The correlation and prediction of depth of vocabulary knowledge to academic reading comprehension of EFL tertiary learners**

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**Abstract:** An in-depth investigation of vocabulary depth knowledge by lexical researchers plays a prominent role in language learning and teaching. The objectives of the present study were to investigate the extent of relationship and prediction of the three constituents of vocabulary depth knowledge (i.e., analytic relations, morphological knowledge, and depth of vocabulary knowledge test which was represented by paradigmatic and syntagmatic relations) to reading comprehension. Therefore, this study employed standard multiple regression analysis under quantitative approach amongst undergraduate EFL learners. The results of the study show that a significant and strong correlation existed between adapted analytic relations aspect of vocabulary depth knowledge and reading comprehension, and also analytic relations made statistically the most significant unique prediction (which had the largest impact on) to reading comprehension. The study concludes that there are significant correlations and prediction of three components of vocabulary depth knowledge to reading comprehension. The inclusion of analytic relations with paradigmatic and syntagmatic relations and morphological knowledge, which represented vocabulary depth knowledge, has added to the body of lexical knowledge.

**Keywords:** vocabulary depth; correlation; contribution; analytic relations; academic reading comprehension.

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## 1 Introduction

Vocabulary dimension of language teaching and learning has gained much prominence, and it has been extensively researched in second language (L2) acquisition, assessment, and instruction (Schmitt, 2010; Zhang and Yang, 2016). The significant role of vocabulary knowledge in L2 has been well documented (Choi and Zhang, 2018; Nation, 1983; Schmitt, 2008; Zhang et al., 2017). A number of studies (Cain et al., 2004; Hadley et al., 2016; Quinn et al., 2015; Vellutino et al., 2007) have demonstrated that a significant association exists between vocabulary knowledge and reading comprehension. Christ (2011) and Schoonen and Verhallen (2008) consider vocabulary knowledge as a complex construct which can not be grasped merely regarding breadth of vocabulary knowledge. In other words, the size or breadth of vocabulary refers to the number of words a learner knows, i.e., the learner needs to possess minimal knowledge of the meaning of the words whereas vocabulary depth knowledge denotes how well or deeply a word is known (Qian and Schedl, 2004; Qian, 2005). Furthermore, researchers have reasoned that adequate vocabulary is pivotal to fluent reading (Allington, 2000; Joshi, 2005; Juel, 1995; Snow et al., 1998), and knowledge of vocabulary facilitates the ensuing in-depth reading comprehension (Choi and Zhang, 2018).

Moreover, L2 vocabulary language researchers (e.g., Bogaards and Laufer, 2004; Chapelle, 1998; Henriksen, 1999; Haastrup and Henriksen, 2000; Li and Kirby, 2015; Milton, 2009; Nation, 1990, 2001; Qian, 1998, 1999, 2002; Read, 1989, 1993, 1998, 2000; Richards, 1976; Wesche and Paribakht, 1996; Zhang, 2012; Zhang and Koda, 2017) reckon that vocabulary knowledge has manifold dimensions. The facet of vocabulary depth knowledge can include different elements, such as, spelling, pronunciation, meaning, frequency, register, and syntactic, morphological traits (Qian, 1998, 1999).

However, vocabulary researchers have mainly focused on the significant role played by vocabulary breadth or size in reading comprehension (i.e., Hadley et al., 2016; Jeon and Yamashita, 2014; Laufer, 1992, 1996; Milton, 2013; Na and Nation, 1985). Qian (2002) and Schmitt (2014) propagate that in the area of L2/foreign language (FL) research, lexical researchers have not given due recognition for the significant role vocabulary depth knowledge plays till recently, and Qian (2002) further contends that few empirical studies report the association between reading comprehension and vocabulary depth knowledge (de Bot et al., 1997; Qian, 1998, 1999). Most likely, the reason behind this is that compared with vocabulary breadth, vocabulary depth knowledge is tougher to test, i.e., ‘complexity of the assessment of depth’ [Choi, (2013), p.420; Schmitt, 2014; Schmitt and McCarthy, 1997]. Qian (2002) argues that both breadth and depth dimensions deserve equal attention for investigating the significant role vocabulary knowledge plays in reading comprehension; as a result, measures which have capability of evaluating vocabulary depth knowledge efficiently get imperatively sought after since L2/FL vocabulary knowledge investigation has demonstrated ‘a clear imbalance’ [Zhang and Yang, (2016), p.699] regarding its multi-dimensionality, particularly in terms of depth of vocabulary knowledge.

In a recently published paper, Hasan and Shabdin (2016) provide rationale for encompassing different dimensions of depth of vocabulary knowledge, namely paradigmatic relations (synonyms, hyponymy, antonymy), syntagmatic relations (collocation), analytic relations (meronymy) and morphological knowledge (affixes) as integral parts of depth of vocabulary knowledge and their correlation and prediction to academic reading comprehension.

To the best knowledge of the authors, there is a considerable lack of empirical researches which deal with correlation and prediction of the said different dimensions as indispensable parts of vocabulary depth knowledge to reading comprehension in English as a second/foreign (ESL/EFL) context. Keeping the discussion mentioned above into consideration, the present study has attempted to examine how different parts of vocabulary depth knowledge are related to academic reading comprehension. In addition, it also seeks to determine the degree to which dissimilar aspects of vocabulary depth knowledge contribute to predicting the performance of EFL learners’ academic reading comprehension. Furthermore, it explores to determine the aspect of vocabulary depth knowledge, which is the most contributing predictor of EFL learners’ academic reading comprehension, and investigates to find out the level that different dimensions of vocabulary depth knowledge affect EFL learners’ academic reading comprehension.

## 2 Review of literature

### 2.1 Paradigmatic, syntagmatic and analytic relations

Read (2004) distinguished that three vital relations prevailed between target words and associates, and they were paradigmatic (synonyms, superordinates), syntagmatic (collocations), and analytic (vocabulary items which represented an essential component regarding the meaning of the target word) relations. Examples of paradigmatic relation comprise *adjust-modify*, *edit-revise*, *assent-agreement*, *abstract-summary*, *edit-revise*; syntagmatic relation encompasses examples, like *abstract-concept*, *edit-film*, *team-sport*, *occur-phenomenon*. On the other hand, examples of analytic relations incorporate *edit-publishing*, *team-together*, *electron-tiny*, and *export-overseas* [as cited in Choi, (2013), pp.426–427].

### 2.2 Research gap

Concerning the relationship between vocabulary depth knowledge and reading comprehension, a considerable vocabulary knowledge researches (i.e., Atai and Nikuinezad, 2012; Chen, 2011; Choi, 2013; Farvardin and Koosha, 2011; Kameli et al., 2013; Kezhen, 2015; Li and Kirby, 2015; Mehrpour et al., 2011; Moinzadeh and Moslehpour, 2012; Rashidi and Khosravi, 2010; Rouhi and Negari, 2013) have 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. Consequently, considering a study along the mentioned research gap requires to be examined (Ma and Lin, 2015).

As far as morphological knowledge and its research gap in literature are concerned, some of the studies (Deacon and Kirby, 2004; Tyler and Nagy, 1990) that encompass the association concerning 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). Moreover, the participants (i.e., English speaking students) of those studies include learners from second to fifth grade (Deacon and Kirby, 2004), students from sixth grade (Kieffer and Lesaux, 2012), learners from fourth to fifth grade (Kieffer and Lesaux, 2008). None of the above mentioned studies that dealt morphological knowledge aspect and its correlation to reading comprehension includes participants from the tertiary level. As a result, morphological knowledge aspect as an integral part of vocabulary depth knowledge is included for investigation in the present study. Furthermore, employing quantitative approach, little is known about empirical researches, which dealt with the correlations and prediction of different dimensions of analytic relations as indispensable parts of vocabulary depth knowledge to reading comprehension in any EFL context. Thus, analytic relations has been considered as one of the significant facets of vocabulary depth knowledge in the present study.

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; Siddiqua, 2016), vocabulary learning strategies (Ashraf, 2015; Bristi, 2016), and the prevalent vocabulary teaching practice (Hasan, 2014), 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), 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 and prediction 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.

### *2.3 Vocabulary depth knowledge and reading comprehension*

In connection with L2 research, Qian (1998, 1999) and Paribakht and Wesche (1997) pointed out that few empirical studies had been conducted on the association concerning knowledge of vocabulary depth and reading skill. de Bot et al. (1997) found out that varying aspects of knowledge of vocabulary, such as morphological aspect and word associations had close relationship with reading comprehension processes. Qian (1999) revealed that knowledge of vocabulary depth provided a distinctive contribution to the prediction of the reading proficiency of the learners. His study pointed out that vocabulary depth of the learners explained about 11% of the additional variance in reading comprehension.

Furthermore, other lexical researchers acknowledged the special role of knowledge of vocabulary depth in reading skill. For example, the research conducted by Nation and Snowling (2004) focused on the predictive role of knowledge of vocabulary depth which was evaluated by an exercise of meaning aspect for the improvement of academic reading success. The results from L2 vocabulary research gave evidence that a distinct relationship existed concerning knowledge of vocabulary depth and academic reading proficiency. The findings also affirmed that vocabulary depth worked as an important contributor to success in reading achievement in L2.

A study conducted by Mehrpour et al. (2011) examined the same issue in a different context, i.e., an EFL context. Their findings showed that depth proved to have greater influence over the academic reading proficiency of the students from a university in Iran than breadth of vocabulary knowledge. In Korean EFL context, Kang et al. (2012) found that in comparison with breadth of vocabulary knowledge, vocabulary depth worked as more significant predictor of reading comprehension of the students of Korean high school. The study of de Bot et al. (1997) found that some parts of knowledge of vocabulary; for example, associations of word, word morphology and other vocabulary depth measures had close relationship with reading comprehension process.

### *2.4 Morphological knowledge and analytical relations*

Particularly, the measures that investigated different parts of vocabulary depth knowledge in English made greater and more powerful influence over reading comprehension in

comparison with the measures which solely tested only one terming of an utterance (Nassaji, 2004). According to Vermeer (2001), there was not much investigation conducted by the lexical researchers on the association among different dimensions of vocabulary knowledge. Special importance is needed for learning of morphological properties of vocabulary knowledge by the learners (Weixia, 2014). Even though other aspects of morphological properties, such as spelling, pronunciation, parts of speech and register were not negligible parts of depth of vocabulary knowledge (Weixia, 2014), the present study has taken one aspect of morphological knowledge (derivative forms of words) as an essential part of depth of vocabulary knowledge. Morphological knowledge is an important aspect of vocabulary depth as Li and Kirby (2015) argued that the knowledge of root and affixes could help learners to comprehend the formation of words which in turn could develop the learners' understanding of the relationships among words. Analytic relations, particularly part-whole is known as important type of semantic relation (Winston et al., 1987). Schmitt and Meara (1997) also claimed the importance of word association knowledge in the field of language learning; consequently, analytic (part-whole) relations can be considered as one of the significant facets of vocabulary depth knowledge.

### **3 Prevalent researches on different dimensions of vocabulary depth knowledge**

It has been mentioned earlier that current views or existing thinking in the field of vocabulary knowledge imply that vocabulary knowledge is multi-dimensional, and it encompasses knowledge of word's meaning, spelling, register traits, collocations, and morphological and grammatical attributes (Nation, 1990, 2001; Qian, 1998, 1999; Schmitt, 2014; Zhang and Koda, 2017). In addition, previous studies show that morphological structure of words encompasses multi-dimensional competence (Zhang and Koda, 2013). The results of the Schmitt and Zimmerman (2002) 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 and prediction of the major derivative word classes (i.e., noun, verb, adjective, and adverb) to academic reading comprehension.

Kieffer and Lesaux (2008) suggest that difficulties in comprehending reading passage exist among EFL learners, so it becomes significant to examine reading comprehension difficulties among EFL learners since morphological knowledge has close relationship with word reading (Zhang, 2016; Zhang et al., 2016). The underlying reason for choosing knowledge of derivational suffixes for the current study is that derivational suffixes represent more vocabulary depth knowledge, and the acquisition of FL derivations has beneficial effect on reading comprehension (Schmitt and Zimmerman, 2002). Moreover, Li and Kirby (2015) assert that only a single vocabulary depth measures can not encapsulate the complete gamut of the construct. Thus, there is a necessity to examine a complete set of measures which embody all the constituents of vocabulary depth knowledge. Thus, the present study attempted to evaluate the multi-dimensional nature of

vocabulary depth knowledge, which fails to get evaluated by FL/L2 lexical researchers so far.

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 both paradigmatic association and analytic association were significantly higher than those for syntagmatic association. Their study included 54 learners of French from two Dutch-speaking universities without considering learners from 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.

### *3.1 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 depth of vocabulary knowledge can be conceptualised in those ways (Schmitt, 2014). Consequently, the difference in conceptualising vocabulary depth knowledge makes it unfathomable to comprehend the ways to approach depth 'from a theoretical perspective' [Schmitt, (2014), p.915]. In addition, lack of definition manifests that the definition is 'clearly theory-driven' [Li and Kirby, (2015), p.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 approaches are discussed in results and discussion section.

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

- 1 How are syntagmatic and paradigmatic relations, which represent vocabulary depth knowledge test, morphological knowledge, and analytic relations of vocabulary depth knowledge related to academic reading comprehension?
- 2 To what extent do syntagmatic and paradigmatic relations, which represent vocabulary depth knowledge test, morphological knowledge, and analytic relations of vocabulary depth knowledge contribute to predicting the performance of EFL learners' academic reading comprehension?
- 3 Which constituent of vocabulary depth knowledge, i.e., syntagmatic and paradigmatic relations, morphological knowledge, and analytic relations, is the most contributing predictor of academic reading comprehension?
- 4 To what level do syntagmatic and paradigmatic relations, which represent vocabulary depth knowledge test, morphological knowledge, and analytic relations

of vocabulary depth knowledge affect EFL learners' academic reading comprehension?

## **4 Methodology**

Generally, researchers do not include (merge) the sample of a pilot study into their main study for analysing data, result and discussion, and the inclusion of the sample of the pilot study shows the flaws of the researchers' previous work. In order to rectify the mentioned flaw of the previous work, the current study excluded the sample of the pilot study and analysed the data, presented the results and discussion of the main study.

### *4.1 Participants*

The participants in the study were a sample of 155 Bangladeshi EFL students (four sections) in the first year of their graduation from a 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 English as a FL. 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 (two 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 20.38.

### *4.2 Measures*

In addition to completing a 'letter of consent form' where the students were asked to provide their willingness to participate in the present study, the students also filled up their background questionnaire. Moreover, the participants also completed three vocabulary instruments, namely a vocabulary depth knowledge test, a morphological knowledge test, an analytical relations test and a reading comprehension test that consisted of three reading passages followed by multiple choice questions.

### *4.3 Vocabulary depth knowledge test*

Vocabulary depth knowledge measure which was administered for current study was partly the version of Word Associates Test (WAT). In other words, partly, a version of the Word Associates Test and vocabulary depth knowledge test used by Qian and Schedl (2004) were adapted and employed in the current study. WAT was considered as a reliable test to assess several paradigmatic and syntagmatic characteristics of vocabulary knowledge (Qian, 2000). Vocabulary depth knowledge 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 out 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 vocabulary depth knowledge test was  $4 \times 40 = 160$ .

#### *4.4 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 to the part-whole relations of words. Part-whole relations is one of the significant aspects of vocabulary depth knowledge. 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, one point was given for each appropriate answer, so the highest score for the test was 30.

#### *4.5 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 form of the target word in each blank. If the learners believed that no derivative form did exist, they simply placed an X in the blank. As the main focus was on derivational, the researcher disregarded any attached inflections. For the current study, the structure of the morphological knowledge test was adopted on the basis of the test designed by Schmitt and Zimmerman (2002). In scoring morphological knowledge test, one point was awarded to the learners for their correct answers. An incorrect answer provided 0 point. The morphological knowledge test had 30 blanks, so the maximum possible score for the test was 30.

#### *4.6 Reading comprehension test*

Reading comprehension test of the study was a standard multiple-choice academic reading comprehension test, and this reading comprehension test was adopted from Longman Test of English as a Foreign Language (TOEFL) [Phillips, (2006), pp.343–345]. Out of 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.

#### *4.7 Research design and data collection procedures*

The present study followed multiple regression analysis of the correlation design under quantitative research. In other words, the quantitative approach was selected, and the correlation design was used to describe the potential associations and predictions among the variables. One reading comprehension test and an analytic relations test were administered in one session, and depth of vocabulary knowledge test and morphological knowledge test were administered in another session with one week interval in between them, i.e., the four tests were conducted in two successive sessions to the students in regular English classes of the students. The time assigned for depth of vocabulary knowledge was 40 minutes and 30 minutes morphological knowledge test. After one week, reading comprehension and analytic relations tests were conducted.

The students were provided 25 minutes to answer reading comprehension test and another 30 minutes to perform the analytic relations test.

In order to find out the level of intercorrelations among depth of vocabulary knowledge test, analytic relations, morphological knowledge and reading comprehension, the two-tailed Pearson correlation was selected as the key instruments for analysing the data. To determine the more powerful predictor of reading comprehension, standard multiple regression analysis was carried out. In other words, force-entry multiple regression (not stepwise) analysis was applied to find out the significant role played by vocabulary depth knowledge in explaining academic reading comprehension. Statistical Package for Social Studies (SPSS) version 24 was exercised as the key statistical program for analysing the data.

## 5 Piloting

Before commencing the main study, the researcher conducted piloting in order to measure the reliability and validity of the major instruments, namely depth of vocabulary knowledge test, reading comprehension, analytic relations, and morphological knowledge of the current research work and also to make an attempt to figure out related pragmatic issues, which included the suitability of the materials for testing and total time which was prerequisite to accomplish the assessments.

### 5.1 Instruments and their validity

Alderson et al. (1995) propound that generally, in order to evaluate the reliability of a test that comprises wrong or right answers, researchers employ Kuder-Richardson Formula 21 or K-R-21 and they have constructed the same to determine how satisfactorily a test is capable of evaluating the extent that researchers desire to assess. In order to check out the internal consistency of the instruments, the researchers reckoned K-R 21 as a procedure of rational equivalence (Alderson et al., 1995) of the four tests and applied K-R 21 for calculating their reliability coefficients. They performed the computing of K-R 21 and followed the formula, which is  $[n / (n - 1) * [1 - (M * (n - M) / (n * Var))]]$  where  $n$  stands for 'sample size';  $Var$  stands for 'variance for the test', and  $M$  stands for 'mean score for the test'.

## 6 Results

### 6.1 Descriptive statistics and reliability

Table 1 demonstrates the performance of the learners ( $n = 20$ ) on all four language tests and the reliability of the tests ( $n =$  number of items) of the pilot study.

The  $r$  values (reliability coefficients) of the four tests of the pilot study, namely depth of vocabulary knowledge test, morphological knowledge test, analytic relations test, and reading comprehension were moderate even though the  $r$  value (0.516) of morphological knowledge was the lowest in comparison with other  $r$  values of other tests. In spite of that, the score of morphological knowledge can be considered to have accepted level of reliability since the number of items ( $n = 20$ ) was small. Even K-R 21 employs less

information to compute, it always provides a lower reliability index than produced by other methods (Alderson et al., 1995). In general, a score, which is, above 0.50 is considered as reasonable. Salvucci et al. (1997, p.115) propound that concerning the extent of reliability scale, the reliability is reckoned low if the value of  $r$  is to a lesser degree than 0.50; the reliability is considered as moderate if the value of  $r$  is in the middle of 0.50 and 0.80; on the other hand, the reliability is considered as high when the value of  $r$  is more than 0.80. In conclusion, it can be said that all the items incorporated in the four instruments under the current study showed an accepted level of internal consistency while assessing their respective measures. In other words, the  $r$  values of the four tests prove that the tests are both reliable and valid.

**Table 1** Means, standard deviations and reliability coefficients value

	$n^*$	Range	Minimum	Maximum	Mean	Std. deviation	$K-R$ reliability coefficients	MPS**
DVK <sup>1</sup>	40	22.00	137.00	159.00	147.8000	6.67754	0.75	160
MKT <sup>2</sup>	30	14.00	12.00	26.00	19.1500	3.71731	0.516	30
AR <sup>3</sup>	30	14.00	15.00	29.00	22.9000	3.72615	0.631	30
RC <sup>4</sup>	20	10.00	8.00	18.00	12.8500	3.28113	0.63	20

Notes: \*\*MPS = maximum possible score and  $n^*$  = number of items.

DVK<sup>1</sup> = depth of vocabulary knowledge test; MKT<sup>2</sup> = morphological knowledge test; AR<sup>3</sup> = analytic relations test and RC<sup>4</sup> = reading comprehension.

## 6.2 Relationship among three components of vocabulary depth and academic reading comprehension

To answer research question one, i.e., regarding the strength and direction of the correlations of three dimensions of vocabulary depth knowledge and academic reading comprehension, a two-tailed Pearson correlation was conducted, and results are presented in Table 2.

**Table 2** Correlations among three components of vocabulary depth knowledge and academic reading comprehension

	DVK <sup>1</sup>	MKT <sup>2</sup>	AR <sup>3</sup>
MKT	0.414**		
AR	0.299**	0.435**	
RC <sup>4</sup>	0.351**	0.385**	0.509**

Notes: \*\*correlation is significant at the 0.01 level (two-tailed). DVK<sup>1</sup> = depth of vocabulary knowledge test; MKT<sup>2</sup> = morphological knowledge test; AR<sup>3</sup> = analytic relations test and RC<sup>4</sup> = reading comprehension.

As shown in Table 2, inter-correlations among the scores of three independent variables, namely vocabulary depth knowledge test, morphological knowledge test, analytic relations were all at statistically significant. According to Cohen (1988), the value  $r$  close to 0.50 shows strong correlation between the variables. Out of the inter-correlations among the three components of vocabulary depth knowledge, the significant correlation between morphological knowledge and analytic relations of vocabulary depth knowledge

was the highest ( $r = 0.435$ ). On the other hand, as presented in Table 2, scores of inter-correlations between scores of three facets of vocabulary depth knowledge and academic reading comprehension showed positive and statistically significant relationship. The significant and positive, high correlation at the level of 0.01 ( $r = 0.509$ ,  $p = 0.000$ ) between six dimensions of analytic relations, which represented vocabulary depth knowledge and academic reading comprehension was the highest in comparison with associations between other two independent variables and academic reading comprehension. This suggests that the students who had more analytic relations (part-whole) knowledge performed better in academic reading comprehension than students who learnt syntagmatic and paradigmatic relations and the four derivative word forms of vocabulary depth knowledge.

Moreover, the four derivative word forms, which represented morphological knowledge of vocabulary depth knowledge bore positive and statistically significant correlation at the level of 0.01 ( $r = 0.385$ ;  $p = 0.000$ ) with academic reading comprehension. This suggests that the students who had also morphological knowledge performed better in academic reading comprehension too. A statistically significant and positive correlation at the level of 0.01 ( $r = 0.351$ ;  $p = 0.000$ ) was found between both syntagmatic and paradigmatic relations, which represented vocabulary depth knowledge test and academic reading comprehension. To conclude, all three components of vocabulary depth knowledge helped learners perform better in academic reading success.

### 6.3 *Manifold dimensions of vocabulary depth and their prediction to reading comprehension*

Research questions two and three were formulated to determine the most significant, unique predictor of academic reading comprehension and to address the extent of prediction of three aspects of vocabulary depth knowledge on academic reading comprehension, so standard multiple regression analysis (force-entry, not stepwise) was carried out. Results of the regression analysis appear in Tables 3 and 4, which show prediction value, ANOVA and coefficient values under coefficients of all three independent variables (i.e., vocabulary depth knowledge test, morphological knowledge and analytic relations) on academic reading comprehension.

Since the  $f$  statistics in ANOVA table was found to be significant at the 0.001 level ( $R^2 = 0.317$ ),  $F(3, 142) = 21.971$ ,  $p < 0.000$ , the run regression model was found to be well-fitted for the data.

**Table 3** Prediction value of independent variables and ANOVA value of all students ( $N = 155$ )

$R$	$R^2$	Adjusted $R^2$	Std. error of the estimate	ANOVA			
				$df$	Mean square	$F$	$p$
0.563	0.317	0.303	2.760	3	167.369	21.971	0.000

Notes: <sup>D</sup>ependent variable: reading comprehension and predictors: (constant), depth of vocabulary knowledge test, morphological knowledge, and analytic relations.

The value  $R$ , multiple correlation coefficient, i.e., 0.563 shows accepted level prediction for the study. The value of R-square ( $R^2 = 0.317$ ) indicates how much the variance in the dependent variable, academic reading comprehension was explained by other three independent variables, namely depth of vocabulary knowledge test, morphological

knowledge, and analytic relations of the model. From Table 3, it can be said that the present regression model, using three predictor (independent) variables jointly explained about 31.7% of the variance in academic reading comprehension. The  $R^2$  value was 0.317, so it can be stated that 31.7% of the variation for the criterion/dependent variable, that is, academic reading comprehension was accounted for jointly by the independent variables, depth of vocabulary knowledge test, morphological knowledge and analytic relations.

Moreover, the  $R^2$  value reflects that whether a student was going to have low or high score in reading comprehension, about 31.7% of that variance was explained by the three independent variables, namely depth of vocabulary knowledge test, morphological knowledge, and analytic relations. The above result of  $R^2 = 0.317$  can be considered to have reached accepted level (The value  $R^2 = 0.26$  and above is considered as significant prediction result in social sciences) in comparison with the yardstick of getting close to 35% to 40% of the variance explained by three independent variables in terms of cross-sectional study under social sciences. Generally, the value of  $R^2$  is close to 50% variance explained is considered as high and significant for other disciplines as well. In addition, the results of the model reached a very statistical significance (sig. = 0.000,  $p < 0.001$ ).

**Table 4** Correlations values under coefficients of three independent variables of students of business and engineering ( $N = 155$ )

IV <sup>1</sup>	Correlations		Sig.	Collinearity statistics	
	Partial	Part		Tolerance	VIF
DVK <sup>a</sup>	0.187	0.157	0.025	0.811	1.233
MKT <sup>b</sup>	0.143	0.120	0.087	0.722	1.385
AR <sup>c</sup>	0.393	0.353	0.000	0.794	1.260

Notes: dependent variable: reading comprehension; IV<sup>1</sup> = independent variables,

<sup>a</sup>depth of vocabulary knowledge test, <sup>b</sup>morphological knowledge, and

<sup>c</sup>analytic relations.

As shown in Table 4, squaring the part coefficient value (0.157)<sup>2</sup> means that syntagmatic and paradigmatic relations, which represented vocabulary depth knowledge test uniquely (alone) explained 2.46% of the variance in total reading comprehension score. Squaring the part coefficient value (0.120)<sup>2</sup> indicates that morphological knowledge, which was represented by the four major derivative word classes, uniquely explained about 1.44% of the variance in total reading comprehension score. On the other hand, squaring the part coefficient value (0.353)<sup>2</sup> reflects that six dimensions of analytic relations, which represented depth of vocabulary knowledge uniquely explained about 12.46% of the variance in the total reading comprehension score. The above discussion shows that the highest unique prediction (12.46%) was explained in academic reading comprehension by analytic relations followed by depth of vocabulary knowledge test (2.46%), and the least unique prediction (1.44%) came from morphological knowledge.

#### 6.4 Effects of different facets of vocabulary depth knowledge on reading comprehension

The aim of fourth research question was to find out which aspects of vocabulary depth knowledge had more effect on academic reading comprehension than other dimensions of

vocabulary depth knowledge on reading comprehension. Results of the regression analysis which appear in Table 5 show beta prediction value under coefficients of depth of vocabulary knowledge test, morphological knowledge, and analytic relations on academic reading comprehension.

**Table 5** Coefficients of all the three variables

IV <sup>1</sup>	Standardised coefficients		t	Sig.
	$\beta$			
DVK <sup>a</sup>	0.174		2.264	0.025
MKT <sup>b</sup>	0.141		1.724	0.087
AR <sup>c</sup>	0.396		5.085	0.000

Notes: dependent variable: reading comprehension; IV<sup>1</sup> = independent variable,  
<sup>a</sup>depth of vocabulary knowledge test, <sup>b</sup>morphological knowledge, and  
<sup>c</sup>analytic relations.

As presented in Table 5, regarding beta values under standardised coefficients, the beta value of analytic relations of vocabulary depth knowledge was the largest ( $\beta = 0.396$ ). In terms of beta value discussion, it is known that a large t-value paired with small significance value suggests ('t' and 'sig.' value) the predictor value (independent value) has large impact on the criterion or dependent value. Moreover, the largest beta value indicates that analytic relations comprising six dimensions, which represented depth of vocabulary knowledge ( $\beta = 0.396$ ;  $t = 5.085$ ,  $p = 0.000$  (significant) ( $p < 0.001$ ) made the largest effect on explaining the outcome variable, academic reading comprehension when the variance was explained by all other variables jointly.

The beta values of the other independent variables, namely syntagmatic and paradigmatic relations, which represented depth of vocabulary knowledge test and morphological knowledge inform that morphological (derivative words) knowledge ( $\beta = 0.141$ ;  $t = 1.724$ ,  $p = 0.087$ ) (significant at the 0.10 level) ( $p \geq 0.05$ ) made lesser effect on explaining the outcome variable, reading comprehension than syntagmatic and paradigmatic relations, which represented depth of vocabulary knowledge test ( $\beta = 0.174$ ;  $t = 2.264$ ,  $p = 0.025$ ) (significant) ( $p < 0.01$ ), and morphological knowledge had the least effect on explaining the outcome variable, academic reading comprehension.

Out of all three independent variables, analytic relations comprised of six dimensions, which represented depth of vocabulary knowledge made statistically significant way the largest effect on the prediction (at the 0.000 level) of the outcome in the model as the 'sig.' value of analytic relations was less than 0.001 ( $p < 0.001$ ), and out of two other variables, both syntagmatic and paradigmatic relations, which represented depth of vocabulary knowledge test also made statistically significant way larger effect on the prediction (at the 0.01 level) since the 'sig.' value of depth of vocabulary knowledge test was less than 0.01 ( $p < 0.01$ ). The other independent variable, namely the four major derivative word forms, which represented morphological knowledge made statistically significant way the least effect on the prediction (at the 0.05 level) of the outcome too as the 'sig.' value was less than 0.10 ( $p < 0.10$ ). From the discussion of the above result, it is observed that all the three independent variables of the present study have statistically significant effect on the prediction of the outcome.

## 7 Discussion

### 7.1 *Manifold dimensions of vocabulary depth and their correlations with reading comprehension*

As presented in Table 2, the correlation between morphological knowledge and analytic relations had the highest, positive, and significant correlation with each other ( $r = 0.435$ ,  $p < 0.01$ ). This suggests that the two aspects are interconnected, and the development of morphological knowledge of EFL learners contributes to the growth of their analytic relations or vice versa. All three independent variables (i.e., vocabulary depth knowledge test, morphological knowledge, and analytic relations) were found positive and either strongly or moderately correlated with academic reading comprehension. The significant and positive, high correlation between analytic relations and academic reading comprehension was the highest. In other words, the students who gained more analytic relations knowledge performed better in reading comprehension than students with morphological knowledge and syntagmatic and paradigmatic relations knowledge.

Moreover, the students who learned morphological (derivative forms of words) knowledge performed better in reading comprehension than students who had knowledge of both paradigmatic and syntagmatic relations. This result did not corroborate the findings of Qian (1998, 1999, 2002). His studies indicate that those students who learned both paradigmatic and syntagmatic relations knowledge performed better in academic reading comprehension than students with morphological knowledge. In the present study, morphological knowledge was found to have significant correlation with reading comprehension than paradigmatic and syntagmatic relations, which represented vocabulary depth knowledge test. On the contrary, the study of Horiba (2012) found no unique and significant effect of depth of vocabulary depth knowledge on reading comprehension. Her findings supported the findings of the current research work.

Moreover, the morphological knowledge aspect of the present study was different from the study of Qian (1998) in terms of designing the test items. Morphological knowledge test under the present study included words that were required to change different parts of speech (e.g., noun, verb, adjective and adverb) by the learners whereas the morphological test in Qian's (1998) study incorporated words which consisted of affixes to be identified to discern whether any change or not in part of speech took place.

### 7.2 *Prediction of vocabulary depth knowledge test, morphological knowledge and analytic relations to reading comprehension*

Depth of vocabulary knowledge, measured by different dimensions, namely paradigmatic relation, syntagmatic relation, morphological knowledge and analytical relations jointly and significantly contributed about 32.0% (31.7) variation in the dependent variable, academic reading comprehension. The result corroborated other previous findings of L2 learners of English (e.g., Li and Kirby, 2015; Qian, 1998, 1999, 2002; Zhang and Yang, 2016) even though the cited studies did not include morphological knowledge and analytic relations under vocabulary depth knowledge test. On the other hand, analytic relations contributed the most to explain the variance in academic reading comprehension than depth of vocabulary knowledge test, represented by syntagmatic and paradigmatic relations and morphological knowledge. Morphological knowledge was the least contributor to explaining the outcome variable, reading comprehension. The least

contribution by morphological knowledge substantiated the previous findings (e.g., Qian, 1998, 1999, 2002); on the contrary, Zhang (2016) found that derivational awareness, i.e., morphological awareness directly and significantly predicted to reading comprehension of ESL learners.

Furthermore, the investigation by Li and Kirby (2015) showcased that breadth of vocabulary knowledge significantly predicted to reading comprehension measure which consisted of multiple choice questions; on the other hand, depth of vocabulary knowledge contributed more to summary writing which was treated as a measure of deeper text processing even though both breadth and depth of vocabulary knowledge contributed to word reading. Their study highlighted the significant roles of different facets of vocabulary knowledge for different types of L2 reading. Similarly, the findings of the current study demonstrated that different aspects of depth of vocabulary knowledge, particularly analytic relations significantly predicted to an academic reading comprehension measure, which comprised three passages, followed by multiple-choice questions.

In addition, the dynamic relations between the growth of vocabulary knowledge and reading comprehension was explored by Quinn et al. (2015), and they pointed out that the development of both vocabulary knowledge and reading comprehension took place every year, but the rate of the development decreased over time. In other words, their study revealed that the growth in the reading comprehension was dependent partly on vocabulary knowledge. The results of Quinn et al. (2015) shed light on the findings of the current study where correlations and prediction of different dimensions of depth of vocabulary knowledge to academic reading comprehension were found.

### *7.3 Effects of different facets of vocabulary depth knowledge on reading comprehension*

In the present study, analytic relations had the most significant effect on the outcome variable, academic reading comprehension. Since analytic relations is considered an important aspect (e.g., Winston et al., 1987) of vocabulary depth knowledge, the significant role played by analytical relations is not surprising. This is the new finding of the current research, and this aspect of inclusion of analytic relations under vocabulary depth knowledge and its contribution to academic reading comprehension in the present study is a contribution to the lexical knowledge domain.

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 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 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 directed affected their performance in academic reading comprehension.



## **8 Implications**

The current study corroborated the significance of the three components of vocabulary depth knowledge and correlations with academic reading comprehension. The incorporation of different aspects of vocabulary depth knowledge in English curriculum would help the students perform better in their respective English language proficiency examinations. In addition, the investigated three dimensions of vocabulary depth knowledge need to be considered as indispensable part of vocabulary knowledge while teaching vocabulary aspect to EFL classrooms. In other words, 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 conducted four tests underwent pilot study and indicted accepted level 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 correlation with academic reading comprehension.

## **9 Suggestions for future research**

While designing the analytic relations test, the researcher focused on taking tests by asking students to fill in the blanks questions option. However, similar multiple choices options (providing distractors responses as well) like vocabulary depth knowledge test of the present study can be tried out for testing analytic relations. Will the results be different when analytic relations test will be conducted in the said fashion? This needs further future investigation. In addition, the present research study did not include the correlation and prediction of different aspects of vocabulary depth knowledge to other language skills, such as listening, writing and speaking. Furthermore, future research investigations can be carried out to find out whether different dimensions of vocabulary depth knowledge would correlate and predict strongly and significantly to other language skills as well.

Regarding the limitations of the study, since the present study investigated primarily the associations between varied dimensions of vocabulary depth knowledge and academic reading comprehension, any impact of native language (i.e., Bengali) or background knowledge of the participants on the test results was not explored. In addition, purposive sampling (non-random sampling) was employed as one of the research methods, so the obtained results of the current study might not be generalisable to other educational institutions.

In the context of recommendations, participants included in the study were from only one university, so learners from different levels of educational sectors would make this study more comprehensive. Future researchers can attempt to find out whether and how different dimensions of depth of vocabulary knowledge would correlate with other language skills, namely listening, writing, and speaking. Moreover, the potential of direction and strength of correlations of depth of vocabulary knowledge to other language skills would be known to academia.

## 10 Conclusions

From the discussion that has been dealt so far, it can be observed that the correlation between analytic relations and academic reading comprehension was the highest, and analytic relations was the most significant predictor of reading comprehension. To the best knowledge of the researchers, there is lack of researches that have included analytic relations jointly with paradigmatic relation and syntagmatic relations and morphological knowledge, represented depth of vocabulary knowledge, and conducting the present research with comprising analytic relations with other aspects of depth of vocabulary knowledge has added to the body of lexical knowledge.

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