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A CORPUS INFORMED STUDY ON LEARNING TECHNICAL COLLOCATIONS BY ENVIRONMENTAL ENGINEERING STUDENTS

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PUBLICATIONS

Uzun, L., Salihoğlu, U. M. (2009). English-Turkish cognates and false cognates: Compiling a corpus and testing how they are translated by computer programs. *Poznan Studies in Contemporary Linguistics, 45*(4), 569-593.

Salihoğlu, U. M. (2012). Pre-service teachers' and their instructors' beliefs on the effectiveness of an English language teacher education program, *Procedia – Social and Behavioral Sciences, Volume 46*, 3440-3444.

Salihoğlu, U. M. (2012). Pre-service English language teacher education: "The Turkish case". C*ontemporary Online Language Education Journal, 2(1)*, 151-168.

Gürsoy E., Bulunuz N., Baltacı Göktalay Ş., Bulunuz M., Kesner, J.& Salihoğlu, U. M. (2013). Clinical supervision model to improve supervisory skills of cooperating teachers and university supervisors during teaching practice. *Hacettepe University Journal of Education, Special issue* (1), 191-203.

Uzun, L., Çetinavcı, U. R., Korkmaz, S, & Salihoğlu, U. M. (2013). Developing and applying a foreign language vocabulary learning and practice game: The effect of VocaWord. *Digital Culture & Education, 5(*1), 48-70.

Bulunuz, N., Gürsoy E., Kesner, J., Baltacı Göktalay, Ş., & Salihoğlu, U. M. (2014). The Implementation and Evaluation of a Clinical Supervision Model in Teacher Education in Turkey: Is It an Effective Method? *Educational Sciences: Theory & Practice 14* (5), 1823-1833.

Salihoğlu, U. M., Gürkan, S. (2016). Pre-service ELT teachers and the concept of teachers' sense of self-efficacy. *Journal of Academic Social Sciences Studies, 42,* 493-505.

Gürsoy, E., Kesner, J. E., & Salihoglu, U. M. (2016). Clinical Supervision Model in Teaching Practice: Does it Make a Difference in Supervisors' Performance? *Australian Journal of Teacher Education, 41*(11), 61-76.

Bulunuz N., Gürsoy E., Baltacı Göktalay Ş., Bulunuz M., Salihoğlu, U. M. & Çağlar-Özteke, H. (2018). *Clinical supervision model. Good teaching practises*. Ankara, Anı Publications.

CONFERENCES

Salihoğlu, U. M. (2012). *Pre-service teachers' and their instructors' beliefs on the effectiveness of an English language teacher education program*. WCES 2012, 4th World Conference on Educational Sciences, Barcelona, Spain. February, 02-05.

Bulunuz N., Gürsoy E., Bulunuz M., Baltacı Göktalay Ş., Çağlar Özteke H., & Salihoğlu, U.M. (2013). *Clinical Supervision Model: Is it a Solution to Improve Teaching Practice.* ULEAD 2013, Annual Congress: International Congress on Research in Education/ICRE, Ürgüp, Turkey. May, 31- June 2.

Baltacı Göktalay Ş., Uzun A., Salihoğlu, U.M., Gürsoy E., Bulunuz N., & Bulunuz M., (2013). *Redefining a Teacher Education Program: CSM and Uludag KDM.* ICITS 2013, 7th International Computer and Instructional Technologies Symposium, Erzurum, Turkey. June, 6-8.

Salihoğlu, U. M., & Gürkan, S. (2014). *Pre-Service ELT teachers and the Concept of Teachers' Sense of Efficacy.* 8th International ELT Research Conference: Innovative Approaches to Research in ELT, Çanakkale, Turkey, May, 15-17.

Salihoğlu, U. M. (2015). *What are the keywords for pre-service teachers in English language teaching?* 5th International Conference on Research in Education ICRE Edirne, Turkey, October, 8-10.

Salihoğlu, U. M. (2016). *An In-depth Lexical Profiling and Analysis of TEOG English Exam Questions Corpus.* 9th International ELT Research Conference: Interdisciplinary Approaches: Beyond the Borders of ELT Methodology, Çanakkale, Turkey, May, 12-14.

Salihoğlu, U. M. (2016). I*mproving Turkish Prospective ELT Teachers' Content Knowledge: A Little Help from Data Driven Learning.* 4th International Symposium on New Issues in Teacher Education, Savonlinna, Finland, August 30 - September 1.

Alabay, S., & Salihoğlu, U. M. (2017). *"Intégrer les outils de communication internet en classe de FLE".* D'hier à aujourd'hui la francophonie à Bursa. Bursa Turkey, April, 7-8.

Salihoğlu, U. M., & Salihoğlu, M. (2017). *"I need to understand this for a nice activity". English for teachers of Arts.* International Conference on New Horizons in Education, Berlin, Germany, July, 17-19.

Salihoğlu, U. M. (2018). *Zekânın Sıfatları: Derlembilimsel bir İnceleme.* International Congress on Gifted and Talented Education - IGATE 18, Malatya, Turkey, November, 1-3.

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ABSTRACT

A Corpus Informed Study on Learning Technical Collocations by Environmental Engineering Students

The present study attempted to evaluate the effectiveness of explicit and implicit instruction of technical collocations in an introductory level engineering course given in English for second year environmental engineering students. The participants of the study were 61 engineering students at a Turkish state university located in north-west of the country. The participants were randomly assigned to two learning conditions. The pre-test scores on vocabulary and reading comprehension indicated that the groups were similar before the treatment. Prior to the instruction, a corpus of 89 engineering books comprised of 17 million words was compiled and technical keywords and their collocations were extracted to serve learners with field-specific technical collocations. Over a period of 14 weeks, the students in the implicit learning group were exposed to the target collocations by reading and listening to texts, whereas the learners in the explicit group completed eight different input- and output- based collocational learning tasks. The effectiveness of the learning conditions and tasks were assessed through a battery of four receptive and productive "knowledge of form and meaning of collocations" tests developed by the researcher and used as pre- and post-tests. To determine whether there were significant differences between the gain scores of the groups on the receptive and productive collocation tests, independent t-tests and Mann-Whitney U tests were performed. Overall, there were statistically significant differences between the mean scores of the two groups on all four measures at the end of the semester. The results of the study confirmed that the explicit study of field-specific collocations followed by

various input and output-based activities effectively contributed to learning of technical collocations. In this regard, the implementation of an activity-based intentional collocation teaching module would be successful in supporting the language aspects of an engineering class for multi-word learning. The present study concludes with pedagogical implications for engineering courses, limitations and suggestions for further research.

Keywords: Collocations; Explicit & Implicit Instruction; English for Specific Purposes; Corpus Compilation.

KISA ÖZET
Çevre Mühendisliği Öğrencilerinin Teknik Eşdizimleri Öğrenimi Üzerine Derleme Dayalı Bir Çalışma

Bu çalışma Çevre mühendisliği bölümü ikinci sınıf öğrencilerinin İngilizce olarak yapılan bir mühendisliğe giriş dersi kapsamında teknik eşdizimli kelimelerin doğrudan ve örtük yöntemlerle öğretiminin etkililiğini değerlendirmeyi amaçlamıştır. Çalışmanın katılımcılarını Türkiye'nin kuzey-batısında yer alan bir devlet üniversitesinde okuyan 61 mühendislik öğrencisi oluşturmaktadır. Dönem başında yapılan kelime seviyesi ve okuma becerisini ölçen ön-testler grupların benzer özelliklerde olduğunu ortaya koymuştur. Öğretim döneminin başlamasından önce, 89 mühendislik kitabının biraraya getirilmesi sonucu 17 milyon kelimelik bir derlem oluşturulmuş ve öğrencilere alana özgü ezdişimlerin öğretilebilmesi için teknik kelimeler ile eşdizimleri çıkartılmıştır. 14 hafta süren dönem boyunca, örtük öğretim grubunda yer alan öğrenciler hedef eşdizimlere okuma ve dinleme parçaları yoluyla maruz bırakılmış; öte yandan, doğrudan öğretim grubundaki öğrenciler sekiz farklı girdi ve çıktı odaklı eşdizim öğrenim etkinliği tamamlamışlardır. Etkinliklerin ve öğretim yöntemlerinin etkililiği, araştırmacı tarafından geliştirilen eşdizim biçim ve anlam bilgisini algısal-üretsel boyutlarda ölçen dört farklı sınavın ön-test son-test şeklinde uygulanması yoluyla değerlendirilmiştir. Grupların algısal ve üretsel eşdizim sınavlarından elde ettikleri fark puanları arasında belirgin farklılıkların olup olmadığını anlamak amacıyla bağımsız örneklemler için T-testleri ve Mann Whitney U testleri uygulanmıştır. Çalışmanın bulguları, girdi ve çıktı temelli etkinliklerle desteklenen doğrudan öğretim yönteminin alana özgü eşdizimlerin öğrenimine oldukça etkili bir biçimde katkıda bulunduğunu ortaya koymuştur. Bu bağlamda, çalışma sonucunda etkinlik temelli kasıtlı bir eşdizim öğretim bileşeninin

uygulanmasının mühendislik sınıflarında çoklu kelime gruplarının öğrenilmesinin desteklenmesine başarıyla katkıda bulunduğu ortaya konulmuştur. Mevcut çalışma, mühendislik dersleri için bir takım eğitsel öneriler; çalışmanın kısıtlılıkları ve yapılabilecek yeni araştırmalar için bazı önerilerle son bulmaktadır.

Anahtar kelimeler: Eşdizimlilik; Doğrudan ve Örtük Öğretim; Özel Amaçlar için İngilizce, Derlem Oluşturma.

CHAPTER 1: INTRODUCTION

1.1 Background to the Study

The existing conditions and overwhelming necessities in the current world urge one to access sources of information and acquire detailed knowledge. One of the main means of gaining that knowledge is through reading in a native language or in a second language. In the case of a second or foreign language, successful comprehension depends on an adequate degree of proficiency which includes skills such as decoding, grammar knowledge, and a sufficient amount of vocabulary.

Languages are made up of words. By varying the combination of those words, we can communicate our message. Thus, vocabulary lies at the centre of language learning both for comprehension and for proficient use. As Wilkins (1972, p.111) explained "Without grammar very little can be conveyed; without vocabulary nothing can be conveyed." Hence, learners need a rich repertoire of vocabulary knowledge both to comprehend texts and to produce written or spoken language.

It was pointed out in Alderson's (1984) seminal work that issues of reading comprehension in a second language might have emanated from problems of one's proficiency in that second language. It has been strongly emphasized in the literature that successful comprehension in reading necessitates extensive word knowledge, which is an indispensable component of language learning. Some research has argued that reaching a lexical knowledge threshold is a vital prerequisite for successful reading comprehension and has offered different figures and percentages for the lexical threshold levels.

For instance; Laufer (1989) proposed a percentage of 95%, Laufer (1992) presented the need for 3000 word families, Hirsh & Nation (1992) indicated the number of 5000 word families, Nation (2006) noted a 98% level, Laufer and Ravenhorst-Kalovski (2010) offered 95% as minimal and 98% as optimal thresholds, Schmitt (2010) pointed to a percentage of 98-99% and Schmitt, Jiang and Grabe (2011) suggested a percentage of 98-99%. The various numbers and percentages provided above, all illustrate figures required for reading for comprehension individually without the help of teachers or classroom instruction.

In the past few years, the traditional conception of vocabulary has drastically changed in the field of English language teaching (ELT). It has been reported by many experts in the field that the previous line of research usually took the single word unit as a starting point (Nation, 1990; Meara, 1996; Read, 2000, Schmitt, 2010) and some trends in this research offered lists of vocabulary for teachers and learners to explore at their own discretion but failed to provide options for successful instruction. However, a growing body of research in the last decade has been devoted to vocabulary acquisition of language learners with the central focus shifted to the receptive and productive knowledge of multi-word units. This body of research has clearly illustrated that English language learners from various proficiency levels fail to comprehend and produce different multi-word types such as collocations (Bahns & Eldaws, 1993; Fargal & Obediat, 1995; Nesselhauf, 2003).

It was argued that traditional classes in English as a foreign language (EFL) contexts might not equip learners with the necessary knowledge for processing these word units and rules to interpret special language use, especially in specific fields of study (Cohen, Glasman, Rosenbaum- Cohen, Ferrera and Fine, 1979; Salager, 1986). All around the globe, learners of English as a second or foreign language generally

have the essential need for reading field-specific English materials as course requirements. (Cohen et al., 1979; Farrell, 1990). Alongside educational requirements, the escalating need for using English in workplaces compels students to devote close attention to language patterns (Dlaska, 1999; 2002). It has also been claimed that students in technical fields do not appear to be ready or are unequipped to cope with the task of working with and comprehending foreign language texts (Salager, 1986). As a result, students have to enrol in a year of education at language schools as the proficiency in English they brought from high schools notably lags behind the expected tertiary course entry levels.

Similar to cases in various other countries, Nurweni and Read (1999) were quite concerned by the fact that Indonesian tertiary level learners did not have a sufficient knowledge of vocabulary necessary for reading English texts. This failure in possessing a satisfactory level of vocabulary was considered to raise the possibility of annoyance and resentment against academic reading texts. Almost identical issues were reported by Hong Kong college students in Evans and Green's (2007) study which stated that the inability to understand field-specific or sub-technical vocabulary constituted impediments in reading comprehension. This failure was reported to have created negative feelings among students' views on perceived language abilities.

The problems of learners in reading in university contexts were reported by Nurweni and Read (1999) for Indonesian college students, Pritchard and Nasr (2004) for Egyptian engineering majors, Evans and Green (2007) for Hong Kong tertiary level learners, and Ward (2007) for Thai and Hsu (2014) for Taiwanese engineering students. In addition, Berman and Cheng (2010) and Evans and Green (2007),

referring especially to understanding field-specific vocabulary by overseas students studying in English speaking countries, claimed that vocabulary knowledge issues constituted the principal sources of failure in reading comprehension in English.

A careful systematic exploration of words and language structures can be achieved through corpus-based studies. O'Keeffe, McCarthy and Carter (2007, p.1) describe the term corpus as "a collection of texts, written or spoken, which is stored on a computer". Moreover, Schmitt (2000, p.88) states that "Corpora provide a consistent source from which to obtain evidence of the behaviour of many different facets of language: lexical, grammatical and pragmatic." There are many advantages of corpus-based studies. First of all, corpora can be used by researchers to create reference books such as dictionaries and grammar books, by teachers and writers to develop language teaching materials, by language testing agencies to construct language assessment tools and by the learners themselves for the investigation of language constructs (McEnery & Xiao, 2011; Hunston,2002). Furthermore, they help researchers, teachers and students to examine the already existing language structures to see explanations of target language forms and to explore real vocabulary usage.

Nation and Chung (2009) suggest ways for a careful investigation of vocabulary retrieved from different corpora, to improve the effectiveness of vocabulary focus. They presume the words in a language to be comprised of four main categories. These are high frequency words, academic words, technical words and low frequency words. Among these words, the words in the third category titled as technical words are very complicated in their nature. Technical words are very context-bound, and their meanings may vary in different contexts. In order to understand the text better, the learner is obliged to interpret the meaning of technical

and very rare words besides the more general words (Puangmali, 1976; Nation, 1990).

Hence, a sophisticated knowledge of a certain field of study is required to classify words as technical in that field. The most straightforward means for the description of field-specific vocabulary is to consult a field expert about a word's technicality in that given discipline (Chung & Nation, 2004; Schmitt, 2010; Nation, Coxhead, Chung & Quero, 2016). Besides, previous research offered other viable options to classify vocabulary items as technical. For instance, Chung and Nation (2004), Nation and Chung (2009), Kwary (2011) and Nation et al. (2016) all state that the identification of technical vocabulary can be made with very high precision by a comparison of the repetition of words in a field-specific text with the occurrence of the same items in a larger general corpus.

Basically, if the frequency of a word is unusually high in a specific field, it may be a key term in that field and a likely candidate to be a technical vocabulary item. In the keyness analysis, the examination of a word's frequency in a target text in comparison to that word's occurrence in a reference corpus is performed. Accordingly, for such an analysis, a large reference corpus and a carefully compiled target corpus comprised of various special purpose texts are required. Nonetheless; the issue of creating a sound corpus that accurately encapsulates the distinctiveness of lexis in a specific domain of study is cumbersome. Miller and Biber (2015) reported that although their focus was on a very restricted register and discipline and included the investigation of 10 full length psychology textbooks, the resulting data was far from an accurate representation of the vocabulary used in the given discipline.

Recently, researchers have shown an increased interest in field-specific technical vocabulary and studies have resulted in technical word lists to provide descriptions of lexical usage in domain-specific texts such as: Ward (1999, 2009a) for engineering; Martínez, Beck and Panza (2009) for agriculture; Coxhead and Hirsh (2007) for science; Konstantakis (2007) for business; Wang, Liang and Ge (2008) for medicine; Hsu (2011) for business; Mukundan and Jin (2012) for nursing; Hsu (2013) for medicine; Valipouri and Nassaji (2013) for chemistry and Hsu (2014) for engineering. As Schmitt (2010, p.11) proposes, the formulaic language which refers to multi-word units serves many linguistic functions among which its function of "precise information transfer" accomplishes the purpose of transferring necessary information without causing any misunderstanding.

Speaking of technicality, one very characteristic feature of technical English is the compounding of bare precise technical meanings that are essentially different from everyday general use, as "words become technical by the compounding of several sub-technical terms" (Salager, 1983; p.61). These complex phrases convey highly compact information. The term for the juxtaposition of words in scientific English has been given many names such as: compound nouns (Swales, 1974); technical compounds (Trimble, Trimble & Drobnic, 1979); heavy noun phrases (Cohen et al., (1979); compound lexical phrases (Salager, 1980); lexicalized compounds (Olstein, 1981); compound nominal phrases (Salager, 1983); nominal compounds (Horsella & Perez, 1991); and complex nominal expressions (Bhatia, 1992). Through a combination of multiple sub-technical lexis, words attain a technical status (Salager, 1983) and the more specialized the texts are, the longer the complex noun phrases will be.

Besides, if students proceed in the higher levels of academic studies, their encounters with nominal compounds will increase (Horsella & Perez, 1991). In order to increase the understanding of nominal compounds, it is recommended that the most frequently used functions and semantic relations of these compounds are taught to students at the early stages of tertiary level studies in cooperation with field experts. Through a study of discoursal patterns and lexis existing in specialist texts, ESP learners are expected to grow into the community they belong to with their competence in appreciating concepts and understanding language structures bearing informative clues about the field of study (Tarantino, 1991).

The last three decades have seen a considerable body of research being devoted to vocabulary acquisition of language learners, yet the central focus has been on receptive and productive knowledge of single words. Until recently a number of researchers have focused on word combinations, collocations and formulaic expressions (Cowie, 1981; Bahns & Eldaw, 1993). As the pioneering researchers in the use and discussion of multiword units and expressions, Pawley and Syder (1983) speculated that speakers are capable of controlling their native language in terms of fluency and use of phrasal units based on their repertoire of structure and expressions that have traditional uses in the culture. In line with the above claim, during the early days of multiword and lexical phrase research, Nattinger (1980) proposed that there are readily available constituents in language production whose suitability is monitored by comprehension and the instruction should rely on those units because knowledge of collocations is a vital prerequisite for a perfect command of English (Bahns & Eldaw, 1993).

Although there had been claims that highly technical words could automatically be learned through studying in specific disciplines (Cowan, 1972; 1974) or "can be worked out from a knowledge of subject matter" (Hutchinson and Waters, 1987), or recommendation for learning more generic semi-technical vocabulary (Farrell, 1990; Jordan, 1997; Dudley-Evans & St. John, 1998; Coxhead, 2000) or specialized vocabulary common across disciplines (Cohen et al., 1979) had been offered; later research showed a variation in findings and stated that that was not the case (Hsu, 2014; Pritchard & Nasr, 2004; Ward, 1999, 2007, 2009b).

Since it seemed impossible for EAP class teachers to provide students with reading materials that would be very much like their future reading texts, instructors switched to using more general content to embrace more and more students from various backgrounds (Clapham, 2001; Dudley-Evans & St. John, 1998). On this matter, Coxhead (2000) speculated that teaching of language patterns, features and lexis that are common across various disciplines might be beneficial, whereas ESP is merely based on the particular idea of fulfilling purposes through language use and getting involved with the other members of the community one belongs to (Hyland, 2002) or developing deep attachment to the field (Coxhead, 2013).

Contrary to this idea, Hyland and Tse (2007) postulated that academic vocabulary from different domains differs with regards to the practices and functions assigned. Based on their in-depth analysis, the authors argued against the feasibility of general academic vocabulary lists. Recently, a growing number of studies that aimed to derive lists of formulaic and collocational patterns in academia have emerged. Among these, Simpson-Vlach and Ellis (2010) aimed to create an academic formulas list found in a number of spoken and written academic texts. A number of other researchers have also emphasized the special need for collocational research

specific to certain disciplines (Peacock, 2012; Ward, 2007; Durrant, 2009); besides, an interest in genre specific research had already been pursued; e.g. Gledhill (2000) and Marco (2000) in research articles, and Baker, Gabrielatos and McEnery (2012) in newspapers.

For example, Peacock's (2012) comparison of collocations from eight different disciplines demonstrates a marked variation across the fields. The author added that the collocations carry different functions which differ across disciplines. Similarly, Ward (2009a, p.21) asserted that collocations were commonly shared elements in the disciplines by stating "A better way to demonstrate the centrality of collocation to specialization is to show data from words that are common in more than one sub-discipline".

With reference to language specialization, one major field of study that requires one to demonstrate a considerable proficiency in English is engineering. The knowledge of technical terms used, the types of discourse and register needed to communicate are pre-requisites for employment in this field. Ward (2009b) indicates that those seeking to attain a promising career in engineering who might wish to work for international firms or might seek to update their knowledge will unavoidably have to refer to sources in English. Although there is a dearth of extensive research in the literature about English for engineers, a number of studies have been promising for the development of the field (Hsu, 2014; Orr & Takahashi, 2002; Mudraya, 2006; Ward, 1999, 2009a).

One other specialist field of engineering which has started to attract some interest recently is Environmental Engineering. This multi-discipline field of engineering is a combination of various fields of engineering that provides precise

scientific answers for the problems in protecting the nature and maintaining sustainability in environment. However, a limited number of studies have investigated the specific vocabulary of this field (Faber, Leon Arauz & Reimerink, 2014; Krausse, 2005, 2008; Liu & Han, 2015) and the specifications and features of English of this field have not been explored extensively.

As previously stated, it may be advisable to extract field-specific collocations unique to each field of study. Only then would learners gain a substantial amount of knowledge on the technical words that co-exist. No doubt that an extensive knowledge would lead to better comprehension and production of collocations. It is therefore crucial to investigate authentic and useful collocations to cater for learners' needs. This may be a good starting point to explore effective ways of learning collocations, as language learners should be exposed to real instances of languages. An attempt to explore and describe the required vocabulary, syntactic structures and language functions of a specific field may help alleviate the burden of learners in learning detailed aspects of a broader language use (Cobb & Horst, 2001).

There have been claims in the literature that for learners in EFL settings, the exposure to language should be at an explicit level for acquiring collocations effectively. For instance, DeKeyser (2003) argued that explicit (mainly deductive) learning tended to result in more substantial gains than implicit learning did. As a rule of thumb, learners should notice the patterns and constructions; thus, it has been frequently mentioned in the ELT literature that noticing is a vital construct. For Schmidt (1990, p. 129) "subliminal language learning is impossible, and that noticing is the necessary and sufficient condition for converting input to intake." Besides, allotment of attention to the task is central to learning and is crucial for

deciphering information into long term memory both for retention and retrieval (Schmidt, 1993).

It can be argued that, not until the learner extends the use of language patterns and notices and discriminates between different uses of the same structures, can we call him an achieving language learner. Automaticity in language production, which allows learners to devote their energy and efforts to thinking and producing their next utterances in their minds, is bound to the practising of certain word units. So, learners should raise their awareness to a conscious level in order to benefit the most and turn intake into acquisition in their long-term memories for future uses. Consequently, some consciousness-raising activities or form-focused exercises might be of great use because learners need to explicitly recognize certain patterns of language, and notice these patterns to further process them so as to comprehend their usage and later acquire and actively produce similar patterns in their successful language production (Ellis, 2006b).

When the concept of exposure with regard to patterns is investigated, we encounter the phenomena of priming. McDonough & Kim (2009) emphasized that once learners are exposed to many instances of a certain language pattern, their ability to distinguish appropriate words that would fit in the lexical slots will improve and eventually they will ascend to an automatic production stage in their language use. Once a language learner attains certain structural patterns, he will later succeed in filling in the existing slots with the essential lexical items (Ellis, 2006a). The concept of priming also extends to vocabulary. For Hoey (2005, p. 13) “Every word is primed to occur with particular other words; these are its collocates”. Thus, Hoey (2013) posits that the theory of lexical priming aims to establish connections between psycholinguistics and concepts like collocations from corpus linguistics.

Through the use of repetition, or priming that is simply re-exposure to a prime, the person perceives the language context in which the word combination occurs, which later enables one to notice characteristics of language use (Hoey, 2013). It may therefore be argued that through learning primed collocations used in specific fields of study, the learners may sensitize their language use and notice the conventions frequently used by their discourse communities.

As Schmitt (2008, p.353) argues, "contextualized word knowledge aspects (e.g. collocation) are probably best learned by being exposed to the lexical item numerous times in many different contexts"; therefore, an effective approach to teaching should mainly give learners the chances to encounter and explore the collocations in a wide range of authentic contexts. Ellis (2002) highlights the importance of investigations of language examples and patterns by learners and maintains that exposing the learners to infinite numbers of language constructions and allowing them to distinguish frequent and recurring patterns would lead to better language attainment.

Regrettably, much uncertainty still exists about effective ways of teaching frequently occurring language constructions in ELT. Coxhead (2008) also states that there is a shortcoming of theoretical basis for teaching multi-words in foreign language teaching. There are also major discrepancies in the field between forms of implicit and explicit instructions. While some argue for a form of direct explicit instruction (Laufer, 2001, 2005; Nation, 2001, 2008), others contend that it is simply possible acquire vocabulary by means of reading in the second language without a need for any explicit instruction (Nagy, 1997; Krashen, 2004, 2013); nonetheless, learning from textual and contextual information provided by books demands longer

time intervals and requires reading millions of words even to attain general levels of vocabulary knowledge (Zahar, Cobb & Spada, 2001).

Even though extensive reading is regarded as an effective way of vocabulary acquisition (Krashen, 1989), the potential attributed to the method might be partially inflated (Horst, Cobb & Meara, 1998). Besides, very low learning rates were reported by Zahar, Cobb and Spada (2001) and they also argued that it would eventually take years to learn even simple general vocabulary items for basic decoding skills and comprehension thresholds. On the other hand, it was argued in the literature that activities specifically focusing on words were more efficacious and took less time to complete in comparison to reading-only conditions. During these activities, students are urged to notice the assigned lexical items (Laufer, 2003). Similarly, Horst, Cobb and Meara (1998) hold the view that a direct vocabulary instruction that is complementary to reading tasks will allow students to seize ample opportunities for encountering lexical items. Ender (2014), too, suggests a mixture of both explicit and implicit learning conditions.

The significant role of multi-words and formulaic language in acquiring and producing language has been emphasized in the literature. Interest in the subject of the retention and retrieval of these units as chunks from human memory has heightened for descriptive and research purposes (Sonbul & Schmitt, 2013; Wood, 2002). It was claimed that English language learners from different proficiency levels failed to comprehend and produce various types of multi-word units, especially collocations. For instance, Hussein (1990), researching the ability of Jordanian English major students' ability to use collocations correctly, concluded that the students failed to demonstrate a vast amount of knowledge.

Similar to this study, Bahns and Eldaw (1993) conducted a research with German learners of English at advanced level. Notwithstanding the amount of lengthy exposure to English in their classes, the German learners were found to fall short in their ability to produce appropriate collocations. Working with Arabic speaking learners and investigating their productive knowledge collocations, Fargal and Obediat (1995) revealed that only few collocations were correctly produced and that erroneous collocational patterns persisted over proficiency levels. Other researchers such as Nesselhauf (2003), studying with German learners; Gencer (2004) and Koç (2006), instructing Turkish students; Webb and Kagimoto (2011), assessing Japanese college students and Laufer and Waldman (2011), working with Hebrew learners; all reported the problems their students encountered while processing collocational patterns.

Despite the considerable attention devoted to the concept of collocations, multi-word units and formulaic expressions, it is interesting to witness the scarce number of studies allotted to the analysis of effective ways of learning collocations. So, it should be reiterated that studies analysing the teaching and learning of collocations under different instructional methods are limited in number (Alali & Schmitt, 2012). The main instruction types are listed in the literature as implicit and explicit instruction.

Firstly, implicit instruction on collocations aims to investigate the occurrences of multiword units in texts and tries to expose learners to the target word combinations through a series of tasks. To explore the issue of the amount of repetition needed for incidental learning of collocations, Webb, Newton and Chang (2013) conducted a research with Taiwanese college students and manipulated the number of target collocations in a graded reader. The researchers postulated that

more than five encounters for the receptive knowledge of form and 15 encounters for the productive knowledge of form were necessary for collocation acquisition. The finding that multiple exposures to the same target collocations within a single text facilitate learning the form of the collocations is promising especially for extensive reading programs.

Laufer and Girsai (2008) also carried out a study to investigate whether single word items and collocations could be learned under incidental learning conditions through meaning-focused, and contrastive and non-contrastive form-focused tasks. The performance of students in the contrastive form-focused group was considerably better than those in the other groups and their success was attributed to noticing vocabulary items. It was clear from this study that even under incidental conditions, form-focused instruction on collocations after reading resulted in notable success rates.

In an example study of comparison of explicit and implicit conditions, Sonbul and Schmitt (2013) carried out two experiments under laboratory settings to research the effectiveness of explicit and implicit learning of adjective-noun collocations by both NS and NNS of English. Both groups achieved substantial gains under explicit conditions, yet it was duly noted that no task type was capable of contributing to any considerable implicit collocation learning for the groups. The significant implications of the studies above for implicit collocation learning can be listed as increasing the exposure periods to collocations, raising the number of recycling tasks.

Explicit instruction in collocations, however, aims to raise learners' awareness of multiword units and directs their attention to the existing word combinations through various tasks. For example, Myers and Chang (2009) were

able to demonstrate the effectiveness of multiple-strategy vocabulary approach for teaching collocations. Correspondingly, Webb and Kagimoto (2009) explored the effectiveness of both recognition and recall activities for learning collocations by Japanese students at tertiary levels in a single experimental session. The researchers postulated that productive and receptive vocabulary learning tasks could be deemed as effective methods for acquiring the knowledge of collocation and meaning. Alali and Schmitt (2012) working with Kuwaiti students explored the differences of single and multi-words students. The results revealed that written reviews led to higher learning gains for both the single and multi-words than oral review conditions.

It was claimed that teaching vocabulary by using explicit tasks gave learners greater chances for involvement. Wood (2002) supported this claim and added that it is important help learners meet target patterns repeatedly in different contexts for the successful acquisition of collocations. Many of the above studies showed that learning collocations under explicit conditions for improving productive and receptive knowledge is an effective means on condition that the type and the amount of exposure is increased and different types of learning tasks are provided.

It was also mentioned in the SLA literature that a popular line of research in learning and teaching collocations is data-driven learning (DDL). According to Sun and Wang (2003) corpus-based concordances are more beneficial in comparison to grammatical examples for learning collocational patterns. Likewise, Yunus and Awab (2012) was able demonstrate that using DDL for teaching collocations explicitly produced significantly better scores than a teacher-centred approach. In parallel to this research, Huang (2014) examining the use of noun collocations by DDL activities, was able to suggest that the students using concordance lines produced better sentences and had less errors than the students consulting

dictionaries for collocations. Therefore, being exposed to real usage patterns in naturally occurring sentences proved helpful for better collocation production. Moreover, Daskalovska's (2015) study with Macedonian learners presented that the corpus activities were significantly better than traditional activities.

Taken together, the types of activities were shown to be effective in the literature, yet the tiresome process of training learners for understanding and using concordances, the fact that the activities are not suited to the preferred learning styles of some learners, and the high need for technical facilities has raised many issues regarding the application of the method.

Along with other countries, the teaching of collocations has also been a point of interest in the Turkish instructional settings as well. For instance, Balcı and Çakır's (2012) 24-hour classroom instruction with secondary school students, Ördem's (2005) ten-week long instruction with ELT pre-service teachers and Koç's (2006) three-hour collocation instruction treatment with language school students indicated that collocation group learners obtained significantly higher scores than traditional learning group students.

The findings from the literature indicate not only some common findings but also some controversial ones. A summary of the research supporting direct instruction demonstrated that exposures to target collocational items and careful continuous repetitions were crucial to learning. The direct teaching of vocabulary is deemed to occupy a large proportion of instructional time; however, if the benefits outweigh the length of time needed then explicit instruction can be deemed a good investment.

1.2 Rationale for the Study

A sufficient knowledge of vocabulary is needed for comprehending technical texts, especially for engineering students, whether it is for students' academic study purposes or for their future careers. There is a dearth of research for the description of the collocations used in Environmental Engineering English (EEE) for instructional purposes. Therefore, an empirical research on the above-mentioned issues might be beneficial. There are also inconclusive findings on the efficacy of explicit and implicit teaching of collocations in the literature.

Besides, there is limited research concerned with technical collocational knowledge, and especially, studies on teaching field-specific technical collocations explicitly are very scarce in the literature. Thus, researchers investigating the underexplored field of EEE collocations may derive invaluable information and input for vocabulary acquisition research in the field of ESP.

1.3 The Purpose of the Study

The current study aims to fulfil the aspirations of learners and their instructors who desire to exceed the lexical threshold levels for successful reading in engineering English in the shortest time possible by learning technical collocations. For this purpose, the study intends to extract multi-word units, namely collocations, which are more frequently found in a field-specific corpus than a more general-purpose one. Thus, the study will first aim for the creation of a list of key words and the collocations in the EEE corpus for informing lecturers and especially learners about the key vocabulary items and collocations used in the field.

The second purpose is to explore if there are any significant differences in productive and receptive knowledge of collocations for the modes of instruction of

the extracted collocations under explicit and implicit conditions. Furthermore, the study will further explore the efficacy of learning key environmental engineering collocations under incidental and intentional instructional conditions for increasing knowledge of the form and meaning of collocations for receptive and productive use.

Thereupon, the present study wishes to address the following research questions:

1. Are there any differences in the receptive knowledge of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

1a. Are there any differences in the receptive knowledge of the form of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

1b. Are there any differences in the receptive knowledge of the form and meaning of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

2. Are there any differences in the productive knowledge of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

2a. Are there any differences in the productive knowledge of the form of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

2b. Are there any differences in the productive knowledge of the form and meaning of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

1.4 Significance of the Study

Firstly, the current study tries to offer a comprehensive description of the technical vocabulary found in environmental engineering textbooks. The rationale of this description is to assist teachers and lecturers with data informed decision-making processes for enhancing the learning of field specific language use. For this purpose, a large corpus comprised of over 17 million words was compiled and keywords and their collocations were extracted. The main advantage of focusing on collocations extracted by keyness analysis is to cater for a manageable amount of vocabulary to lay the foundation for a well-planned lexical framework for teaching. It is hoped that this line of empirical data-based procedures on vocabulary can act as a way of endowing students with significantly improved vocabulary knowledge for comprehending the genres in tertiary settings.

Secondly, and most importantly, the study intends to explore the effectiveness of two modes of collocation instruction on learning technical collocations in the field of environmental engineering, where there is a notable absence of research. The current study hopes to deepen a sophisticated understanding of the role of technical collocation teaching for the acquisition of multiword units and the enhancement of receptive and productive knowledge of collocations.

CHAPTER 2: REVIEW OF LITERATURE

2.1 Vocabulary in Technical English

With the introduction of communicative language teaching in educational settings, there has been a shift on the focus of language teaching, from the command of structures to communicative proficiency. However, as Zimmerman (1997) noted, very little attention was given to vocabulary in communicative language teaching because vocabulary was not the focus of activities. As native-speaker language use and authenticity were placed in the centre, a careful and systematic study of vocabulary was not given attention in communicative language teaching. The foreign language learners were heavily exposed to real instances of languages, whereas the depth and size of vocabulary were regrettably neglected.

Vocabulary was claimed to be introduced only in context. There were certain other problems with the definitions of authentic language and usefulness between communicative language teaching and current perspectives as well. Therefore, the concepts based on intuitions in communicative teaching differ from the current view. “In the preparation of communicative materials, frequency counts have been largely displayed by subjective assessments of usefulness of words” (Zimmerman, 1997, p.14).

On the issue of authenticity, Nation (2001) holds the view that learners should be exposed to authentic materials as early and as often as possible. Accordingly, a systematic exploration of words and language structures is necessary for accessing the authentic language data. Corpus studies may allow for this systematic exploration of vocabulary items and language patterns. O’Keeffe, McCarthy and Carter (2007, p.1) state, “A corpus is a collection of texts, written or

spoken, which is stored on a computer". This stored information is useful in exploring authentic and real usage patterns directly from the real sources of data, and not based on any intuition.

On this issue, Schmitt (2000) reiterates that with the help of corpora it is possible to observe the syntactic structures and vocabulary units that occur persistently in real language data. With the help of corpora both students and teachers can investigate formal and informal language structures and target vocabulary items.

2.2 Defining Technical English Vocabulary

For Nation (2001, p.198) technical words are described as "recognizably specific to a particular topic, field or discipline." This specificity is mainly caused by the knowledge base of a field. Thus, technical words are very context-bound and their meanings may vary in different contexts. "The major difficulty is that technicalness is a functional aspect of a word and thus the particular use of a word must be taken into account when deciding whether it is a technical term or not" (Chung & Nation 2004, p. 251).

For Chung and Nation (2004), the identification of technical words is possible by consulting field experts who are knowledgeable in their subject area. Therefore, it may be claimed that a profound knowledge of a specific field of study is a prerequisite for classifying some vocabulary items as technical that are highly specific to a discipline (Nation 2001). However, research has offered solutions to the problem of identifying technical vocabulary. One frequently used method of extracting technical vocabulary items is keyness analysis. In very simple terms "The

basic principle is that a word-form which is repeated a lot within the text in question will be more likely to be key in it" (Scott &Tribble, 2006, p.58).

Scott (1997, p. 236) explains the complicated steps to carry out a keyword analysis and further states that when statistically compared to other texts "if a word occurs outstandingly frequently in our text, it will be key". In keyness analysis, a word's frequency is compared to the occurrence of that word in a reference corpus. Hence; to carry out a keyword analysis, a reference corpus has to be used. It is therefore necessary to compile a well-designed corpus of texts as a point of departure to provide detailed information of the field of study.

According to Paquot and Bestgen (2009, p.252) the log-likelihood ratio is designated as "probably the most commonly used statistical test in keyword analysis". Log-likelihood ratio tests are not so much dependent on normality assumptions; "Instead they use the asymptotic distribution of the generalized likelihood ratio" (Dunning, 1993, p.65) and this allows them to be used with texts of smaller sizes and uneven distributions (Oakes, 1998). Paquot and Bestgen (2009, p.262) indicate "…the log-likelihood ratio which also gives prominence to discipline or topic-dependent words". It can therefore be claimed that the ratio can be a reliable tool to extract words that are unique to a certain field or used in texts in a very technical sense.

2.3 Using Corpora for Specific Purposes

According to McCarthy (1999), there are two systematic approaches to using the data obtained from corpora in SLA namely corpus-driven and corpus-informed approaches. McCarthy (1999, pp. 26-27) explains that "A corpus-driven approach is absolutely faithful to the evidence of the corpus; a corpus-informed approach takes

insight from the corpus but filters that insight through common-sense language teaching practices". In the light of this definition, a corpus-driven approach might be useful in describing the existing language patterns, regularities and lexis in a body of texts, whereas a corpus-informed method might be more useful for teachers and students as it provides invaluable data for altering the language used for communication and instruction.

In the last decades, a number of researchers have been interested in the concept of field specific technical vocabulary and studies mainly have produced field specific vocabulary word lists (Ward, 1999; Konstantakis, 2007; Hsu, 2011). For example, the creation of medical word lists from research papers by Wang, Liang and Ge (2008) and from medical textbooks by Hsu (2013); business lists from textbooks by Konstantakis (2007) and by Hsu (2011), and an agricultural science word list from research articles by Martínez, Beck and Panza, (2009) provided comprehensive descriptions of word usage in various genres.

Among the other scientific fields of study, engineering has a special place and a successful degree of English proficiency is usually a prerequisite for following recent advances in the field. A sophisticated understanding of an excessive number of English technical words and special use of discourse and register specific communication patterns are regarded as fundamental skills for anyone wishing to be recruited into engineering.

For instance, Orr and Takahashi (2002) aimed to fulfil the English needs of working professionals and engineering students in Japan by compiling a written English engineering corpus that identified key English vocabulary. Their internet queries on engineering texts resulted in a corpus of 1500 words which they

considered “a balanced collection of Engineering English vocabulary that is appropriate for initial mastery by NNS” (Orr &Takahashi, 2002, p.406). Based on this list they created language tests for engineering English in Japan.

Mudraya (2006); on the other hand, compiled a two million-word Engineering English student corpus with the aim of supplying engineering students with a data-driven lexical approach to cater to their needs. The compilation included whole length textbooks from courses that were defined as: “compulsory for all engineering students, regardless of their field of specialization” (Mudraya, 2006, p. 235). The rationale for the corpus was threefold as: a) creating a lexis-based student engineering corpus, b) serving instructors and learners with an engineering word list, and c) analysing the language properties of Engineering English. The finalized list was comprised of 1200-word families found in the engineering coursebooks. Yet the word families in the corpus also included words from the GSL and AWL.

2.3.1 Identification of Field-Specific Vocabulary

Finding out specific words that would ease the process of reading by lower proficiency learners has also attracted the attention of other researchers. For instance, Ward (1999) sought to justify his claim that engineering students would be able to read EAP texts with ease after acquiring a specific list of 2000 word families. Besides, he asserted that the general tendency to start learning lexis with a general vocabulary list would prove useless for engineering students. To support his claim, he first compiled a corpus of introductory level engineering texts comprised of one million words, then extracted the 3000 most common word families in the specialized corpus and tested the predictive power of the list by comparing it with numerous texts from various disciplines. The results showed that the engineering list

predicted better than the GSL and UWL. However, he admitted that his list failed to contain a number of technical words unique to the subject matter.

A decade later Ward (2009a) reported that engineering students failed to surpass the first 1000 GSL word family level, even after years of studying English. To remedy learners' failure in reading and vocabulary; he proposed compiling a corpus of engineering texts to set up a very basic list. The final list that intended to ameliorate the vocabulary knowledge of less equipped engineering students contained 299 words. The list had a good coverage of engineering textbooks but was not merely technical as it included words such as show, limit and last.

One major field of engineering that has also gained momentum in recent years is environmental engineering. This discipline combines knowledge of different engineering fields for offering solutions to existing problems in providing a sustainable environment. The variety of English used in this field of engineering is underexplored. To this date, very few studies have explored the field specific vocabulary. For instance, Krausse (2005) compiled a corpus of various types of environmental engineering texts ranging from formal letters written by engineering firms to governmental reports. The final written corpus was comprised of 2 million tokens and further analyses were performed on the textual features and implications for classroom settings were offered.

Lately, Hsu (2014) created a corpus of 100 English Engineering textbooks from various fields ranging from aerospace to environmental engineering with the aim of compiling an engineering word list. Five textbooks from each field comprised a corpus of around four and a half million tokens. The researcher created a 729-word family list to be used with engineering students from distinct engineering fields.

Hyland and Tse (2007) asserted that the use of academic vocabulary in different disciplines tended to differ in terms of practices and functions assigned to them. Their in-depth analysis challenged the conception of usefulness of general academic vocabulary lists by revealing that words assumed different semantic roles in different science fields. To test the variability among disciplines, a corpus of 3 million-words comprising of various genres ranging from coursebooks to doctoral dissertations was compiled. The data from the corpus revealed that the usage of vocabulary items varied widely across disciplines. As a result, the authors suggested that a very crucial point of departure would be "the student's specific target context" (Hyland &Tse, 2007, p.251) if the instructors were willing to derive considerable benefits from the endeavour of learning. Based upon the analysis of lexical items, previous research usually offered vocabulary lists for instructors and lecturers to explore on their own accord but did not offer comprehensive solutions for offering better instruction.

2.4 Multiword units and Collocational Knowledge

Collocations are among the building blocks of a high degree of language proficiency because of their extremely frequent occurrence in everyday and formal language use. The highly influential role of collocations in comprehending the incoming information through language processing has been the primary focus of research in SLA studies for a long time. Nattinger and DeCarrico (1992, p.36) state that "Collocations are strings of specific lexical items, such as rancid butter and curry favor, that co-occur with a mutual expectancy greater than chance", while Hunston (2002, p. 12) defines collocations as "the statistical tendency of words to co-occur". What is common in the above definitions is that, the words favour the company of each other significantly, exempted from the chance factor. From a psychological

perspective Newell (1990, p. 7) asserts that “A chunk is a unit of memory organization, formed by bringing together a set of already formed chunks in memory and welding them together into a larger unit”. Brown (1974, p.3) asserts that “Every useful collocation is another step towards understanding the concept of a word.”

Likewise, Ellis (2001, p. 38) defines chunking as follows: “It is the development of permanent sets of associative connections in long-term memory and is the process which underlies the attainment of automaticity and fluency in language.” Learners start to acquire the chunks that establish these connections from the very early moments of the language learning journey (Ellis, 2003). Having regular patterns in the language use, these language sequences allow themselves to be processed more easily and quickly as the mind (through exposure) is adjusted to the regularities of these clusters. According to Ellis (2003, p. 79), a competence, that is regarded as nativelike is mainly comprised of being able to use the existing sequences in language with fluency and accuracy and chunking lays the very foundation and awareness of these patterns.

With the help of chunking, more memory space might be allocated to the new incoming information to be processed and as a result, this may relieve the burden on the components of the working memory (Baddeley, 1983, p.316). It is by these means that future retrieval of collocations might be enhanced with stronger ties between the short- and long-term sequencing of chunks. If the recursive nature of word groups leads to better memory traces, then instruction based on those multi-word units will become more meaningful. Therefore, if learners wish to communicate more effectively and fluently, they have to obtain a certain level of proficiency in their knowledge of collocations. On this issue, Bahns and Eldaw

(1993, p. 109) argue that: “a knowledge of collocations is essential to full communicative mastery of English”.

Besides, Hoey (2012) contends that recurring exposures to a word and its associations like textual, pragmatic or semantic contexts would allow a person to “identify 'the genre, style, or social situation it is characteristically used in' and 'features of the context that are also being repeated” (Hoey, 2013, p.3). For Ellis (2009, p. 141) language constructions are “basic units of language representation” and they are rooted in the awareness of language for learners and are mainly shaped by the society for referring to form and meaning relations. To create these relations, Ellis and Collins (2009) suggested that the learner should be equipped with a repertoire of acquired patterns of language use to sensitize themselves to the input frequency of constructs, since “Human learning is sensitive to frequency: the more times a stimulus is encountered, the faster and more accurately it is processed” (Ellis 2006a, p. 5). Therefore, Ellis (2009, p.145) contends that “multiple repetitions are also necessary for entrenched representation”, which would allow language learners to process items more quickly, respond to stimuli in a more fluent way and acquire patterns for future uses in appropriate contexts.

Currently a number of researchers have directed their attention to various genres and contexts and created lists for collocational patterns and formulaic language. For instance, Simpson-Vlach and Ellis (2010) compiled a formulas list by exploring a corpus of 4 million written and spoken academic texts. The researchers extracted 3-, 4- and 5-grams occurring in the corpora. In order to find out the n-grams specific to academic texts, they used the log-likelihood ratio statistics. Later the word strings were checked by the mutual information statistical measure to ascertain that the component words in the n-grams were not juxtaposed together

based on the chance factor. “The MI measure compares the probability of two words occurring together through intention with the probability of the two words occurring together by chance” (Kennedy, 2003, p.473).

According to Hunston (2002, p.70), “Very generally, an MI-score indicates the strength of a collocation.” Church and Hanks (1990, p. 29) referring to their measure of association ratio based on the mutual information state that “It can help us decide what to look for; it provides a quick summary of what company our words do keep.” It is therefore clear that, higher ratios will indicate a stronger connection between the two words. “Significant collocations are collocations that occur more frequently than would be expected on the basis of the frequency of occurrence of the individual items” (Herbst, 1996, p.382). Simpson-Vlach and Ellis (2010) later assigned pragmatic functions to the formulas with the help of EAP experts and asserted that the list of formulas could be incorporated into EAP instructions and language texts.

Furthermore, Peacock (2012) studied the disciplinary variation of collocations with high frequencies from eight different disciplines. His corpus consisted of 320 articles helped the extraction of 16 abstract nouns for further investigations. A comparison of the findings retrieved from the disciplines indicated a substantial variation across different fields. The author argued that a vast majority of collocations were “standard terminology in the discipline” (Peacock, 2012, p.42) and added that the collocations bore functions and meanings that varied across different disciplines.

Based on the above definitions, it seems feasible and beneficial to sort out field specific collocations from areas of study, in order to allow learners to acquire

higher numbers of technical collocations. To explore the spoken collocations in contrast to the highly dominant written collocation research, Shin and Nation (2008) extracted collocations with high frequencies from the spoken part of the British National Corpus (BNC). The study employed an exhaustive list of criteria for the collocation selection. The authors recommended their list as a valuable starting point for designing language syllabi. Besides, Kennedy (2003) examined the collocations of adverbs of degree in the British National Corpus and specifically explored maximizers and boosters. The study used the mutual information measure for collocation extraction.

Even though the role of collocations in language proficiency has long been highlighted and instruction has been offered to learners, the previous research eloquently expressed that many English L2 learners had serious comprehension and production problems with collocations (Fargal& Obediat, 1995; Nesselhauf, 2005). For example, Hussein's (1990) assessment on Jordanian students' ability to use collocations correctly pointed to apparent failures. Although the students were English majors, a language proficiency test showed that they were lacking in language skills. A multiple-choice test for measuring the receptive knowledge of form was administered to 200 students. The results illustrated that more than 50 percent of the answers were wrong. The researcher attributed the mistakes to the learners' first language (Arabic) and to fossilized forms of use that are idiomatic expressions and substitutions of some broad concepts for specific words that is overgeneralization.

In order to test their assertion that learners fail to attain considerable levels of success in their collocational knowledge in comparison to vocabulary knowledge levels; Bahns and Eldaw (1993) worked with advanced level L2 German on their

knowledge of collocations. The findings indicated that the advanced level students failed to provide correct answers in almost half of the questions in both tests. Despite years of exposure to English in classes, the students had limited ability in producing correct collocations. Eventually, Bahns and Eldaw (1993, p. 109) asserted that "... collocations should indeed be taught".

Fargal and Obediat (1995) assessed the knowledge of collocational form recall, and collocational form and meaning recall of Arabic speaking learners. The researchers took an identical testing design from Bahns and Eldaw (1993) yet they had 11 fill-in-the-blanks and 11 translation items. The study claimed to test 22 commonly used English collocations related to food, clothes and weather. The results showed that the correct production of target collocations was limited to very few items. The data also displayed clear patterns of lexical simplification strategies. The strategies were listed as: synonymy, paraphrasing, transfer and avoidance. The researchers were able to demonstrate that almost all of the errors in the advanced learner group's collocation production were caused by parallel translation from L1 by using different verbs to express a similar meaning.

With a larger data base, Laufer and Waldman (2011) carried out a comparative study of collocations in written assignments by native and non-native speakers. Focusing on the most frequent 220 verb-noun collocations, the researchers explored the concordances for comparing NS and NNS. The comparisons indicated that NSs' production of verb + noun collocation was significantly higher than the Hebrew learners' production at every proficiency level. The analysis indicated that there was a correlation at advanced level and there was a significant difference between advanced and beginner students. The proportions of erroneous collocations comprised almost one-third of total collocations produced at each proficiency level.

To compare the collocation processing and production of NS and NNS in student produced written academic texts, Siyanova and Schmitt (2008) manually extracted collocations. With specific reference to the number of adjective-noun collocations, the researchers displayed that the NNS produced as many collocations as the NS English students. Therefore, the authors provided counter-evidence against the findings of previous research indicating failures of NNS in collocational performance. However, the second part of their study focusing on the NS and NNS collocation frequency judgements, acknowledged that it takes longer and becomes harder for NNS to recognize and process less frequent collocations. It can still be argued that the writing task in terms of its nature might have lent the NNS more time to go over and examine their production whereas the judgement task required simultaneous processing and evaluation of collocation items. Although a large number of studies have researched collocations, multi-word units and formulaic expressions, it is quite interesting to notice the limited amount of research on the exploration of the efficacy of ways of acquiring collocations.

2.5 Collocational Knowledge and Language Learning

With specific reference to the concept of vocabulary learning, the term incidental corresponds to the word learning that occurs as the unintended result of tasks at hand which have not been tailored to teach lexis directly, whereas the body of tasks that explicitly intend to engage the mind with vocabulary items is referred to as intentional learning (Hulstijn, 2001).

In the circles of SLA, Nagy and Anderson's (1984), Nagy, Herman and Anderson's (1985), and Nagy's (1997) pioneering work affirmed that an average American high school student had a vocabulary size of 25,000 or more words. Thus, the researchers demonstrated the improbability of learning such a high number of

words simply by explicit instruction and resorted to the nature of learning that occurred during reading texts extensively by multiple exposures to explain this learning phenomenon.

2.6 Collocation Instruction

The significant role of multi-words and formulaic language in acquiring and producing language has been strongly emphasized in the literature. Interest in the retention and retrieval of these units as chunks from human memory for descriptive and research purposes has been heightened (Sonbul & Schmitt ,2013; Wood, 2002). As Ellis (2003, p.76) reiterates "Chunks that are repeated across learning experiences become better remembered". However, there is a dearth of studies on effective ways of teaching multiple words (Alali & Schmitt, 2012; Webb & Kagimoto, 2009).

According to Bahns (1993, p.61) "To teach English collocations to speakers of other languages, it would, of course, be very useful to have a rich variety of teaching material like collections of exercises and workbooks." He further added that it would decrease the time and diminish the efforts for observing and studying collocations via reading through the course of learners' academic lives. "It is necessary and important to raise learners' collocation awareness in the process of learning English as a foreign language. To do so, suitable materials are a must" (Jiang, 2009, p.113).

2.6.1 Implicit Instruction of Collocations

The acquisition of vocabulary is a kind of incremental, step-by-step increase which starts with simplicity and later progresses to complexity in knowledge; accordingly, the more chances of encountering lexical items in rich contexts a student has, the more sophisticated and successful his vocabulary acquisition will be.

During the procedure of implicit learning, the mind disseminates the available information subconsciously from the contextual clues.

As specified by Ellis (1994, p. 1), “Implicit learning is acquisition of knowledge about the underlying structure of a complex stimulus environment by a process which takes place naturally, simply and without conscious operations”. This definition allows for the interpretation of two major aspects of implicit learning as a) a simple effortless process and b) a condition devoid of consciousness. Thereby, the learners are expected to gradually absorb the regular patterns in the input automatically in the course of time and unconsciously acquire the necessary core knowledge base. The previous research on implicit collocation instruction intended to explore the acquisition of this knowledge base for multi-word units in texts and tried to expose students to the target collocations by a combination of tasks.

For instance, Webb, Newton and Chang (2013) worked with Taiwanese college students and changed the number collocations in a reader to discover the minimum number of occurrences required to learn the form of collocations. The learners read the graded readers and listened to the audio files simultaneously. Their findings suggested that multiple exposures to the same target collocations within a single text facilitated learning the form of collocations. The study further postulated that at least 5 encounters for receptive and 15 encounters for productive knowledge of form would be inevitable. It can be argued that collocations can be learned under incidental conditions with multiple exposures; yet instructors have to ascertain that the learners first notice the existing collocations. In addition to this, the instructors must also confirm that they serve learners with multiple occurrences of the same target elements in reading texts which does not seem to be the typical case especially for English for specific purposes.

Laufer and Girsai (2008) conducted a study for the exploration of whether there would be any differences in learning single words and collocations under incidental conditions by using explicit translation and contrastive analysis methods. During the instructional treatment period, all learners read texts and later carried out tasks assigned to their groups. An unannounced active and passive translation recall test was administered after the tasks were completed. The results tests showed that the contrastive form focused group students outperformed the others; thus, the noticing, the role of L1 and the output tasks were regarded to be the reasons for the groups' success. This study showed that form focused collocation instruction following reading comprehension activities resulted in higher learning rates even under incidental conditions.

The above research indicates that the acquisition of lexis under incidental conditions is not an effortless routine, yet relies upon numerous elements such as opportunities to encounter the lexical items with contextual clues and the rate of occurrence and saliency of items (Ellis, 1994). In line with this, Alcon (2007) postulated that a teacher-led focus on word forms accompanying the process of incidental learning of vocabulary by reading fosters the noticing of words by students and is an efficacious means of promoting acquisition and future use of vocabulary. Therefore, it was advised in the literature that students should confine a fair amount of their attention not only to the form of an encountered word but also to the meaning for vocabulary acquisition to happen (Ellis, 1997). However, Nation (2007) reiterates that the gains made from reading under incidental conditions are fairly low in comparison to deliberate learning routines and that this progress can transform to substantial gains only if the input is received by the learners in massive quantities.

To question the claims about incidental and intentional study of collocations, Sonbul and Schmitt (2013) made two experiments on the effectiveness of learning adjective noun collocations by both NS and NNS of English under explicit and implicit conditions. Both groups learnt medical collocations through reading texts and were later tested with explicit and implicit measures of assessment. It was clear from the results that both groups had high gains in the explicit settings however the emphasized and bolded collocations were more effective for L2 learners. It was seen that implicit collocation learning was not successful under any task conditions. Based on the findings above, the significant implications for implicit learning of collocations can be listed as: increasing the numbers and times of exposures to collocations, raising the number of recycling tasks and enhancing the input for raising awareness.

2.6.2 Explicit Instruction of Collocations

According to Ellis (1994, p.1), "Explicit learning is a more conscious operation where the individual makes and tests hypotheses in a search for structure". In this type of learning, the learners are consciously and selectively looking for patterns of regularities in the input and test their underlying assumptions about the structure. In a parallel fashion, Hulstijn (2005) argued that explicit learning was a type of language processing with an intention to explore whether the information in the input included regular patterns and how these regularities could be figured out with the help of rules and concepts. There is an overwhelming need to heighten the awareness of students through the use of special tasks and activities to direct their attention to the significance of vocabulary learning **(**Hulstijn, 2001). The idea of accomplishing the task of gaining a complete understanding of the language input even by a major increase in the time spent for reading and listening, is an

unattainable goal, as long as it is not approached with a multi-faceted approach for vocabulary learning.

The major aim of explicit collocation instruction is to foster a heightened awareness of multi-words for learners and to turn their attention to the combinations of words by using different vocabulary tasks. For instance, Myers and Chang (2009) explored the effects of exposures to collocations for vocabulary acquisition through a vocabulary teaching approach. The experiment was carried out with high school students from Taiwan. Two trained teachers instructed learners under three conditions which were: a) a control condition where the students merely worked on English pronunciations and used translations for explaining the target collocations without any specific vocabulary strategies; b) an experimental condition where students were given strategy instructions with concept wheels, sentence plus definition method, word maps and personal vocabulary notebooks and c) another experimental condition, which exposed the learners to semantic mapping, sentence plus definition method, a word-to- picture word association technique and pantomiming as strategies for vocabulary instruction. The study followed a "post-test only" research design. The post-test mean-scores revealed that experimental group students were more successful than the control group students. The study concluded that the multiple strategy vocabulary instruction method to teach students the collocational and lexical knowledge was effective. The researchers attributed this effectiveness to multiple exposures to target collocations in meaningful contexts with explicit explanations.

In line with the above study, Webb and Kagimoto (2009) explored the effectiveness of exercises for learning collocations. The study used a 90-minute experimental session. The experimental group did a receptive task with the target

collocations glossed and sample sentences showing the highlighted collocations in real contexts. The learners were simply instructed to read the collocations in the sample sentences. Whereas, the second experimental group who were assigned to the productive (cloze) tasks encountered the same target collocations and the glosses. Yet, in this condition the target collocations in the identical sentences were removed. The learner's task was to write them in the blanks by choosing from two options. The control group received no training.

The students were administered four post-tests which were: productive knowledge, receptive knowledge, productive translation and receptive translation of collocations to identify the gains in their collocational knowledge. It was found that both vocabulary learning tasks helped learners to gain knowledge of collocations at significant levels; hence the difference between the amounts of improvement was small. The study further proposed that the receptive exercises were more effective for learners at lower levels and the students at higher-levels benefited more from the productive learning tasks. Nevertheless, the researchers were able to show the efficiency of recall and recognition tasks in acquiring the knowledge of collocations.

To explore whether differences existed between learning single and multi-words; Alali and Schmitt (2012) carried out a research with 35 female Kuwaiti students at a public school. The students were instructed to learn single words and idioms with the same direct vocabulary instruction methods. The learners were presented with the target vocabulary items via Power Point slides which provided the native language translations (Arabic in this case) for one minute per item. The variety of learning conditions, namely "no review, oral review and written review" assisted the learners for target item revisions. Delayed post-tests were given 12 days after the treatments. The single word-learning test scores indicated a higher learning

rate than the idiom learning treatment. Significant differences were observed between single-word and idiom learning groups for form and meaning recall.

The researchers further questioned the effects of repetition and concluded that, if only word recognition knowledge is considered then questions arise about the value of repetition. Yet, “if recall knowledge is necessary, then repetition was shown to be effective in increasing learning” (Alali and Schmitt, 2012, p.167), and learners may benefit from repeated exposures for better word learning and retention. Overall, the word learning gains through written reviews for both the single and multi-words facilitated significantly higher gain scores than under oral review conditions. The researchers asserted that learning vocabulary items through the use of explicit tasks provides learners with greater chances of involvement and “it is clear that more reviews lead to greater learning” (ibid, p.167). This finding is in line with that of Wood (2002) who argues that it is crucial to ascertain that the target formulas are repeated in a variety of convenient contexts for an effective acquisition.

Webb and Kagimoto (2011) explored several issues with 41 Japanese college students. The first issue explored was the number of collocations used with the same node, the second was the node’s position and the third was the effectiveness of learning collocations for synonymous items. One 90-minute class period was reserved for learning target collocations with translations in different sets. The collocations were taken from a corpus of general English. Items like shortcuts, social life and powerful figures were learned by the learners. A pre-test with a productive translation was given to learners prior to the study where they were requested to supply an English equivalent of the collocation in Japanese. The statistical analysis revealed that the node words with more collocates were learned better. So, it was argued that offering multiple collocates of a given node facilitated better learning.

The findings indicated that the position of the collocates did not have any significant effects and learning collocations for synonym pairs was not an effective technique.

Gencer (2004) aimed to point out that some verb collocations of words known by intermediate EFL Turkish learners would go unnoticed while reading English texts. To test his hypothesis, he focused on 25 verb noun collocations in a reading text. A group of 18 learners worked with the verb-noun collocations in the texts whereas another group of learners were instructed in single word. The results showed better scores for the learners in the collocation instruction group. In his investigation of the effectiveness of explicit collocation instruction on collocational awareness, Koç (2006) indicated that students were able to gain better retention scores even in three treatments when they were instructed on collocational patterns through activities such as translation in comparison to their peers who focused on single words.

Among the rare studies that focused on the explicit teaching of collocations in real classroom settings, Ördem's (2005) study comes to prominence with its quasi-experimental design and ten-week long instruction pattern. Working with two classes of ELT pre-service teachers, the researcher taught the target collocations from the learners' textbooks explicitly to the experimental group students and used traditional guessing from the context and antonyms-synonyms exercises in the control group. The results revealed that the experimental group test scores were significantly higher than those of the control group. Besides, the scores from the writing tasks indicated that more appropriate collocations were produced with higher percentages by the experimental group.

Another experimental research study that was carried out with secondary school students by Balcı and Çakır (2012) compared the teaching of collocations versus traditional single word teaching. By the end of a 24-hour instruction, it was found that the higher scores were obtained by collocation group learners. Recently, Bağcı (2014) examined the receptive and productive knowledge of intermediate and advanced Turkish EFL learners at a Turkish university. The study sought to identify proficiency differences with regard to the collocational knowledge of learners and the results indicated that the advanced level learners outperformed the intermediate learners. What the above research indicates is that, it is recommendable to study collocations under explicit conditions for improving receptive and productive knowledge of collocations. However, it can be recommended that the amount of exposure to collocations should be ascertained and different types of effective tasks should be offered. "Classroom activity could consist of exposure to large amounts of input, with attention paid to the formulaic sequences being used" (Wood, 2002, p.10).

Another line of research that has gained momentum in the learning and teaching of multiword units is data driven learning. For Johns and King (1991, p. iii) "the use in the classroom of computer -generated concordances to get students to explore regularities of patterning in the target language, and the development of activities and exercises based on concordance output" is the definition of data driven learning. The approach makes use of a target corpus and requires learners to explore target text features by themselves for self-directed learning and also makes uses of concordance (Cobb,1999; Boulton, 2010). Among many other studies, DDL has recently shifted its attention to collocational units.

To explore the effectiveness of paper-based and computer enhanced data driven learning on the issue of explicit teaching of collocations of prepositions; Yunus and Awab (2012) initiated a study with 40 Malaysian law major undergraduates at intermediate to advanced proficiency levels. An experimental group of 20 students was introduced to module-based data driven learning materials created from written law texts. The comparison group students were given the same structures in full sentences yet with a teacher-centred traditional approach. The students were instructed with the two assigned methods over the course of six weeks. The data obtained through the same pre- and post-tests consisting of 25 questions that focused on sentence completion, error identification and semantic function indicated that the experimental group using the module-based DDL significantly outperformed their counterparts.

With a rationale of examining the extent of improvement on learners' use of abstract nouns through the use of DDL activities, Huang (2014) initiated a corpus-based concordance study with 40 upper intermediate Chinese EFL learners. The experimental group learners were required to use concordance lines for studying, whereas control group learners used dictionaries for collocation consultation. The control group studied 5 target words by dictionary consultation. The treatment group was given ten concordance lines for each of these five target words to explore at the end of the class. The results from both post-tests indicated that the essays written by learners in the concordance group were more successful and contained fewer errors.

Sun and Wang (2003) aimed to investigate the effects of deductive and inductive means for collocation instruction. 81 Taiwanese high school students were allocated two learning settings. Firstly, both groups were administered a pre-test on an error correction task on four collocation patterns. The experimental group

members were required to explore those four collocations on three online concordancers to induce the rule patterns. Meanwhile, the control group was provided with grammatical rules and example sentences to study deductively. The findings from the error correction test results pointed to superiority of the inductive approach.

Koosha and Jafarpour (2006) aimed to investigate three issues in their research, which were: a) whether paper-based DDL concordances exerted any noticeable effects in learning collocations of prepositions, b) whether learners' levels of English language proficiency would make a difference in knowledge of collocations of prepositions, and c) whether there was an effect of learners' L1 in learning collocations of prepositions. 200 Iranian learners of EFL, studying English at three universities were involved. There were two groups of learners where the first group was instructed with traditional activities based on grammar reference books to study collocations of prepositions and the other group was trained to use paper-based concordancing lines for exploring the collocations of prepositions retrieved from the Brown corpus over the course of twelve weeks. The experimental group students who used the data-driven learning method surpassed the control group students in terms of gains in knowledge of collocations.

With the aim of exploring the effectiveness of corpus-based activities over traditional ones for collocation learning, Daskalovska (2015) conducted a study with 46 Macedonian learners. The treatment group learners worked on an online corpus database whereas the control group learners studied the verb-adverb patterns via the activities in their books such as multiple choice and matching activities. The treatment session lasted for one hour and the learners were given an immediate post-test similar to the pre-test.

The results revealed significant differences between the two groups on both the immediate and the delayed post-tests. It was indicated that the experimental group learners in the online concordancing condition outperformed the learners in the control condition which led the researcher to claim that "the corpus-based activities were more effective for learning verb-adverb collocations than the traditional activities" Daskalovska (2015, p.137). The literature review for DDL activities revealed their efficiency; however, the long exhaustive phases of teaching learners how to use corpus and concordance resources and the limited technical facilities impeded the use and application of the method.

The findings from this exhaustive list of the literature indicate some common findings as well as some controversies. A summary of the research supporting the direct instruction method demonstrates that exposures to target collocational items and careful continuous repetitions are the key to learning gains. It is known that acquiring substantial amounts of vocabulary has an incremental nature and necessitates exposure to the words under numerous conditions and in a range of contexts (Nattinger & DeCarrico, 1992). The direct teaching of vocabulary is deemed to occupy a large proportion of instructional class time. However, if benefits outweigh the time limitation then it can be argued that explicit instruction is needed. To summarize, "the direct teaching of vocabulary during reading is definitely worth the effort" (Sonbul & Schmitt, 2009, p.259).

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter includes seven sections. Section 3.2 reintroduces the research questions. Section 3.3 draws a comprehensive picture of the context of the present study while section 3.4 describes the two phases of the study. Phase one identifies the processes of compilation of environmental engineering textbook corpus and the stages utilized in the extraction of technical vocabulary and their collocations. Phase two describes the steps for the meticulous preparations for the experimental study and outlines the construction of the receptive and productive collocation tests. Section 3.5 provides complete details of the design and application of the instructional procedures. Finally, section 3.6 gives brief details about the test administration and scoring.

3.2 Research Questions

The current study explored two different types of instruction, namely implicit and explicit collocation instruction, with a rationale of determining if significant differences existed between learner scores in the two treatment groups.

1. Are there any differences in the receptive knowledge of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

1a. Are there any differences in the receptive knowledge of the form of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

1b. Are there any differences in the receptive knowledge of the form and meaning of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

2. Are there any differences in the productive knowledge of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

2a. Are there any differences in the productive knowledge of the form of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

2b. Are there any differences in the productive knowledge of the form and meaning of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

3.3 Context

The context for the study was chosen primarily because of the personal connections with the faculty members in the engineering department and the proposal blossomed out of discussions generated by some of the instructors and the researcher. The participants of the study were 61 second year (sophomore) environmental engineering majors in the department of environmental engineering, Uludağ University, Bursa, Turkey. There were initially 75 students but 14 of them were excluded from the final data analysis because they missed more than one session of classes or were unable to attend the post-tests.

There were 49 female and 12 male learners in the study groups. The mean age for the participants was 20.76. The participating students had all studied English for about seven or eight years in primary, secondary and high school levels as part of the

Turkish national curriculum. 59 of the students were taught English in a year of intensive language classes during their high school years. All participants had also attended a year-long English preparatory school before starting their freshman year.

In the engineering department where the study was carried out, the classes were generally conducted in large auditoriums with a large group of students. When the number of learners enrolled in a course exceeded 60, the students were automatically split into groups by the student registrar's office automation system based on their student numbers. The students with even numbers were enrolled in the first class and the remaining odd numbers were enlisted in the second section. Thus, the participants of the current study were assigned to two classes at the beginning of the study randomly. Therefore, the present research used a close to true experimental design where participants were randomly assigned to one of the study groups. The concept of random assignment allows researchers to restrict any pre-existing differences between the groups (Schreiber & Asner-Self, 2011).

The medium of instruction in the department is Turkish. However, new regulations from accreditation committees obligated the engineering department to have compulsory English courses in the curriculum corresponding to 30 percent of the whole curriculum. As part of these regulations, the department required students to take a course entitled "Introduction to Environmental Engineering" which was taught in English each spring semester. It was stated in the syllabus that "The objective of the course is to improve the English terminology knowledge of the students related with the Environmental Engineering field and improve the ability of the students to communicate in English on Environmental Engineering field topics". Over the course of 14 weeks and 90 minutes per week, the course aimed to introduce learners to general topics of Environmental Engineering, water pollution, air

pollution, soil pollution, solid and hazardous waste management. There were two classes for this course and four different lecturers taught the course in the three weeks reserved for their field, and later they exchanged classes. The syllabus of the course for both classes is given below.

Table 1. Syllabus of the 'Introduction to Environmental Engineering' Course

Week	Class A		Week	Class B
1	Introduction		1	Introduction
2	Water treatment		2	Air pollution, definition, sources
3	Water quality management		3	Air pollutants, characteristics, effects
4	Wastewater treatment		4	Air pollution meteorology, dispersion
5	Air pollution, definition, sources		5	Water treatment
6	Air pollutants, characteristics, effects		6	Water quality management
7	Air pollution meteorology, dispersion		7	Wastewater treatment
8	Midterm exam		8	Midterm exam
9	Soil pollution, pollutant types, sources		9	Solid Waste, definitions, characteristics and management
10	Pollution mechanisms in soil, movement of pollutants		10	Engineered systems for solid waste management
11	Management of contaminated soils, soil treatment technologies		11	Hazardous waste management
12	Solid waste, definitions, characteristics and management		12	Soil pollution, pollutant types, sources
13	Engineered systems for solid waste management		13	Pollution mechanisms in soil, movement of pollutants
14	Hazardous waste management		14	Management of contaminated soils, soil treatment technologies
15	Final exam		15	Final exam

In the first lesson of the term for the course the learners were introduced to the course and were given a background questionnaire for determining their language learning backgrounds and their views on language needs and expectations from the course to be filled during their free time. During this class students were informed that they would take a general proficiency test if they were willing to participate.

3.4 Procedure

The following section briefly explains the procedures followed for the preparation of the treatments in this proposal. The first sub-section dissects the steps taken in the target keyword and collocation extraction. The second sub-section presents the stages in the process of designing explicit and implicit instruction for the learners.

3.4.1 Identifying Target Keywords and Collocations

First of all, in order to extract and identify the keywords and collocations a reference corpus is needed. Nonetheless, a general or even specific English corpus would not cater for researching the features of EEE. A large and representative corpus is needed to find keywords and discover collocations with significance (Herbst, 1996). Since, there are no publicly available corpora on EEE textbooks; the compilation of a representative corpus was considered necessary in an attempt to create reference corpus.

First, to collect a sufficient number of texts from each of the EEE fields, nine academicians (full and associate professors), including the lecturers of the course from the Environmental Engineering department, were consulted on their ideas about the fundamental and useful textbooks in the field. They were also requested to name the recently published books which they would regard as significant and useful. The professors provided a list of books, and kindly lent their books and also named some books available in the school library system. In some cases, it was possible to access the electronic versions of the books from the school library system. In those cases, the texts were copied from the electronic versions. The total number of the textbooks included in the corpus was 89. The publication dates for the books are as follows: five books were published between 1993-1999, 46 books were published between

2000-2009 and the remaining 38 books were published between 2010-2014. A full list of books is provided in Appendix 1. Next, the remaining textbooks were scanned and transformed into machine readable text files. The information included in the front matter of the textbooks, tables of contents pages, page headers, appendices, indexes, bibliographies and reference sections were manually removed from the stored text files from each book,

The corpus was also cleaned up and arranged for typo errors and special characters which would hinder the analysis. Next, the text files were loaded into a corpus analysis program. The program used for all types of textual analysis for the data in this research is called AntConc, a freely available computer program developed and distributed by Laurence Anthony (2011). The program is a free corpus-software that allows the users to make different types of analysis and can be used for different purposes such as creating wordlists, keyword lists, clusters and n-grams and for exploring collocates and concordances. The features of the resulting Environmental Engineering English Textbook Corpus (EEETC) can be seen below:

Table 2. Specifications of the EEETC

	Name of the Reference Corpus	**Number of Text Files**	**Word Types**	**Word Tokens**
1	Environmental Engineering English Textbook Corpus (EEETC)	89	188,348	17,786,090

For the purposes of finding out important and key vocabulary used in the corpus, a keyword analysis was carried out. “A key word may be defined as a word which occurs with unusual frequency in a given text” (Scott, 1997, p. 236). In order to carry out a keyness analysis, a reference corpus is needed to make comparisons between the target and the reference corpus. “Since most collocations are relatively

rare, in comparison to individual words, a large corpus is required in order to find such items" (Durrant, 2009, p.159). In order to make better comparisons; the British National Corpus (BNC) (2007), the Open American National Corpus (OANC) (Ide, Fellbaum, Baker &Passonneau, 2010) and the British Academic Written English Corpus (BAWE) (Gardner & Nesi, 2012) were chosen to provide a wider range and variety from different fields and genres. The table below provides the specifications of the reference corpora.

Table 3. Specifications of the Reference Corpora

	Name of the Reference Corpus	**Number of Text Files**	**Word Types**	**Word Tokens**
1	BNC	4049	345,366	98,036,654
2	OANC	4132	105,971	9,805,223
3	BAWE	2761	87,295	6,688,806

As mentioned in the literature the log likelihood ratio test is used for keyness analysis. Paquot and Bestgen (2009, p.265) state that "The log-likelihood ratio has a distribution similar to that of the chi-square. A statistical table for the distribution of the chi-square test can thus be used to find the log-likelihood ratio probability value". It has long been mentioned in the literature that keyness analysis reveals an enormous number of key items while working with large corpora such as the current one (Scott, 1997, 2010; Baker, 2006; Pojanapunya & Todd, 2016).

The first phase of the keyness analysis on the EEETC with the BNC as a reference corpus produced 156,561 keywords when no significance level was set beforehand. With the aim of working with a more manageable number of items, the cut-off significance level for the keywords was set at the critical value of 33 at the $p < 0.00000000000001$ (10^{-14}) significance level (Gabrielatos & Baker, 2008; Pojanapunya & Todd, 2016), which ensured the selection of keywords only based on

significance exempted from the chance factors. As Baker (2006, p.127) puts it: “the higher the score, the stronger the keyness of that word.” The analysis was replicated for each of the other two reference corpora and only the words common to these corpora were selected for further analysis.

For the keyword selection process, the study benefitted from the selection criteria that Coxhead (2000), Wang et al. (2008), and Yang (2015) used. The steps included were specialized occurrence, range and frequency, but the present study did not include the specialized occurrence step, as the exclusion of words from the General Service list with domain-specific uses would cause problems (Mudraya, 2006, Hyland & Tse, 2007). (Further analysis indicated that 53 out of the first 100 keywords would have been eliminated. See Appendix 2 for a list of the first 100 keywords). Based on these two stages, to be included in the further analysis a word should a) occur in a minimum range of 25 books out of 89, and b) have a minimum frequency of 500 occurrences in the whole EEETC.

After the keywords were obtained from the keyword analysis between the reference corpora and the corpus, the findings from the resulting list of words were analysed manually for any problems; for example, cognateness was an issue for defining foreign language vocabulary (see Uzun & Salihoğlu, 2009). The cognate words that were easily recognized as Turkish words were eliminated.

In the first round, this final list of words was checked against the words in the lecture notes and only the words common to the two lists were kept. The finalized list was given to the course lecturers and five other professors in order to obtain their opinion on the technicality of the words. Therefore, the current study used a combination of keyness analysis and expert opinion as a hybrid approach as

suggested in the literature (Chung &Nation, 2003; Kwary, 2011; Tongpoon-Patanasorn, 2018).

The rating scale for technical word selection by Chung and Nation (2003, p. 105) was given to the lecturers and they evaluated the words according to the table (See Appendix 3). The lecturers chose only type 3 and type 4 words which had a closely related or specific meaning in the field of environmental engineering. At the end of their analysis, the remaining list of words was adopted for choosing the nodes for deciding on the target collocations to be taught. The following table shows the 35 target words selected randomly as keywords:

Table 4. Target Keywords, Frequencies and Log-likelihoods

	Keyword	***Frequency***	***Log-likelihood***		***Keyword***	***Frequency***	***Log-likelihood***
1	adsorption	5725	20.498.826	**19**	landfill	8365	29.296.472
2	aquifer	2111	7.158.793	**20**	leachate	4700	17.484.594
3	coagulant	705	2.531.809	**21**	lime	3992	11.035.028
4	combustion	7527	25.571.686	**22**	moisture	4048	11.382.259
5	desorption	1025	3.731.611	**23**	plug	651	561.169
6	disposal	12221	34.386.087	**24**	plume	1710	5.327.787
7	effluents	9078	31.468.769	**25**	porous	1704	5.360.960
8	enclosed	572	272.494	**26**	precipitate	811	2.024.334
9	floating	741	349.492	**27**	remediation	3371	12.364.199
10	flocculation	1478	5.349.585	**28**	runoff	3052	10.949.371
11	gravel	1225	1.609.860	**29**	scrap	907	1.244.993
12	grinder	697	332.673	**30**	sewer	2116	6.535.724
13	grit	915	2.195.522	**31**	sludge	25709	93.912.588
14	hopper	508	599.229	**32**	suspended	5793	12.759.592
15	impermeable	539	1.338.994	**33**	titration	592	1.774.376
16	incinerator	2253	7.417.515	**34**	trace	2284	3.116.262
17	inertial	518	549.665	**35**	volatile	4183	12.441.347
18	infiltration	1882	5.801.837				

In the second round, which was the extraction of the target collocates of the keywords found in the previous analysis; the data were extracted from the EEETC. It is mentioned in the literature that in order to find the words that are in a close relationship, an analysis with the Mutual Information (MI) measure is a preferred

method in Applied Linguistics. Based on the analysis, only the collocations with an MI score of 3 or higher were accepted as true collocations (Hunston, 2002, p. 70). The resulting list of collocations was also checked for cognateness and items were discussed with the professors for their reliability to be accepted as technical collocations. The list of extracted collocations was compared against concordances from the lecture notes and the ones occurring in the corpus were noted. In the case of multiple options, we have randomly selected target collocations. The following table shows the 35 words selected as target collocations and their MI scores.

Table 5. Target Collocations and MI Scores

	Target Collocation	***MI Score***		***Target Collocation***	***MI Score***
1	porous medium	8.97	**19**	trace nutrient	7.04
2	scrubber effluents	4.74	**20**	coarse gravel	10.35
3	raw sludge	5.93	**21**	volatile compounds	8.68
4	sewage disposal	6.72	**22**	intrinsic remediation	7.57
5	unconfined aquifer	11.82	**23**	trunk sewer	11.51
6	grit chamber	10.59	**24**	nonferrous scrap	9.78
7	coagulant aid	10.07	**25**	flocculation basin	7.78
8	leachate migration	7.21	**26**	impermeable liner	9.62
9	slaked lime	12.23	**27**	subsequent desorption	6.49
10	suspended solids	9.54	**28**	combustion furnace	6.84
11	incinerator residue	8.03	**29**	insoluble precipitate	9.39
12	reagent adsorption	7.81	**30**	landfill seepage	6.63
13	inertial impaction	14.36	**31**	circular grinder	9.31
14	floating scum	10.34	**32**	moisture retention	6.30
15	excessive infiltration	6.76	**33**	plume rise	9.78
16	agricultural runoff	8.09	**34**	enclosed vat	7.12
17	titration curve	10.13	**35**	plug flow	9.15
18	dust hopper	8.41			

3.4.2 Data Collection Tools

The present study aimed to assess the effectiveness of two instructional settings on the learners' receptive and productive knowledge of the form and the form and meaning of technical collocations from the EEETC which also existed in

the lecture notes. For this purpose, four collocation tests were devised and their reliabilities were calculated after the piloting sessions.

A list of keywords was used for the extraction of the target collocates in the EEETC and only the collocations with MI scores higher than 3 were accepted for the final form of the pre- and post-tests for receptive and productive knowledge of collocations. In order to write reliable and valid tests for the measurement of collocations an exhaustive review of the literature was carried out on studies including tests of collocational knowledge. Based on the analysis, the test formats used by Laufer and Goldstein (2004), Webb and Kagimoto (2009) and Webb, Newton and Chang (2013) were adopted. The data collection procedure for the present study started in the spring semester of the 2015-2016 academic year and lasted over 14 weeks until the end of the semester. The data for the study were collected by the instruments explained in the following section.

3.4.2.1 Preparation of Tests

In order to provide a description of collocational knowledge and assess learners' levels with multiple test batteries; the present study created four different tests of knowledge of collocations. Schmitt (2010) maintains that using tests that assess the knowledge of both recognition and recall of vocabulary and measuring various facets of the dimensions of lexical knowledge gives considerably more precise estimates of the learning that has taken place. Two of the collocation tests aimed to obtain data on the learner's receptive collocational knowledge of the form and the form and meaning constructs whereas the remaining two tests aimed to assess these constructs from a productive perspective.

To further elaborate and define what was involved in those constructs, the present study made use of the definitions created by Nation (2001) and later revised by Nation and Webb (2011). An adapted table can be seen below.

Table 6. Definitions of Receptive and Productive Knowledge

Form	written	R	What does the collocation look like?
		P	How is the collocation written and spelled?
Meaning	form and meaning	R	What meaning does this collocation signal?
		P	What collocation can be used to express this meaning?

R: Receptive Knowledge P: Productive knowledge

Adapted from Nation and Webb (2011, p. 190)

Throughout the study receptive knowledge of collocations was interpreted as the type of knowledge required to comprehend the meaning of English collocations. The receptive knowledge of a word involves the knowledge of spelling and syllabification (Nation, 2001, p. 292), whereas the receptive knowledge of the form and meaning includes the knowledge of derived forms and a familiarity with the examples of any given collocation. When a test purports to measure the concept of recognition, the students who take the test are given the target vocabulary items and are asked to demonstrate whether they know the meaning of a word. Since, the productive knowledge of collocations is described as the type of knowledge necessary for the retrieval of the form of English collocations, for a test asserting to measure the construct of recall, a clue to evoke the meaning of a target item from memory is provided (Nation, 2001; Read, 2000).

The first two tests assessed the productive knowledge aspects of collocations. The first test measured students' productive knowledge of the form of collocations and the second one proposed to estimate the levels of productive knowledge of the

form and meaning of collocations. The third and the fourth tests tapped on the receptive knowledge of collocations. The third test assessed the receptive knowledge of the form of collocations and the fourth measured the receptive knowledge of the form and meaning of collocations.

3.4.2.1.1 Test of Productive Knowledge of the Form and Meaning of Collocations

According to Nation (2013) the productive measurement of the form and meaning constructs can be performed by supplying a translation for the target item into the second language, from Turkish to English for this study. Thus, the Productive Knowledge of the Form and Meaning of Collocations (PKFMC) test requires the learners to write the English equivalent for Turkish collocations for the 35 target items. The learners are required to demonstrate their knowledge of which collocations can be used to refer to the given L1 meaning.

Figure 1. An Example PKFMC Test Item

Please translate the words from Turkish to English
geçirimsiz şilte:

Along with the 35 items eight distracters (see Appendix 4) that were very easy for the learners were included in all four tests to give the students the sense that they could easily answer some items. The translations for the test were requested from 9 professors from the Environmental Engineering department including the lecturers. As the translations of the target items differed from professor to professor, only the most frequently supplied translations were selected. In the cases where the translations differed greatly, the most frequently provided translation were noted down and later two other professors aside from the nine mentioned above were

consulted for the selection of the best option possible. The full test can be seen in Appendix 5.

3.4.2.1.2 Test of Productive Knowledge of the Form of Collocations

This test abbreviated as PKFC requires the learners to write the collocations for the node given so they are supposed to know how the target collocation is spelled and written. The context sentences for this test were retrieved from the Environmental Engineering English Corpus by a thorough analysis of long concordances where the uses of collocations were examined. The researcher attempted to provide the learners with the sentences that were as informative as possible, with an underlying rationale that the context could foster the acquisition of words (Nation, 2001; Webb, 2002; Schmitt, 2010). The suitability of the target context sentences to be used as test items was ensured in five consecutive steps.

First, the candidate sentences were handed to five professors from the department who acted as field experts to evaluate the appropriateness of the given information. Besides, four native speakers, two British and two American instructors, who had assisted in the preparation of the instructional materials, also evaluated the sentences from the perspective of an outsider to the field in terms of grammar and accuracy. Next, the sentences which were confirmed to be informative by the two groups of informants were paraphrased and simplified to ensure their familiarity to the students and to cater to the learners' needs for understanding the vocabulary. Later, the resulting set of sentences was given back to the two groups of instructors to seek their opinion on the fitness of the items as contexts for the collocation tests. As a final step, the sentences which had been approved by the informants were pilot-tested with five freshman and five junior students to see if there were any unknown words to hinder the comprehension of the sentences.

Figure 2. An Example PKFC Test Item

Fill in the blanks with suitable words. In a wind speed of 10 m/s, a **plume** .....of 220 metres is ideal for a power station.

After the corrections based on the feedbacks from the student informants were made, the formatting for the test was finalized. The full test can be seen in Appendix 6.

3.4.2.1.3 Test of Receptive Knowledge of the Form of Collocations

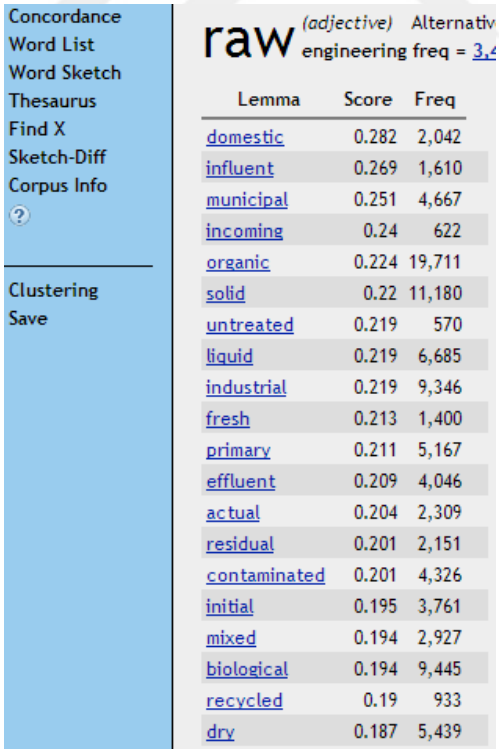
This test abbreviated as RKFC asks the learners to choose the option that collocates with the target item. Thus, learners are expected to know what the target collocation looks like. This test was probably the hardest of all in terms of the preparation process. The context sentences were identical with the test of productive knowledge of the form of collocations. The number of distracters in an MCQ test has long been an area of enquiry in the literature. It was postulated that the issue at hand was not the number of distracters that were used but their quality and effectiveness (Nation, 2001; Rodriguez, 2005; Nation & Webb, 2011). Thus, the ideal number of choices in an MCQ was deemed to be three including the correct option (Haladyna, Downing & Rodriguez, 2002, Rodriguez, 2005).

Therefore, the multiple-choice test for the receptive knowledge of the form and meaning of collocations offered three distracters which would not be dismissed easily as they were chosen from items associated closely to the meaning of the target item plus an “I don’t know option” to avoid wild guessing. For all of the items in the test, Nagy, Herman and Anderson’s (1985) advice for keeping the degree of difficulty at an intermediate level by supplying distracters from the same parts of

speech and providing distracters with similar concepts for higher levels of difficulty was followed.

The target items were assumed to be at much higher levels than the learners' proficiency level. For each item the distractors were produced as follows: With the hope of finding good distractors, some well-known thesauruses were referred to, for paradigmatically and syntagmatically good candidates. Yet, the meaning that was sought for the target words was not provided. As a result of this; an online corpus processing website called the Sketch Engine (Kilgarriff, 2014) that allows researchers to create a thesaurus based on their own corpus was consulted. The EEETC was loaded on the website and the distracters were produced via this website.

Figure 3. Sample Thesaurus Creation by Sketch Engine



Lemma	Score	Freq
domestic	0.282	2,042
influent	0.269	1,610
municipal	0.251	4,667
incoming	0.24	622
organic	0.224	19,711
solid	0.22	11,180
untreated	0.219	570
liquid	0.219	6,685
industrial	0.219	9,346
fresh	0.213	1,400
primary	0.211	5,167
effluent	0.209	4,046
actual	0.204	2,309
residual	0.201	2,151
contaminated	0.201	4,326
initial	0.195	3,761
mixed	0.194	2,927
biological	0.194	9,445
recycled	0.19	933
dry	0.187	5,439

Nevertheless, the process was not as straightforward as one would assume. For example, when working on the item "raw sludge", the analysis from the website

had provided the list on the right (Figure 3). A number of problems were encountered during the analysis as the program used an algorithm which investigated the target word and offered another word that was used in the same slot as the target. However, it was found that all items provided were collocations of sludge. Besides, many of the words were also above the learners' level.

Therefore, every attempt to find a good choice returned with a distractor that was also a collocation of the target node "sludge" The entries from the general thesauruses were also in a collocational relationship with the target node. Accordingly, it was decided to use COCA and BNC as general corpora and HKEC and PERC as engineering corpora in addition to the EEETC corpus. Below are the details of the reference corpora.

Table 7. Specifications of the Reference Corpora Used for Distractor Selection

	Corpus	**Size**	**Field**
1	Professional English Research Consortium (PERC)	17 million words	Science, Engineering, Technology
2	Hong Kong Engineering Corpus (HKEC)	9 million words	Engineering industry in Hong Kong
3	British National Corpus (BNC)	100 million words	Various Genres
4	Corpus of Contemporary American English (COCA)	450 million words	Spoken, Fiction, Popular magazines, Newspapers, Academic Journals
5	Environmental Engineering Textbook Corpus (EEETC)	17 million words	Environmental Engineering

In some cases, it was impossible to use words even from the GSL 2000 and AWL lists, as those words were also found to be collocates of the node words. Due to the fact that almost every attempt failed to provide perfect candidates in some cases, a few synonyms that had similar meanings were supplied as distractors. The full test has been provided in Appendix 7. A sample question from the test can be seen in the figure below.

Figure 4. An Example RKFC Test Item

Choose the best option

A rock or sand that does not have a limiting layer on the top is an ..... **aquifer.**

a) unlocked b) unconfined c) unrestricted d) unsecured e) don't know

3.4.2.1.4 Test of Receptive Knowledge of the Form and Meaning of Collocations

This test abbreviated as RKFMC requires the learners to recall the meaning of the collocation in their L1 (Turkish equivalent in this case) and to write the translations for the 35 target English collocations.

Figure 5. An Example RKFMC Test Item

Please translate the words from English to Turkish

impermeable liner:

The translations which were retrieved from the professors in test of the productive knowledge of the form and meaning of collocations were used as answer keys. In these types of recognition of meaning tests, the learners are expected to display an understanding of what meaning the target collocation signals. The full test can be seen in Appendix 8.

In addition to this, before the administration of the tests to the students, for piloting purposes the four collocation tests were given to 52 freshman students who were going to take the same course the following year. A great deal of effort was put in to make sure that the final versions of the tests had an acceptable level of reliability. The reliabilities of the tests (Cronbach Reliability) were calculated as **α:** 0.719 for PKFC, **α:** 0.704 for PKFMC, **α:** 0.812 for RKFC and **α:** 0.761 for RKFMC during the piloting sessions.

After calculating the reliability measures, the sophomore students were administered the four collocation tests a week before the first instructional session which took place during the second week of the semester.

3.5 The Instructional Design

The students were randomly divided to two classrooms based on their school registration numbers. The students with even numbers were in Class A which was labelled as the "Implicit instruction group" and the students with odd numbers were in Class B which was called the "Explicit instruction group". None of the students were informed about the instructional conditions they were assigned to. For both classes, all of the students were required to read the assigned materials for the corresponding topics weekly before coming to the class. These notes were mainly comprised of compilations from various sources such as textbooks and presentations. The topics of the lecture notes were the four major branches in the field: water, air and soil pollution and waste management. The instructional design for the present study can be seen below.

Table 8. Instructional Design for Both Groups

Week	Class A (Control)	Class B (Experimental)
1	Introduction. Proficiency+ Pre-Tests	Introduction Proficiency+ Pre-Tests
2	Water (Reading + Listening)	Air (Spaghetti matching)
3	Water (Reading + Listening)	Air (Filling in the blanks)
4	Water (Reading + Listening)	Air (Matching with definitions)
5	Air (Reading + Listening)	Water (Filling in the blanks)
6	Air (Reading + Listening)	Water (Word Puzzle)
7	Air (Reading + Listening)	Water (Correcting the mistakes)
8	Midterm Exam	Midterm Exam
9	Soil (Reading + Listening)	Waste (Translation)
10	Soil (Reading + Listening)	Waste (Rearranging phrases)
11	Soil (Reading + Listening)	Waste (Correcting the mistakes)
12	Waste (Reading + Listening)	Soil (Rearranging phrases)
13	Waste (Reading + Listening)	Soil (Translation)
14	Waste (Reading + Listening) Post-Tests	Soil (Writing sentences) Post-Tests
15	Final Exam	Final Exam

During the course, the lecturers introduced the learners to the topic and gave a lecture using Power-Point presentations. Students usually asked for translations and preferred to keep quiet. There was also a question and answer session.

3.5.1 Implicit Instruction

For the purposes of carrying out an experimental instruction design, the students in the control group studied the course with the lecturers in a traditional fashion for 70-75 minutes starting at 1 p.m. every Thursday. During the last 15-20 minutes of the class another instructor, who was also the researcher, carried out some activities for teaching the target collocations implicitly. Each week, the implicit group students were handed out a worksheet that included a text to be read (See Appendix 9). The texts were taken from the lecture notes and they contained the target collocations to be learned. At the beginning of each instructional session, students were given handouts which included the paragraphs taken from the corresponding week's lecture notes that contained the target collocation items.

At first, the learners were instructed to listen to the text on the handouts from a sound file played through a computer via a powerful sound system. The sound files were recorded by the four native speakers of English mentioned earlier in the study. The native speakers recorded the sound files in a silent room to avoid background noise and devoted considerable efforts to make the narration of the passages as naturalistic and clear as possible. With special consideration for the learners' level, a mean speech rate of 90-100 words per minute was preferred. The audibility of the sound file was confirmed by the students sitting at the very back of the class. While listening to the sound files, the students concurrently read through the paragraphs.

This procedure was proposed to ensure that the entire passage was followed by the participants (Horst et al., 1998; Zahar et al., 2001). As well as providing the learners with chances to be exposed to the text once again, this technique helped the instructor to prevent the learners from doing deliberate learning tasks such as writing down words for further study, using dictionaries or simply memorizing, etc. No explicit translation of the target item was provided for the learners by the instructor.

3.5.2 Explicit Instruction

The students in the explicit learning group (Class B) studied the course with their lecturers in a traditional fashion for 70-75 minutes starting at 1:30 p.m. every Thursday just like the implicit learning group. An instructional design was also established to teach the experimental group learners. A number of collocation learning tasks that had previously been suggested in the literature and textbooks had been investigated. The students were exposed to both receptive and productive activities in real contexts from their fields of study.

As Joe (1995, p.149) suggests "Text-based tasks which require learners to attend to new vocabulary and use it in original ways can, in so doing, facilitate vocabulary acquisition." The activities were carefully selected to support different strands of vocabulary teaching Nation (2001; 2007). For the classification of the collocation activities, the present study uses the five-level classification scheme developed by Paribakht and Wesche (1996) through their adaptation of Gass's (1988) second language acquisition framework. The Paribakht and Wesche (1996) framework defines the five levels as: selective attention, recognition, manipulation, interpretation and production.

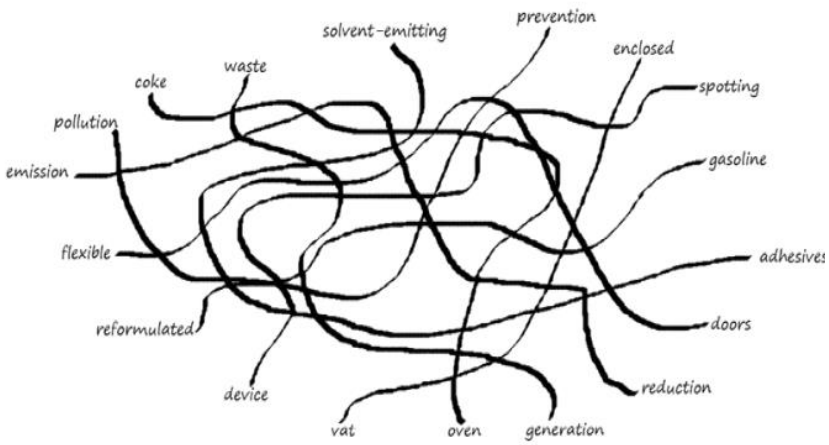
3.5.2.1 Activity Types for the Explicit Instruction

The following activities classified by using the above framework were proposed for the explicit instruction of receptive and productive knowledge of collocations.

1-Matching the parts of target collocations:

This consciousness raising activity which aims to introduce the concept of collocations to students is placed in the selective attention category of Paribakht and Wesche (1996) and is also defined as apperceived input by Gass (1988). For Gass (1988), apperceived input comprises the process of noticing by learners that the language input has something to be considered. The term apperceived input corresponds to the concept of noticing by Schmidt (1990) which claims that the first step in processing the incoming language to transform it into intake is the condition that the learners initially recognize it. That is, if learners can be made intensely aware of the incoming language, it is quite possible for them to increase the retention rates of the input in their memory for longer periods of time. This activity was adapted from the spaghetti matching activity by Lewis (1997, p. 115). A sample activity where learners followed the lines used in the present study can be seen below:

Figure 6. Matching the Parts of Target Collocations



The activity was aimed at introducing the students to the concept of technical collocations prior to learning how certain words are frequently used adjacent to each other. Based on the analysis of the documents and teaching materials obtained from the university's language preparatory school that the students were enrolled at two years previously, it was affirmed that the learners had already been familiar with and exposed to collocations. Thus, understanding the concept was assumed to be a familiar task for the learners.

2- Matching target collocations with the definitions:

The second activity type listed as a recognition activity in the framework provides learners with all the crucial components and merely requires some partial knowledge for combining the form of collocations with the meanings provided. This activity aims at strengthening the connection between the form and meaning of a collocation and to establish the connection, a learner is required to recall the meaning when he/she sees it among other definitions (Ward, 2007; Wesche & Paribakht, 2000). The format can be seen in the figure below.

Figure 7. Matching the Collocations with the Appropriate Definitions.

a) intrinsic remediation	1) an approach that uses natural processes to remove or transform contaminants from groundwater or soil.
b) suspended solids	2) layer of water-holding material without a limiting layer at the top of the groundwater.
c) volatile compounds	3) pollutants that can be directly used as single carbon and energy sources by bacteria.
	4) small particles that float on the surface of sewage or other liquids.

In this activity, the learner chooses and matches the correct definition from a list of definitions of collocations he/she had previously encountered during the Power Point presentation session.

3- Correcting collocational mistakes:

The third activity format intends to raise students' awareness about the proper use of collocations (Hill, Lewis & Lewis, 2000) and aims to ameliorate the effects of using erroneous patterns for collocations and finally, to attract learners' full attention to how and with what items collocations should not be used (Boers et al., 2014; McCarthy & O'Dell, 2005). This exercise is labelled as a production activity by Paribakht and Wesche (1996), as the students were expected to identify the collocational mistake in the sentence and correct it by recalling the right item from their mind. For this activity an intentional collocation mistake is provided in each sentence. The students are asked to supply the correct word by looking up the word in bold in their lecture notes. A sample exercise can be seen in the figure below.

Figure 8. Correcting Collocational Mistakes

Correct the collocational mistakes in the sentences:

1- When the depth of settled sludge or **floating** filth approaches the depth specified in the manuals, the tank needs cleaning.*

2- Crushed stone or rough **gravel** should be filled in between the outside of the leaching pit wall and the earth hole.*

3- In addition, the nitrogen in the air will also react with oxygen at the elevated temperatures of a **combustion** grill.*

*: Incorrect collocation

The mistakes that have been presented were obtained from informant first year engineering students with a similar language background through a Turkish to English collocation translation task.

4- Writing target collocations in the blanks:

The fourth activity type listed in Paribakht and Wesche's (1996) interpretation category includes the analysis of meanings of lexis regarding the connection between selected words and the other options in the context. The learners were given a list of node words for the collocations and were required to fill in the blanks. A sample exercise can be seen in the figure below.

Figure 9. Writing target collocations in the blanks:

Fill in the blanks with the following words:

wetland, migration, liner, coarse

1- Treatment areas are often covered with an impermeable……. to reduce the amount of leachate entering the uncontaminated soil.

2- Because the wastewater is kept below the surface these systems of the medium which ranges from ……. gravel to sand, these systems reduce mosquito and odour problems.

3- In order to limit the leachate ……., circumferential drainage around the scarp foot of the field was built.

4- The major components of constructed ……. systems are the plants, soils, and microorganisms.

5- Writing target collocations in puzzles:

Puzzles are usually pleasurable activities that can motivate learners, as they present them with a challenge by requiring some kind of productive retrieval (McCarthy & O'Dell, 2005, Walter& Woodford, 2010). In this activity, the students were supplied with the whole collocations that had already been studied in the Power

Point presentation section of the collocation instruction. Authentic sentence contexts were given as clues to find and write the answers in the down and across boxes in a crossword puzzle format.

For the reason that the collocations were introduced as a whole in the present study, the learners were able to encounter the correct nodes and collocates, so the possibilities for any mismatching of collocations were avoided (Boers et al., 2014, 2016). A sample exercise can be seen in Appendix 10.

6- Translating target collocations into the first language:

Due to its requirement of only partial knowledge of the target collocation where learners need to notice the form and give the equivalent of the target collocation, the translation activity is placed in the recognition category of the Paribakht and Wesche (1996) framework. Translation has long been acknowledged as an assessment tool for measuring learners' knowledge of specific vocabulary (Nation, 2001; Schmitt, 2010). Besides, Laufer & Girsai (2008) argue for the effectiveness of using translations for learning collocations in English. The translation activity is also regarded as a language focused learning activity that has a "deliberate focus on meaning as well as form" (Nation 2007, p.6). A sample exercise can be seen in the figure below.

Figure 10. Translating target collocations into the first language

Translate the following sentence into Turkish:

Recent studies evaluated the antimicrobial activity of acetone extracts and the **volatile compounds** of **freshwater green algal species** obtained from specified wetlands.

Yakın dönemde yapılan çalışmalar seçili sulak alanlardan elde edilen **tatlı su yeşil alglerinin** aseton ekstraktlarının antimikrobiyal aktivitelerini ve **uçucu bileşenlerini** değerlendirmiştir.

This activity draws learners' attention to the collocations and requires them to translate the target items into their L1 as whole units without breaking chunks down. A carefully and regularly designed vocabulary programme should include this activity to raise learners' awareness of collocations and should help them curb their tendency to translate collocations word for word (Hill, Lewis & Lewis, 2000).

7- Rearranging phrases including target collocations to write sentences:

The activity of rearranging chunks and phrases into sentences is intended to help learners in raising an awareness of the structures of collocations. As the activity requires some amount of re-organization and exploitation of forms it is placed in the manipulation category by Paribakht and Wesche (1996). The learners manipulate the jumbled phrases and use their syntactic and grammatical knowledge to form meaningful sentences (Ward, 2007; Wesche & Paribakht, 2000). A sample format can be seen below.

Figure 11. Rearranging Phrases to Write Sentences

[the uncontaminated soil**]** **[**are often covered**]** **[**the amount of leachate**]** **[**to reduce**]** **[**entering**]** **[**impermeable liner**]** **[**with an**]** **[**treatment areas**]**

8- Writing sentences using target collocations:

This activity format adapted from Schmitt & Schmitt (2005, p.9.) supplies the students with three sentences containing the same collocation and the learners are asked to create a sentence of their own by using the same collocation. This activity requires a high level of productive generation because the learners needs to extend their knowledge by enhancing and manipulating their understanding of the form and meaning of given collocations. A sample exercise can be seen in the figure below.

Figure 12. Writing Sentences Using Target Collocations

Each sentence below has the same collocation. Write your own sentence using the same collocation.

1. **a)** Slag milling and classification generates wastewater that is high in **suspended solids**, copper, lead, and zinc.

b) The principal pollutants are total **suspended solids**, oil, and grease, and low levels of particulate metals.

c) The waste-streams from the air pollution control devices contain significant levels of **suspended solids** and chlorides or fluorides, as well as moderate amounts of heavy metals.

d) ……..

With the help of this productive activity in which the learners had to look for and use a correct word form and write grammatically correct sentences; they were expected to perceive the eventual shortcomings in their productive knowledge. They would benefit from this output activity due to the fact that using the language productively urges the students to carry out comprehensive analysis of the language input for successful retrieval (Gass, 1988; Nation, 2007).

3.5.2.2 Instruction

After 70-75 minutes of the regular engineering class, the learners in the experimental group were instructed with one of the above collocational tasks. In other words, the last 15-20 minutes of the class hour was reserved for explicit teaching of collocations. The 35 target collocations were allocated evenly over twelve weeks of instructions, in sets of 3 except for one week which included two target items. The items were not randomly assigned to the three weeks appointed for each of the four major branches (air, water and soil pollution and waste management) but were used each week corresponding to their first mention in the lecture notes.

The sentences and items on the worksheets were identical to the sentences and phrases in the lecture notes in a majority of cases or were the definitions of words or the paraphrases of those sentences. After eliciting the answers from individual students and discussing their correctness with the whole class, the instructor went over each item to ensure the whole class was presented with the right answers. As explained before, the participants were instructed on a continuum of receptive to productive collocation-learning activities throughout the 12 weeks.

To avoid any extra exposure to the target collocations which would result in an imbalance between the explicit and implicit groups, no additional task or homework was given. Every week, the lesson started with a Power-Point presentation that included a predefined number of target collocations alongside other collocations in the lecture notes. Each collocation was supplied in the slide and the learners heard its pronunciation by a native speaker three times from an audio file. The Turkish equivalent of the collocation was displayed on the same page. Once all of the collocations had been practiced with the presentation by focusing learners' attention explicitly on the collocations, the worksheets were distributed to the students. (See Appendices 11 and 12).

In each of these sessions, the learners were instructed to complete the worksheets with the help of an example or an explanation that was provided on the blackboard. Yet, the learners were not explicitly told that certain items were target collocations. The 8 tasks proposed above were allocated to different weeks to ensure variability between different types of exercises ranging on a scale from receptive to productive. As mentioned before, the students were given handouts for practicing collocations and the sentences and contexts in those sheets were taken from the lecture notes and also contained the target collocations to be learned.

3.6 Administration of Tests and Scoring

First of all, in order to determine whether there were any significant differences in the general English proficiency in reading and the vocabulary knowledge levels of students from the two classes, two tests were administered on the same day in the first week of the semester. The first test which assessed the learners' reading proficiency was the section of reading from a previous Preliminary English Test (PET) by Cambridge University. The reading test had 35 questions with different question types.

Subsequently, the learners were administered the test of 1000-word level by Nation (1993) and the 2000, 3000 and AWL sections of the Vocabulary Levels Test of Schmitt, Schmitt and Clapham (2001). The revised and expanded version of the Vocabulary Levels Test by Schmitt, Schmitt and Clapham (2001) was administered to see the knowledge levels of participants. Since no test to date has been fully successful in accounting for the whole picture of knowledge of vocabulary for a learner, "The closest thing the field has to such a vocabulary test is the Vocabulary Levels Test" (Schmitt, Schmitt & Clapham, 2001, p.55). The whole testing procedure took about 40-55 minutes to complete for all learners. After the test, on the following day the students were invited to take other tests that would help them learn their language levels. The next day almost all of the students appeared to attend the testing sessions during their engineering lab hours. The procedures of these test administration sessions are explained in detail in what follows.

The following procedure was adopted for both the pre-test and the post-test sessions for the administration of the four collocation tests identically. All of the four tests were administered in a large lecture hall under controlled classroom conditions. The two groups were tested simultaneously during their laboratory hours on Fridays,

without the knowledge that they were allocated to different instructional groups. The engineering laboratory professors kindly allowed the learners to sit for the exam. All of the participants were offered refreshments before and during the exams to create a relaxed atmosphere. Before the exams started, the researcher and learners had a casual chat. The students knew that they would not be graded on these tests, yet knew that the tests were aimed at measuring their progress throughout the semester.

Another invigilator from the language department was introduced to the learners as being there to help with the distribution and collection of the test papers. Although, the researcher did not set strict time limits for each test, the students were informed about the time constraints and they knew they had to go back to their studies in the lab. In order to ensure that a previous test did not influence the following tests, all of the test papers were individually printed on single sheets and were handed out to the students on completion of the previous test.

To prevent any complications, all four test sheets were printed on different coloured sheets to avoid any disturbances in the correct order of tests. So, the sequencing of each test was rigorously monitored to avoid any influence of a prior test on the later ones. Firstly, the productive PKFMC test which required the translation of the L1 equivalent into English by using the target collocation was given to the students. Because the L1 translations given in this test were also the expected responses in the fourth RKFMC test, the learners were given a challenging memory task including mathematical calculations and comprehension questions in Turkish to erase the items from the memory immediately after the first test as suggested by Schmitt (2010). The students were urged to answer this Turkish test as quickly as possible and were requested to note the time they spent answering the questions.

The next test in line was the PKFC test where the students wrote the collocations to the given nodes. The learners spent about 10 minutes for each test; however, the times spent on each test varied among learners. The researcher and the invigilator observed each learner carefully and without interruption, and prevented learners from spending a long time on each test by offering the next test if they were struggling to answer the one they had. The third test, the RKFC, was the receptive multiple-choice question test. The final test to be administered was the RKFMC test where the learners saw the target collocation and supplied the L1 meaning as mentioned above. In both of the pre- and post-test sessions, it was observed that all of the students complied with the time limit and were able to finish all four tests in approximately 45-60 minutes.

After all of the four collocation tests had been completed by the learners, they were submitted for scoring. The answers to the tests were scored dichotomously, where correct answers were assigned 1 and incorrect ones were given 0. Except for very minor spelling errors, no partial knowledge was rewarded. It was obvious that the translation test would yield a number of responses that would require some subjectivity to be accepted as true answers. In those cases, the researcher referred to the translations supplied by the lecturers as mentioned in the test preparation procedures and in cases where it was beyond the researcher's knowledge, the items were discussed with three other professors from the department, and the responses received one point if the professors reached an agreement. The scores from all four tests were later submitted for statistical analysis.

CHAPTER 4: FINDINGS

The quantitative data obtained from the four collocation tests were analysed using descriptive statistics (namely means, percentages and standard deviations). The study employed normality tests for making decisions on the application of parametric or nonparametric statistical tests. In order to answer research questions 1 and 2, independent samples t-tests and Mann-Whitney U tests based on gain scores were conducted to determine whether there were any statistically significant differences between the groups in terms of the type of instruction received.

In order to determine whether there were differences between the groups in the measures of reading proficiency levels and vocabulary knowledge at the beginning of the semester, the results from the 1000, 2000, 3000 and AWL word level tests and the PET test scores were investigated. After confirming the normality assumptions on the test scores, independent samples t-tests were used to analyse any existing differences between groups. The results from the following table indicate that there were no significant differences between groups.

Table 9. Independent T-Test Results for Vocabulary and Proficiency

Test	Groups	*N*	$\overline{X}$	*SD*	***df***	***t***	***p***
1000 level	Explicit	31	28.84	3.358	59	1.819	.074
	Implicit	30	27.07	4.218			
2000 level	Explicit	31	16.52	5.347	59	1.755	.084
	Implicit	30	13.87	6.410			
3000 level	Explicit	31	10.61	5.841	59	0.799	.428
	Implicit	30	9.43	5.685			
AWL level	Explicit	31	11.97	5.295	59	1.192	.238
	Implicit	30	10.20	6.266			
PET Test	Explicit	31	17.13	5.632	59	1.800	.077
	Implicit	30	14.80	4.37			

The results from Table 9 indicate that there were no significant differences between groups in terms of their reading proficiency scores and vocabulary levels test scores.

Prior to investigating the results from the collocation tests, the researcher aimed to enquire if the two groups were significantly different from each other on their receptive knowledge of the form of collocations before the experiment. So, the n being over 30, a Kolmogorov-Smirnov test was used. The Kolmogorov test revealed that the explicit group scores (p=0.000< 0.001), and implicit group scores (p=0.000< 0.001) were not normally distributed. Based on this finding, the Mann-Whitney U test was preferred for the analyses. The Mann-Whitney U test performed on the pre- RKFC tests of both groups showed that the explicit learning group (*Mdn*= 2) and implicit learning group (*Mdn*= 3) did not significantly differ in terms of their receptive knowledge of form, U = 438.50, z = -0.39, p> 0.05.

Furthermore, before exploring the results from the collocation tests, the researcher aimed to inquire if the two groups were significantly different from each other on their receptive knowledge of the form and meaning of collocations before the experiment. So, the n being over 30, a Kolmogorov Smirnov test was used. The Kolmogorov test revealed that the explicit group scores (p=0.000< 0.001); and implicit group scores (p=0.000< 0.001) were not normally distributed. Based on this finding, the Mann-Whitney U test was preferred for the analyses. The Mann-Whitney U test performed on the pre-RKFMC tests of both groups showed that the explicit learning group (*Mdn*= 1) and implicit learning group (*Mdn*= 0) did not significantly differ in terms of their receptive knowledge of form, U = 404, z = -0.93, p> 0.05.

In addition to the above analysis, further exploration of whether the two groups were significantly different from each other on their productive knowledge of the form of collocations before the experiment was carried out. A Kolmogorov-Smirnov test was used as the n was over 30. The Kolmogorov test revealed that the explicit group scores (p=0.000< 0.001); and implicit group scores (p=0.000< 0.001) were not normally distributed. Based on this finding, the Mann-Whitney U Test was preferred for the analyses. The Mann-Whitney U test performed on the pre-PKFC tests of both groups showed that, the explicit learning group (*Mdn*= 0) and implicit learning group (*Mdn*= 0) did not significantly differ in terms of their receptive knowledge of form, U = 419, z = -0.75, p> 0.05.

The research also enquired if the two groups were significantly different from each other on their productive knowledge of the form and meaning of collocations before the experiment. The n being over 30, a Kolmogorov-Smirnov test was used. The Kolmogorov test revealed that the explicit group scores (p=0.000< 0.001); and implicit group scores (p=0.000< 0.001) were not normally distributed. Based on this finding, the Mann-Whitney U test was preferred for the analyses. The Mann-Whitney U test performed on the pre-PKFMC tests of both groups showed that, the explicit learning group *(Mdn*= 1) and implicit learning group *(Mdn*= 0) did not significantly differ in terms of their receptive knowledge of form, U = 415.5, z = -0.82, p> 0.05 at the beginning of the term.

4.1 Research Question 1

Are there any differences in the receptive knowledge of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

The first research question intended to find out if there were any differences in receptive knowledge of collocations of learners in the incidental and intentional collocation learning groups. Therefore, the research made a comparison between the types of instruction based on the scores that indicated levels of collocational learning attained. The RKFC and RKFMC pre- and post-test results were analysed for this purpose.

4.1.1 Research Question 1a

Are there any differences in the receptive knowledge of the form of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

In order to understand whether significant differences occurred between the implicit and explicit group learners in their ability of collocational form recognition as a result of instruction, normality of the data calculated from gain scores was first checked. The total number of participants was higher than 30, so the Kolmogorov Smirnov test was used. The results indicated that explicit group scores (p=0.200 > 0.05), and implicit group scores (p=0.137 > 0.05) had a normal distribution. Thus, an independent samples t-test was selected for the analyses.

Table 10. Independent T-Test Results for RKFC Test scores

Group	N	*X*	*SD*	*df*	*T*	*p*
Explicit	31	13.32	5.78	59	4.73	0.000
Implicit	30	7.53	3.54			

An independent samples t-test conducted on scores from the RKFC test showed that the students in the explicit learning group remembered more collocation forms and thus, performed significantly better than the students in the implicit learning group.

4.1.2 Research Question 1b

Are there any differences in the receptive knowledge of the form and meaning of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

With the purpose of analysing whether the instructional conditions had any significant effect on the receptive knowledge of the form and meaning of collocations for students in each condition; the change scores obtained from pre and post-tests were checked for normality. The n being over 30, the Kolmogorov-Smirnov test was preferred. The results revealed that the explicit group change scores (p=0.200> 0.05) did not deviate from normal distribution, whereas the change scores for the implicit group (p=0.000< 0.05) were not normally distributed. Therefore, it was decided to use a non-parametric test for analyses.

Table 11. Mann-Whitney U Test Results for RKFMC Test scores

Group	N	*Mean Rank*	*Sum of Ranks*	*U*	*p*
Explicit	31	37.21	1153.5	272.5	0.005
Implicit	30	24.58	737.5		

The Mann-Whitney U test performed on the RKFMC test scores illustrated that the students who learned collocations under explicit conditions recognized more collocations and achieved significantly higher scores in comparison to the learners in the implicit group**.**

4.2 Research Question 2

Are there any differences in the productive knowledge of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

The second research question aimed to examine whether any significant differences existed between learners in the implicit and explicit collocation learning groups in terms of their productive knowledge of collocations. For this aim, a comparison between the PKFC and PKFMC pre- and post-test results was made.

4.2.1 Research Question 2a

Are there any differences in the productive knowledge of the form of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

In order to carry out further analysis for exploring whether the instruction created any significant differences in the recall of the form of collocations for students from each group, the scores from pre- and post-tests were checked for the assumption of normality. As n was over 30, the Kolmogorov Smirnov test was used for checking the assumption. The results indicated that the scores from the explicit group (p=0.200> 0.05); and the scores from the implicit group (p=0.088> 0.05) were normally distributed. Based on this finding, an independent samples t-test was chosen for the analyses.

Table 12. Independent T-Test Results for PKFC Test scores

Group	*N*	*X*	*SD*	*Df*	*t*	*p*
Explicit	31	8.64	3.64	59	5.5	0.000
Implicit	30	4.9	1.9			

An independent samples t-test comparing scores on pre- and post-PKFC tests demonstrated that the explicit group students produced more collocations and performed significantly better than the students in the incidental learning group.

4.2.2 Research Question 2b

Are there any differences in the productive knowledge of the form and meaning of collocations of environmental engineering students who receive implicit or explicit collocation instruction?

Following the collection of scores from the pre- and post-tests, a change score was calculated and scores were submitted for normality. For the reason that n≥30, the Kolmogorov-Smirnov test was selected. The results demonstrated that the scores of both the explicit group members (p=0.004< 0.05) and the implicit group members (p=0.046< 0.05) significantly deviated from normal distribution. Thus, the non-parametric Mann-Whitney U Test was chosen for the analyses.

Table 13. Mann-Whitney U Test Results for PKFMC Test scores

Group	N	*Mean Rank*	*Sum of Ranks*	*U*	*p*
Explicit	31	40,76	1263,5	162,5	0,000
Implicit	30	20,92	627,5		

The Mann-Whitney U test conducted on the scores obtained from the pre and post PKFMC tests indicated that, the students in the explicit group were able to recall significantly higher numbers of technical collocations than the students in the implicit learning group**.**

CHAPTER 5: DISCUSSION & CONCLUSION

5.1 Introduction

This study aimed to explore the effectiveness of learning of technical collocations under intentional and incidental learning conditions and provided the preliminary findings for the acquisition of these collocations in a field of engineering where there is a dearth of research on the efficiency of instructional methods. In the remainder of this chapter, the study briefly summarizes and discusses the findings obtained from the analysis of the data from the tests, and the results pertaining to each of the two main research questions are elaborated with specific reference to previous collocational research and instructional theories.

5.2. Research Question 1

In light of the findings mentioned in the analysis, it can be posited that the analysis of the first research question aiming to explore whether any differences existed in the receptive knowledge of the form and the form and meaning of collocations of environmental engineering students under implicit and explicit collocation instruction was able to demonstrate particularly promising results for the explicit teaching of technical collocations. The students in the explicit learning group were observed to have increased their knowledge on recognition and recall of the form and meaning of collocations. The following sub-research questions discuss these findings in detail.

5.2.1 Research Question 1a

The first sub-question of research question 1 aimed to determine whether there were significant differences in the scores of learners in terms of their receptive knowledge of the form of collocations. The results indicated that the number of

successfully recognized forms of collocations in the intentional learning group was significantly higher, with a larger effect size, than that of the students in the implicit learning condition. In summary, the whole set of results points to significantly higher gain scores obtained by learners who were exposed to deliberate collocation learning tasks ranging from receptive activities to controlled production.

A literature review on collocation instruction indicated that there were a limited number of studies that attempted to inquire into the efficacy of implicit learning of collocations. With a stringent control of the frequency and occurrences of collocations embedded within a story during a reading task Pellicer-Sanchez (2017) was able to exhibit the possibility of learning collocations incidentally; nonetheless, manipulating the number of occurrences of collocations did not produce a statistically significant impact on collocation acquisition. It is without doubt that reading under incidental vocabulary learning conditions helps in the expansion of vocabulary and foster word recognition and decoding. The problem of how to successfully modify authentic tasks to accommodate 15 occurrences of the same target collocations (see Webb, Newton & Chang; 2013) without disrupting the natural flow of language and by preserving the ecological validity still remains a difficult one (Snoder, 2017). The comparison of the learner scores on the learning of technical collocations proposed that implicit collocation instruction also had a positive but non-significant effect on the acquisition of collocations.

Besides, organising and controlling the number of exposures and amount of time needed to support an incidental learning condition in a fully loaded academic schedule also raises doubts about the practicality of the method. Furthermore, learners using deliberate techniques retained higher numbers of collocations than the

incidental learning group in a shorter time, as their undivided attention was attracted to the target collocations.

For instance, Serrano (2018) compared the differences between the use of attention drawing techniques, explicit activities and implicit conditions for learning Spanish collocations by second language learners in a seven-week treatment. The results showed that it was possible to acquire receptive knowledge of collocations under all conditions with mere exposure, noticing with enriched input and explicit exercise conditions yet the substantial contributions to the learning were made through the use of explicit exercises. In agreement with the above claims, Pellicer-Sanchez (2017) postulated that receptive knowledge of collocations was more easily improved and took less time to be intensified than productive aspects.

With reference to these claims, Boers et al. (2006) emphasized that "noticing may be a prerequisite for learning, but it does not necessarily guarantee the acquisition of every single element that gets noticed" (p. 257), and this assertion was further justified by Webb and Kagimoto (2009) and Sonbul and Schmitt (2013) who demonstrated the superiority of direct explicit approaches in facilitating collocational knowledge for both non-native and native speakers of the English language. The superiority of explicit teaching was also approved by Gheisari and Yousofi (2016) who explored the effectiveness of incidental and intentional learning of receptive knowledge of the form of collocations with students encountering collocations in their textbooks repeatedly by the input treatment, and learners investigating collocations through consciousness-raising activities as the explicit group. The study determined that students who were requested to recognize and study collocations explicitly were superior in identifying the form of target collocations.

In many cases in SLA, it is easier to enhance the receptive features of the form of collocations than to recall the item from memory for production. The possibility of encountering a collocation with multiple occurrences in the same text is highly unlikely. The manipulation of frequency of collocations in texts does not guarantee the successful acquisition of those collocation; since frequency is an immensely complicated construct for one to grasp (Laufer & Rozovski-Roitblat, 2011; Szudarski & Carter, 2016). Not until a sufficient number of exposures to collocations is ensured by reading materials, will the plausibility of acquiring collocations incidentally appear to be at a minimal level. Majd (2017) assessed the effectiveness of three different tasks that were practicing through recalls, answering multiple-choice questions and filling in the blanks with target collocations. Although, all three tasks facilitated some amount of learning, the recall practices provided the highest gains.

The present study attempted to provide students in the implicit group with the highest possible number of exposures to the target collocations through the use of simultaneous listening and reading activities without manipulating the authenticity of texts and learning conditions. In addition to this, the learners were asked to re-read the text which possibly increased their chances of re-exposure.

The findings from the research question investigating the receptive knowledge of form are consistent with the data provided by El Dakhs, Amroun and Charlott Muhammad (2017) who exhibited the superiority of explicit learning tasks over incidental learning tasks. El Dakhs et al. (2017) were able to demonstrate that long-term comparisons between incidental and control groups revealed no significant differences, yet the instructed explicit group members were able to maintain their scores on receptive knowledge tests. The findings from the RKFC receptive test in

the present study support the view of El Dakhs et al.'s (2017) study and reiterate the advantages of learning collocations intentionally for higher levels of achievement.

5.2.2 Research Question 1b

In response to the second sub-question of the first research question, which inquired whether there were any significant differences in the participants' receptive knowledge of the form and meaning of collocations, the data revealed differences at statistically significant levels in favour of the explicit condition. The findings of the present study are in line with the previous research that investigated teaching collocations which indicated the effectiveness of intentional learning.

For instance, in an explorative study, Hu (2015) worked with three groups of learners who all read texts accompanied with L1 glosses and highlighted collocations. The groups differed in terms of the post-reading activities which were comprehension questions, fill-in-the-blanks exercises and multiple-choice questions. It was found out that enhancement techniques plus glosses supported by post-reading comprehension questions were unable to foster any receptive or productive knowledge of collocations. The results also indicated that the students who answered multiple choice questions received better scores than the participants writing collocations in the blanks in the tests of receptive knowledge of the form and meaning.

Peters (2009) demonstrated that the attention-drawing technique for collocations did not produce any significant differences between students who were instructed to notice collocations and students who paid attention to single-word items in terms of their recall of collocations. The non-significant results might be due to the fact that the students were notified of a follow-up test after the instruction.

Additionally, Szudarski (2011) used a very similar methodology to draw learners' attention to collocations through the use of enriched exposure. His findings mirrored Peters' (2009) results in that both groups improved their scores, whereas, no differences existed between the two groups. The current study makes it evident that the use of various collocation activities in addition to attention drawing is a more effective method than simply asking learners to make notes of collocations.

Szudarski and Carter (2016) explored the learning of collocations by Polish ESL learners under enhancement conditions and input flood technique. The number of collocations was increased from 6 to 12 by changing the number of repetitions in the texts. Both groups encountered identical types of input; yet, the enhanced condition learners were given the target collocations boosted by underlining. The results obtained from delayed post-tests revealed better scores for the enhancement method over the input flood technique for recognition of collocations. However, the form- and meaning-related features of collocational knowledge were not improved even with textual enhancement. The findings from the present research investigating the receptive knowledge of the form and meaning are consistent with the data provided by Szudarski and Carter (2016). Although some amount of learning was possible, the implicit learning group learners who had read and listened to lecture notes could not outperform the intentional group learners.

To compare the effectiveness of the exercise types used while teaching collocations, Boers et al. (2014) specifically focused on three task types that were connecting parts of collocations, inserting the node and inserting the collocations as a whole. No significant differences were found between the types of activities in terms of effectiveness and very few gains were achieved in knowledge of collocations. In contrast, the current study demonstrated that the provision of collocations explicitly,

seeing their translations beforehand and doing additional exercises afterwards are significantly effective methods for collocation learning. Despite the non-significant findings, Boers et al. (2014) also suggested that the collocations should be supplied in an intact form to expose the learners to the correct forms of collocations as a whole.

The significance of using various input- and output-type activities was also acknowledged by Zhang (2017) who explored the receptive and productive integration tasks for learning collocations. The findings show that activities requiring recognition and recall of items on a continuum are more effective than mere use of single techniques. In line with this study, a large number of activities for the form and meaning recall and recognition of collocations were presented to the learners in the current study.

In many of the exercises used in the present research especially in re-arranging tasks the learners were served with opportunities for encountering the intact collocations as authentic phrases taken from their lecture notes; therefore, it might arguably be claimed that this has contributed to their success. Furthermore, the results of the two receptive tests indicate that the explicit treatment had a significant impact on learners' ability to recognize the correct spelling (the form) and supply the L1 translation (the meaning) of technical collocations.

5.3 Research Question 2

The vast majority of research indicates that the learning of productive vocabulary brings more burdensome necessities which require learners to devote a great deal more effort than they would put in for improving their receptive knowledge. It is clear that the productive knowledge encompasses the receptive

knowledge and broadens it. On this issue, Laufer and Waldman (2011, p. 652) claimed that "the real problem of collocations in L2 does not lie in recognition, but in learning to use them properly".

The purpose of the second research question was to examine whether there were any statistically significant differences in the performance scores of the two groups in producing the forms and meanings of technical collocations. In other words, were the reading-plus-listening implicit group learners more successful in translating the target collocations from Turkish to English and writing them correctly than their counterparts in the intentional learning condition? The students' score changes from the pre- to post-tests were converted into gain scores and an independent samples t-test and a Mann-Whitney U test were applied on these scores. The following sections give further details of the assessment of the acquisition of productive knowledge of collocations.

5.3.1 Research Question 2a

The analysis of the results of the first sub-question of the second research question of the present study demonstrated that explicit technical collocation instruction was effective in fostering an understanding of the productive form of collocations, with findings indicating statistically significant scores obtained by students in the explicit learning group.

As was indicated in the literature review, previous research on single and multiword vocabulary studies has clearly demonstrated that deliberate study of vocabulary has profound impacts on learners' language competence and allows the learning to take place in a shorter period of time in the tight schedules reserved for instruction. Besides, a large number of studies have investigated the acquisition of

collocations under intentional learning conditions through explicit teaching and it was shown that the use of the explicit type of activities (such as matching, multiple-choice exercises and cloze tasks) helps considerably in the learning of collocations in a foreign language (Boers et al., 2014; Boers et al., 2016; Chan & Liou, 2005; Sun & Wang, 2003; Webb & Kagimoto, 2009).

Norris and Ortega (2000), Spada and Tomita (2010) and Goo, Granena, Yılmaz, and Novella (2015) also focused on the effectiveness of the instruction types and the efficacy of tasks by using the meta-analysis technique for applied linguistics studies. The results of all of the studies above affirmed the effectiveness of language instruction and the efficiency of explicit learning conditions over implicit instruction. Nonetheless, the current literature further points to the unlikelihood of learning collocations, which are unlimited in number, through explicit techniques on the grounds that the instruction times are limited and should be reserved for other aspects of language study. Accordingly, this issue has directed researchers to seek and study different ways to foster the learning of collocations like implicit learning approaches (Pellicer-Sanchez, 2017; Szudarski, 2012; Webb, et al., 2013).

While researching the effects of manipulation of the number of collocations in texts, Webb et al. (2013) were able reveal the efficacy of listening while reading the manipulated texts for L2 collocation acquisition; however, in another study Szudarski (2012), a simple reading-only condition with increased number of collocations did not result in a great amount of learning. With a specific reference to input enhancement techniques, Szudarski & Conklin (2014) asserted that short repeated presentations, even with textual enhancements such as highlighting, were not sufficient enough to enhance L2 learners' collocational recall performance.

It is clear that knowledge of collocations should be reinforced and consolidated regularly through increased exposures (Szudarski & Conklin, 2014). If recurrence of target items can be ensured in numerous texts, the learners will be given a fair amount of opportunities to process the repeated items and the chances for acquisition of collocation under incidental conditions may be seized more frequently (Horst, Cobb and Meara, 1998).

On the other hand, the results of the present study are not in line with those of Zarei and Tondaki (2015) who explored the effects of implicit and explicit presentation techniques on learning noun-noun collocations with 180 upper-intermediate level Persian learners of English. They used textual enhancement techniques such as underlining- capitalising and the word-card technique for incidental learning groups and jigsaw techniques and individual learning for intentional learning groups. The two post-tests for receptive and productive knowledge of the form of collocations did not indicate any significant differences between implicit and explicit instructional settings. The researchers attributed their findings to the higher proficiency of their learners; however, it can be claimed that the use of the word card technique might have violated the assumptions of implicit learning and might have transformed the focus of the study to an intentional mode. In order to avoid disruption in the nature of implicit conditions, the current study ensured that no specific attention was given to collocations in the incidental listening and reading group.

In conclusion, with regard to learning and retention of technical collocations, the results show that there were substantial gains for the experimental group over the semester; additionally, further analysis revealed that the gains were significantly

higher than the implicit group scores on measures of receptive knowledge of the form of collocations.

5.3.2 Research Question 2b

The second sub-question of research question 2 aimed to demonstrate if any significant differences in the scores of learners in terms of their productive knowledge of the form and meaning of collocations existed. The findings of the study affirmed that there was a statistically significant increase in learners' scores in the intentional group when they were served with explicit collocation instruction on learning collocation forms and meanings. Thus, these results lend adequate support for the efficacy of acquiring productive knowledge of collocations under explicit conditions through a number of activities. It was, however, revealed that reading and listening to texts under implicit conditions did not provide substantial benefits in comparison to the intentional learning condition.

Norris and Ortega (2000), Spada and Tomita (2010) and Goo et al. (2015) acknowledged in their meta-analyses that the use of target language patterns under controlled conditions and structured exercises such as filling-in-the-blanks and multiple-choice questions produced larger effect sizes than free production activities such as making sentences or writing paragraphs in the second language learning settings. Additionally, the research evidence suggests that when reading tasks reinforcing comprehension are accompanied by activities concentrating on word forms (Paribakht & Wesche, 1997; Nation, 2001; Schmitt, 2000) more favourable conditions for successful L2 vocabulary acquisition are created.

Exploring the efficacy of tasks on instruction, Minaei and Rezaie (2014) focused on the outcomes of two output activities, namely text editing and close tasks.

Besides, they considered individual versus cooperative learning of productive knowledge of collocations. Their results pointed to the superiority of cloze tasks as productive output activities over editing, as well as the effectiveness and importance of successful collaboration among students while learning collocations. The learners in the intentional learning group in the present study were instructed and encouraged to study in pairs and groups while doing collocation tasks. These joint efforts by students to allocate their attention through cooperation might arguably have assisted the learners in the acquisition of collocations.

Akin to Minaei and Rezaie's (2014) findings, the present study indicated that students who were exposed to collocations under explicit conditions tended to obtain higher scores in productive tests. The findings of the study also confirmed the views of Falahi &Moinzadeh (2012) who replicated Webb and Kagimoto's (2009) study with 94 English majors in Iran and showed that significant increases in recall and recognition of collocation scores were possible with the help of productive and receptive activities. In line with the above research, in a very recent study which lent support for the efficacy of explicit teaching of collocations for successful language acquisition and improving proficiency scores, Keshavarz & Taherian (2018) recruited a group of teenage Persian learners who were later placed in two explicit and no-emphasis groups. As could be expected, the learners in the treatment group who were requested to record, transcribe, listen and productively use the collocations from their course content surpassed the achievements of the control group that studied the same course materials with no special emphasis placed on collocations.

One plausible explanation for the higher scores of students in the experimental group of the current study on the post-test for receptive knowledge of the form and meaning of collocations can be proposed as the amount of close

attention devoted to the collocations with the help of extra exercises (Nation, 2001; Schmidt, 1990; 2001). The wider variety of tasks in the explicit learning group might have given the students a fair chance for being exposed to the target collocations multiple times; likewise, paying scant attention to distinct aspects of multi-word units might have contributed to careful organisation and broadening of knowledge of collocations (Paribakht & Wesche, 1997). A large collection of exercises that focus on the form, meaning, and use of a word will also incorporate a more sophisticated processing of the lexis with specific reference to noticing, retrieval, and production of the given items (Craik & Tulving, 1975; Nation, 2001).

The repetition of multi-word items gives learners the opportunity to be exposed to words on multiple occasions, which may reinforce the conceptual ties between the new information and the items to be stored in the mind, which in turn may offer the chance to enhance retrieval (Paivio, 1986; 1991). With reference to the dual coding theory, Paivio (1991) postulates that it is possible to trigger the mental representations in both verbal and non-verbal systems consciously or unconsciously. This may be elaborated as the feasibility of activating the verbal system by studying the spoken or written form of a word and processing the context of a word as a whole in the non-verbal system. Because of this, the present research asserts that encountering technical collocations by presentation techniques and doing further exercises which create enhanced and repeated contexts for target collocations may facilitate associative connections in the mind for creating sophisticated neural networks.

According to the depth of processing theory (Craik & Lockhart, 1972), special emphasis placed on the meaning of collocations and input processing at deeper levels may support the retention of the multiword units in the memory for

longer periods of time. As a result, the findings of the current study support the belief that explicit learning tasks which are supported by various receptive and productive exercises will help the processing of items at deeper levels. These types of tasks will eventually lead to more successful recognition and recall of technical collocations.

To summarize, the results of this study revealed that there were increases in the change scores of both groups which means a higher number of collocations were recognized and produced by all of the students at the end of the semester. However, the gain scores of the explicit group students were significantly higher than those of their counterparts in the incidental group which indicates that explicit instruction supported by collocation exercises improves multi-word knowledge more in comparison to the implicit type of instruction.

5.4 Pedagogical Implications

Based on the results of the present study, it can be recommended that tertiary level instructors should benefit from explicit collocation instruction which accelerates the learning of technical language even for low proficiency level learners, while remembering the incremental nature of implicit instruction. Since explicit collocation instruction helps to intensify the way multi-word units are acquired in shorter time periods, the additional time obtained from this method can be allocated to reinforcing other language skills. It is undoubtedly impossible for L2 teachers and learners to allocate the time and efforts required to teach and learn the number of words in the target language lexis explicitly that native speakers acquire incidentally (Hulstijn, 2005). For this reason, it seems more reasonable and advantageous to focus on specially selected frequent items.

Nation (2001) argues that words with higher frequencies in the language can be regarded as more useful than words occurring in texts with lower frequencies and that studying these items will have its own rewards. The learners are charged with the primary duty of acquiring a knowledge base that goes further than simply comprehending word meanings, and in which, they also have to possess field-specific information. On these grounds, it may be advised that lecturers should benefit from carrying out small-scale corpus studies, especially for courses where knowledge of the English language is directly associated with field-dependent professional knowledge, and help alleviate the learners' burden.

The present study demonstrated that close cooperation with the engineering department in the faculty for the establishment of the collocation-learning component of the disciplinary course proved very beneficial. Thus, it can be suggested that active collaboration and interaction between field expert instructors and teachers of English for specific purposes can offer abundant sources of techniques and activities for acquiring a profound knowledge of collocations, under which conditions they are learned more efficiently.

In addition, the present study observed that even the engineering students who had obtained considerably low scores from the PET and Vocabulary Levels Tests were able to surpass their counterparts in the implicit group. Mudraya (2004) postulated that engineering students are analytical thinkers and have the advantage of technical expertise as an asset. Thus, by serving engineering students with practical and pragmatic tasks, explicit learning may provide some support to learning in their technical and analytical minds. Besides, explicit instruction can be rewarding in

facilitating these learners' engagement with the collocations for gaining a profound knowledge on both recognition and recall.

In parallel to current ongoing discussions in second language vocabulary research, it should be reiterated that there is no best way to acquire lexis in every language setting for every language learner; still, there are effective comprehensive forms of instruction for certain conditions and student personality traits. The results of the current study recapitulate the previous lexical research findings which demonstrate the probability of acquiring collocations both explicitly and implicitly yet with the superiority of explicit learning gains being highlighted in a vast majority of the studies. Consequently, it may be advisable to use the benefits of various learning techniques and methods and offer learners a rich repertoire for successful language acquisition.

5.5 Limitations of the Study

One major limitation of the study is that it was limited only to students from the engineering department with low vocabulary and proficiency scores; thereby, it is not possible to generalize the results of the study to higher level learners. As indicated earlier, the students who had not successfully acquired the frequent English words earlier had to shoulder the heavy burden of learning low frequency technical words as a course requirement.

One other limitation of the study is that the compilation of the corpus was confined merely to introductory-level engineering coursebooks representing the field of environmental engineering studies. If different types of texts that future engineers will encounter throughout their academic studies or work-life such as lab reports, product manuals, regulations and articles are selected, the representatives and

coverage of materials will be increased. Besides, the selection of the books was dependent on the advice given by the faculty members; therefore, it was limited to their background and knowledge of the field.

A survey conducted with faculties around the country or the globe would have resulted in a totally different list of books to be investigated in the corpus. Additionally, the study could have included a follow-up focus group discussion with the explicit group participants to discuss their preferences on the activity types used, to be able to paint a better picture of the effectiveness of the activities.

Another serious limitation of the study for both groups is the amount of time allocated to the implicit and explicit collocation activities carried out after the regular engineering class. The heavy class and laboratory schedules of the second-year students in the study did not allow the researcher to create extra study time for language focused activities. Had this been possible, the nature of voluntary participation by the students would have changed and thus the students might have suspected and guessed the major aim of the study as teaching collocations, which had never been clearly stated to them.

However, despite the impossibility of having an extra class hour, thanks to the generosity and the unfailing courtesy of the lecturers in dividing the existing class into two sections and allowing the researcher to claim the second part of the class, they made it possible to insert the implicit and explicit study procedures. Notwithstanding the above limitations, this study contributes to research that seeks for a proper understanding of the learning of technical collocations by engineering students which is scarcely available in the vocabulary teaching literature.

5.6 Suggestions for Further Research

Further research can be carried out with other technical English learners with varying levels of proficiency to study the effectiveness of explicit collocation learning in different educational settings. Considering the fact that, the current study was limited to second year engineering students with varying foreign language proficiency levels in an introductory level engineering course taught in English in a Turkish tertiary setting, findings from different second language learners with diverse proficiency levels learning technical English in other educational settings would increase confidence in the generalizability of the research findings.

Should the study be carried out with larger student populations from other environmental engineering departments around Turkey, offering English medium instruction in certain classes, the efficacy of explicit instruction could be explored in a more detail manner. A study that tracks the English vocabulary acquisition of engineering students over the course of four years and after graduation with a longitudinal research design can produce evidence. Besides, a more detailed corpus study aiming to compile various field specific written and spoken text types can deepen the understanding of collocational units used in specific domains and can broaden the instructors' knowledge on field-specific language use.

With regards to the recent developments in educational technology, a study exploring the effectiveness of blended instruction on learning technical collocations where learners are supported by synchronous and asynchronous learning opportunities and materials in longer periods of time can be helpful in gaining more insights into the processes of technical multi-word learning.

The present study demonstrated that the deliberate study of compound nouns or noun-noun and adjective-noun collocations was effective through explicit teaching. A further study can explore whether acquiring the other types of collocations such as verb-noun collocations under intentional conditions would be successful as well. Further research can also investigate the effectiveness learning of technical collocations on learners' productive language use mainly in their written works. Making further comparisons of teaching methods such as DDL, input flood, and textual enhancement techniques may also help in revealing more successful methods for instruction.

REFERENCES

Alderson, J. C. (1984). Reading in a foreign language: A reading problem or a language problem? In J. C. Anderson & A. H. Urquhart (Eds.), *Reading in a foreign language* (pp. 1-27). London & New York: Longman.

Alali, F., & Schmitt, N. (2012). Teaching formulaic sequences: The same or different from teaching single words? *TESOL Journal 3*(2), 153-180.

Alcon, E. (2007). Incidental focus on form, noticing and vocabulary learning in the EFL classroom. *International Journal of English Studies, 7*(2), 41-60.

Anthony, L. (2011). AntConc (Version 3.2.2) [Computer Software]. Tokyo: Waseda University. Available from http://www.antlab.sci.waseda.ac.jp/.

Baddeley, A. D. (1983). Working memory. *Philosophical Transactions of the Royal Society of London. B, Biological Sciences, 302* (1110), 311-324.

Bağcı, N. D. (2014). *Turkish university level EFL learners' collocational knowledge at receptive and productive levels.* Unpublished master's thesis, Middle East Technical University, Ankara, Turkey.

Bahns, J. (1993). Lexical collocations: a contrastive view. *ELT Journal, 47*(1), 56-63.

Bahns, J., & Eldaw, M. (1993). Should we teach EFL students collocations? *System, 1*(1), 101-114.

Baker, P. (2006). *Using Corpora in Discourse Analysis.* London: Continuum.

Baker, P., Gabrielatos, C., & McEnery, T. (2012). Sketching Muslims: A corpus driven analysis of representations around the word 'Muslim' in the British press 1998-2009. *Applied Linguistics, 34*(3), 255-278.

Balcı, Ö., & Çakır, A. (2012). Teaching vocabulary through collocations in EFL classes: The case of Turkey. *International Journal of Research Studies in Language Learning, 1*, 21-32.

Berman, R., & Cheng, L. (2001). English academic language skills: Perceived difficulties by undergraduate and graduate students, and their academic achievement. *Canadian Journal of Applied Linguistics, 4*(1), 25-40.

Bhatia, T. K. (1992). Discourse functions and pragmatics of mixing: Advertising across cultures. *World Englishes, 11*(2), 195-215.

Boers, F., Dang, T. C., & Strong, B. (2016). Comparing the effectiveness of phrase-focused exercises. A partial replication of Boers, Demecheleer, Coxhead, and Webb (2014). *Language Teaching Research, 21*(3), 362-380.

Boers, F., Demecheleer, M., Coxhead, A., & Webb, S. (2014). Gauging the effects of exercises on verb-noun collocations. *Language Teaching Research, 18,* 54-74.

Boers, F., Eyckmans, J., Kappel, J., Stengers, H., & Demecheleer, M. (2006). Formulaic sequences and perceived oral proficiency: Putting a lexical approach to the test. *Language Teaching Research, 10*(3), 245-261.

Boulton, A. (2010). Data-driven learning: Taking the computer out of the equation. *Language Learning, 60*(3), 534-572.

Brown, D. F. (1974). Advanced vocabulary teaching: the problem of collocation. *RELC Journal 5*(2), 1-11.

Chan, T. P., & Liou, H. C. (2005). Effects of web-based concordancing instruction on EFL students' learning of verb–noun collocations. *Computer Assisted Language Learning, 18*(3), 231-251.

Chung, T.M., & Nation, I. S. P. (2003). Technical vocabulary in specialised texts. *Reading in a Foreign Language, 15*, 103-116.

Chung, T.M., & Nation, I. S. P. (2004). Identifying technical vocabulary. *System 32*, 251-263.

Church, K. W., & Hanks, P. (1990). Word association norms, mutual information and lexicography. *Computational Linguistics, 16*, 22-29.

Clapham, C. (2001). Discipline specificity and ESP. Inj. Flowerdew 8c M. Peacock (Eds.), *Research perspectives on English for academic purposes* (pp. 84-100). Cambridge: Cambridge University Press.

Cobb, T. (1999). Breadth and depth of lexical acquisition with hands-on concordancing. *Computer Assisted Language Learning, 12*(4), 345-360.

Cobb, T., & Horst, M. (2001). Reading academic English: Carrying learners across the lexical threshold. In J. Flowerdew & M. Peacock (Eds.), *Research perspectives on English for academic purposes* (pp. 315-329). Cambridge: Cambridge University Press.

Cohen, A. D., Glasman, B., Rosenbaum-Cohen, P. R., Ferrara, J., & Fine, J. (1979). Reading English for specialized purposes: Discourse analysis and the use of student informants. *TESOL Quarterly, 13*, 551-564.

Cohen J. (1988). *Statistical Power Analysis for the Behavioral Sciences.* New York, NY: Routledge Academic

Coxhead, A. (2000). A new academic word list. *TESOL Quarterly, 34*(2), 213-238.

Coxhead, A. (2008). Phraseology and English for academic purposes. In F. Meunier & S. Granger (Eds.), *Phraseology in Foreign Language Learning and Teaching* (pp. 149-162). Amsterdam: John Benjamins Publishing Company.

Coxhead, A. (2013). Vocabulary and ESP. In B. Paltridge & S. Starfield (Eds.), *The Handbook of English for Specific Purposes* (pp. 141-158). West Sussex: John Wiley & Sons, Inc.

Coxhead, A., & Hirsch, D. (2007). A pilot science-specific word list. *Revue française de linguistique appliquée, 12*(2), 65-78.

Cowan, J. R. (1972). *Toward a comprehensive reading program for university students in Iran*. Paper presented at the Second Annual Seminar on the Improvement of English Language Teaching in Iran, 1972.

Cowan, J. R. (1974). Lexical and syntactic research for the design of EFL reading materials. *TESOL Quarterly, 8* (4), 389-399.

Cowie, A. P. (1981). The treatment of collocations and idioms in learners' dictionaries. *Applied Linguistics, 2*, 223-235.

Craik, F.I.M., & Lockhart, R.S. (1972). Levels of processing: A framework for memory research. *Journal of Verbal Learning and Verbal Behavior, 11*, 671-684.

Craik, F.I.M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General,104*, 268-294.

Daskalovska, N. (2015). Corpus-based versus traditional learning of collocations. *Computer Assisted Language Learning,* 28(2), 130-144.

DeKeyser, R. M. (2003). Implicit and explicit learning. In C. Doughty & M. H. Long (Eds.), *The Handbook of Second Language Acquisition* (pp. 313-348). Oxford: Blackwell.

Dlaska, A. (1999). Suggestions for a subject-specific approach in teaching foreign languages to engineering and science students. *System, 27*(3), 401-417.

Dlaska, A. (2002). Sites of construction: language learning, multimedia, and the international engineer. *Computers & Education, 39*(2), 129-143.

Dudley-Evans, T., St John, M. J., & Saint John, M. J. (1998). *Developments in English for specific purposes: A multi-disciplinary approach.* Cambridge: Cambridge University Press.

Dunning, T. (1993). Accurate methods for the statistics of surprise and coincidence. *Computational Linguistics, 19*(1), 61-74.

Durrant, P. (2009). Investigating the viability of a collocation list for students of English for academic purposes. *English for Specific Purposes, 28*, 157-169.

El-Dakhs, S., Abdel, D., Amroun, F. P., & Charlot-Muhammad, M. (2018). What Works Better for Collocation Learning-Explicit Instruction or Incidental Learning? A Case Study of Arab Female Undergraduate Learners of English. *Electronic Journal of Foreign Language Teaching, 15*(1), 39-54.

Ellis, N. C. (1997). Vocabulary acquisition: Word structure, collocation, grammar, and meaning. In M. McCarthy & N. Schmidt (Eds.), *Vocabulary: description, acquisition and pedagogy* (pp. 122-139). Cambridge: Cambridge University Press.

Ellis, N. C. (2001). Memory for language. In P. Robinson (Ed.), *Cognition and second language instruction* (pp. 33-68). Cambridge: Cambridge University Press.

Ellis, N. C. (2002). Frequency effects in language processing. *Studies in Second Language Acquisition, 24*(2), 143-188.

Ellis, N. C. (2003). Constructions, chunking and connectionism: The emergence of second language structure. In C. Doughty & M. H. Long (Eds.), *The Handbook of second language acquisition* (pp. 63-103). Oxford: Blackwell.

Ellis, N. C. (2006a). Language acquisition as rational contingency learning. *Applied Linguistics, 27*(1), 1-24.

Ellis, N. C. (2006b). Selective attention and transfer phenomena in L2 acquisition: Contingency, cue competition, salience, interference, overshadowing, blocking, and perceptual learning. *Applied Linguistics*, *27*(2), 164-194.

Ellis, N. C. (2009). Optimizing the input: Frequency and sampling in Usage-based and Form-focused Learning. In M. H. Long & C. Doughty (Eds.), *Handbook of Language Teaching* (pp. 139- 158). Oxford: Blackwell.

Ellis, N. C., & Collins, L. (2009). Input and second language acquisition: The roles of frequency, form, and function, introduction to the special issue. *The Modern Language Journal, 93*(3), 329-335.

Ender, A. (2014). Implicit and explicit cognitive processes in incidental vocabulary acquisition. *Applied Linguistics, 37*(4), 536-560.

Evans, S., & Green, C. (2007). Why EAP is necessary: A survey of Hong Kong tertiary students. *Journal of English for Academic Purposes, 6*(1), 3-17.

Faber, P., León-Araúz, P., & Reimerink, A. (2014). Representing environmental knowledge in EcoLexicon. In *Languages for Specific Purposes in the Digital Era* (pp. 267-301). Springer, Cham.

Falahi, M., & Moinzadeh, A. (2012). Effects of receptive and productive tasks on Iranian EFL students' learning of verb-noun collocations. *Journal of Language Teaching and Research, 3*(5), 953-960.

Farghal, M., & Obiedat, H. (1995). Collocations: a neglected variable in EFL. *International Review of Applied Linguistics in Language Teaching, 33*(4), 315-331.

Farrell, P. (1990). *Vocabulary in ESP: A lexical analysis of the English of electronics and a study of semi-technical vocabulary.* CLCS Occasional Paper No. 25, Trinity College

Gabrielatos, C., & Baker, P. (2008). Fleeing, sneaking, flooding: A corpus analysis of discursive constructions of refugees and asylum seekers in the UK press, 1996-2005. *Journal of English linguistics, 36* (1), 5-38.

Gardner, S., & Nesi, H. (2012). A classification of genre families in university student writing. *Applied Linguistics, 34*(1), 1-29.

Gass, S. (1988). Integrating research areas: A framework for second language studies. *Applied Linguistics, 9* (2), 198-217.

Gencer, B. (2004). Raising EFL learners' awareness of verb-noun collocations through chunking to extend their knowledge of familiar nouns. Unpublished master's thesis, Anadolu University, Eskişehir, Turkey.

Gheisari, N., & Yousofi, N. (2016). Iranian pre-university student's retention of collocations: Implicit exposure or explicit instruction. *Cogent Education, 3* (1), 1184826.

Gledhill, C. (2000). The discourse function of collocation in research article introductions. *English for Specific Purposes, 19*, 115-135.

Goo, J., Granena, G., Yılmaz, Y., & Novella, M. (2015) Implicit and explicit instruction in L2 learning: Norris & Ortega (2000) revisited and updated. In P. Rebuschat (Ed.), *Implicit and explicit learning of languages* (pp. 443-482). Amsterdam: John Benjamins.

Haladyna, T. M., Downing, S. M., & Rodriguez, M. C. (2002). A review of multiple-choice item-writing guidelines for classroom assessment. *Applied Measurement in Education, 15*, 309-334.

Herbst, T. (1996). What are collocations: Sandy beaches or false teeth? *English Studies, 77*,379-393.

Hill, J., Lewis, M., & Lewis, M. (2000). Strategies, activities, and exercises. In L. Lewis (Ed.), *Teaching Collocation* (pp. 86-117). Hove: LTP.

Hirsh, D., & Nation, P. (1992). What vocabulary size is needed to read unsimplified texts for pleasure. *Reading in a Foreign Language, 8*, 689-696.

Hoey, M. (2005). *Lexical Priming: A New Theory of Words and Language*. London: Routledge.

Hoey, M. (2012). *Lexical priming: A new theory of words and language.* London: Routledge.

Hoey, M. (2013) Lexical Priming. In C.A. Chapelle (Ed.). *The Encyclopaedia of Applied Linguistics*. Oxford: Wiley-Blackwell.

Horsella, M., & Perez, F. (1991). Nominal compounds in chemical English literature: Toward an approach to text typology. *English for Specific Purposes, 10*(2), 125-138.

Horst, M., Cobb, T., & Meara, P. (1998). Beyond a clockwork orange: Acquiring second language vocabulary through reading. *Reading in a Foreign Language, 11*(2), 207-223.

Hsu, W. (2011). A business word list for prospective EFL business postgraduates. *Asian ESP Journal, 7*(4), 63 99.

Hsu, W. (2013). Bridging the vocabulary gap for EFL medical undergraduates: The establishment of a medical word list. *Language Teaching Research, 17*(4), 454-484.

Hsu, W. (2014). Measuring the vocabulary load of engineering textbooks for EFL undergraduates. *English for Specific Purposes, 33*, 54-65.

Hu, M. H. (2015). The effects of different tasks on verb-noun collocation learning. *The Asian Journal of Applied Linguistics, 2*(3), 213-225.

Huang, Z. (2014). The effects of paper-based DDL on the acquisition of lexico-grammatical patterns in L2 writing. *ReCALL, 26*, Special Issue 2, 163-183.

Hulstijn, J.H. (2001). Intentional and incidental second language vocabulary learning: a reappraisal of elaboration, rehearsal and automaticity. In *Cognition and Second Language Instruction* (ed P. Robinson), pp. 258-286. Cambridge: Cambridge University Press.

Hulstijn, J.H. (2005). Theoretical and empirical issues in the study of implicit and explicit second-language learning. *Studies in Second Language Acquisition*, *27*, 129-140.

Hunston, S. (2002). *Corpora in Applied Linguistics.* Cambridge: Cambridge University Press.

Hussein, R. F. (1990). Collocations: The missing link in vocabulary acquisition amongst EFL learners. In J. Fisiak (Ed.), *Papers and studies in contrastive linguistics, Volume 26. The Polish-English contrastive project* (pp.123-136). Poznan, Poland: Adam Mickiewicz University & Washington, DC: Center for Applied Linguistics.

Hutchinson, T., & Waters, A. (1987). *English for specific purposes.* Cambridge: Cambridge University Press.

Hyland, K. (2002). Specificity revisited: how far should we go now? *English for Specific Purposes, 21*(4), 385-395.

Hyland, K., & Tse, P. (2007). Is there an "academic vocabulary"? *TESOL Quarterly, 41*(2), 235-253.

Ide, N., Fellbaum, C., Baker, C., & Passonneau, R. (2010). The manually annotated sub-corpus: A community resource for and by the people. In *Proceedings of the ACL 2010 conference short papers, ACL Short '10* (pp. 68-73). Stroudsburg, PA, USA: Association for Computational Linguistics.

Jiang, J. (2009). Designing pedagogic materials to improve awareness and productive use of L2 collocations. In A. Barfield & H. Gyllstad (Eds.), *Researching collocations in another language* (pp. 99-113). New York: Palgrave Macmillan.

Joe, A. (1995). Text-based tasks and incidental vocabulary learning. *Second Language Research, 11*(2), 149-158.

Johns, T., & King, P. (1991). *Classroom Concordancing.* Birmingham: University of Birmingham.

Jordan, R. R. (1997). *English for academic purposes: A guide and resource book for teachers*. Cambridge: Cambridge University Press.

Kennedy, G. (2003). Amplifier collocations in the British National Corpus: Implications for English language teaching. *TESOL Quarterly, 37,* 467-487.

Keshavarz, M. H., & Taherian, P. (2018). The effect of explicit instruction of collocations on EFL learners' language proficiency. *Hacettepe University Journal of Education, 33*(4), 987-1001.

Kilgarriff, A., Baisa,V., Busta, J., Jakubicek, M., Kovar, V., Michelfeit, J., Rychly, P., Suchomel,V. (2014). The Sketch Engine: Ten years on. *Lexicography, 1*, 7-36.

Koç, G. (2006). Developing collocational awareness. Unpublished MA Thesis. Bilkent University. Ankara

Konstantakis, N. (2007). Creating a business word list for teaching business English. *Estudios de Linguistica Inglesa Aplicada,7*, 79-102.

Koosha, M., & Jafarpour, A. A. (2006). Data-driven learning and teaching collocation of prepositions: The case of Iranian EFL adult learners. *Asian EFL Journal, 8*, 192-209.

Krashen, S. (1989). We acquire vocabulary and spelling by reading: Additional evidence for the input hypothesis. *The Modern Language Journal, 73*, 440-464.

Krashen, S. (2004). The case for narrow reading. *Language Magazine, 3*(5), 17-19.

Krashen, S. (2013). Reading and vocabulary acquisition: supporting evidence and some objections. *Iranian Journal of Language Teaching Research, 1*, 27-43.

Krausse, S. (2005). Testing the validity of small corpus information. *ESP World, 4*, 1-9.

Krausse, S. (2008). *A Corpus-informed investigation into environmental engineering English*. Frankfurt: Peter Lang.

Kwary, D. A. (2011). A hybrid method for determining technical vocabulary. *System, 39*(2), 175-185.

Laufer, B. (1989). What percentage of text lexis is essential for comprehension? In C. Lauren & M. Nordman (Eds.), *Special language: From humans thinking to thinking machines* (pp. 316-323). Clevedon: Multilingual Matters.

Laufer, B. (1992). How much lexis is necessary for reading comprehension? In H. Bejoint & P. Arnaud (Eds.), *Vocabulary and applied linguistics* (pp.126-132). Basingstoke & London: Macmillan.

Laufer, B. (2001). Reading, word-focused activities and incidental vocabulary acquisition in a second language. *Prospect, 16*, 44-54.

Laufer, B. (2003). Vocabulary acquisition in a second language: Do learners really acquire most vocabulary by reading? Some empirical evidence. *Canadian Modern Language Review, 59*(4), 567-587.

Laufer, B. (2005). Focus on form in second language vocabulary learning. In S.H. Foster-Cohen, M. Garcia-Mayo, & J. Cenoz (Eds.), *Eurosla Yearbook: Volume 5* (pp. 223-50). Amsterdam / Philadelphia, PA: John Benjamins.

Laufer, B., & Girsai, N. (2008). Form-focused instruction in second language vocabulary learning: A case for contrastive analysis and translation. *Applied Linguistics, 29*, 694-716.

Laufer, B., & Goldstein, Z. (2004). Testing vocabulary knowledge: Size, strength, and computer adaptiveness. *Language Learning, 54*, 399-436.

Laufer, B., & Ravenhorst-Kalovski, G.C. (2010). Lexical threshold revisited: Lexical text coverage, learners' vocabulary size and reading comprehension. *Reading in a Foreign Language, 22*, 15-30.

Laufer, B., & Rozovski-Roitblat, B. (2011). Incidental vocabulary acquisition: The effects of task type, word occurrence and their combination. *Language Teaching Research, 15*, 391-411

Laufer, B., & Waldman, T. (2011). Verb-noun collocations in second language writing: A corpus analysis of learners' English. *Language Learning, 61*(2), 647-672.

Lewis, M. (1997) *Implementing the Lexical Approach: Putting Theory into Practice*, Boston: Thomson Heinle.

Liu, J., & Han, L. (2015). A corpus-based environmental academic word list building and its validity test. *English for Specific Purposes, 39*, 1-11.

Majd, N. (2017). Investigating the effectiveness of involvement load in acquisition and retention of ESL learners' collocational knowledge. Unpublished doctoral thesis. University of Queensland, Australia.

Marco, M. J. L. (2000). Collocational frameworks in medical research papers: A genre-based study. *English for Specific Purposes, 19*, 63-86.

Martínez, I. A., Beck, S. C., & Panza, C. B. (2009). Academic vocabulary in agriculture research articles: A corpus-based study. *English for Specific Purposes, 28,* 183-198.

McCarthy, M. (1999). 'Turning numbers into thoughts: Making sense of language corpora technology and observing language'. *The Language Teacher, 23*(6), 25-27.

McCarthy, M., & O'Dell, F. (2005). *English collocations in use: Intermediate.* Cambridge: Cambridge University Press.

McDonough, K., & Kim, Y. (2009). Syntactic priming, type frequency, and EFL learners' production of Who questions. *The Modern Language Journal, 93*(3), 386-398.

McEnery, T., & Xiao. R. (2011). What corpora can offer in language teaching and learning. In E. Hinkel (Ed.), *Handbook of Research in Second Language Teaching and Learning (Vol. 2),* (pp.364-380). New York: Routledge.

Meara, P. (1996). The dimensions of lexical competence. *Performance and competence in second language acquisition, 35,* 33-55.

Miller, D., & Biber, D. (2015). Evaluating reliability in quantitative vocabulary studies: the influence of corpus design and composition. *International Journal of Corpus Linguistics, 20*(1), 30-53.

Minaei, N., & Rezaie, G. (2014). The effects of collaborative and individual output tasks on learning English collocations. *Journal of Language & Translation, 4*(2), 37-47.

Mudraya, O. (2004). The student engineering English corpus. *ICAME Journal, 28,* 139-143.

Mudraya, O. (2006). Engineering English: A lexical frequency instructional model. *English for Specific Purposes, 25*(2), 235-256.

Mukundan, J., & Jin, N. Y. (2012). Development of a technical nursing education word list (NEWL). *International Journal of Innovation in English Language Teaching and Research, 1*(2), 105-124.

Myers, J. L., & Chang, S. F. (2009). A multiple-strategy-based approach to word and collocation acquisition. *International Review of Applied Linguistics, 47*(2), 179-207.

Nagy, W. (1997). On the role of context in first- and second-language vocabulary learning. In N. Schmitt & M. McCarthy (Eds.), *Vocabulary: Description, acquisition and pedagogy* (pp. 64-83). Cambridge: Cambridge University Press.

Nagy, W. E., & Anderson, R. C. (1984). How many words are there in printed school English? *Reading Research Quarterly, 19*, 304-330.

Nagy,W. E., Herman, P. A., & Anderson, R. C. (1985). Learning words from context. *Reading Research Quarterly, 20*, 233-253.

Nation, I.S.P. (1990). Teaching and Learning Vocabulary. Newbury House, New York.

Nation, I.S.P. (1993). Measuring readiness for simplified material: a test of the first 1,000 words of English. In M.L.Tickoo (Ed.) *Simplification: Theory and Application* (pp. 193-203), RELC Anthology Series 31.

Nation, I.S.P. (2001). *Learning vocabulary in another language.* New York: Cambridge University Press.

Nation, I.S.P. (2006). How large a vocabulary is needed for reading and listening? *Canadian Modern Language Review, 63,* 59-82.

Nation, P. (2007). The four strands. *International Journal of Innovation in Language Learning and Teaching, 1*(1), 2-13.

Nation, I. S. P. (2008). *Teaching vocabulary: Strategies and techniques.* Boston, MA: Heinle.

Nation, I.S.P. & Chung, M. (2009) Teaching and testing vocabulary. In M. Long & C. Doughty (Eds.) *Handbook of Language Teaching* (pp. 543-559) Malden, MA: Wiley-Blackwell.

Nation, P., & Coxhead, A., Chung, M., & Quero, B. (2016). Specialized word lists. In I. S. P. Nation, *Making and Using Word Lists for Language Learning and Testing* (pp. 145-151). Amsterdam: John Benjamins.

Nation, I.S.P., & Webb, S. (2011). *Researching and Analyzing Vocabulary*. Boston, MA: Heinle.

Nattinger, J. R. (1980). A lexical phrase grammar for ESL. *TESOL Quarterly, 14*, 337-344.

Nattinger, J.R., & DeCarrico, J. (1992). *Lexical phrases and language teaching.* Oxford: Oxford University Press.

Nesselhauf, N. (2003). The use of collocations by advanced learners of English and some implications for teaching. *Applied Linguistics, 24*, 223-242.

Nesselhauf, N. (2005). *Collocations in a learner corpus*. Amsterdam: John Benjamins.

Newell, A. (1990). *Unified theories of cognition*. Cambridge, Mass: Harvard University Press.

Norris, J., & Ortega, L. (2000). Effectiveness of L2 instruction: A research synthesis and quantitative meta-analysis. *Language Learning, 50*, 417-528.

Nurweni, A., & Read, J. (1999). The English vocabulary knowledge of Indonesian university students. *English for Specific Purposes, 18*(2), 161-175.

Oakes, M. P. (1998). *Statistics for corpus linguistics.* Edinburgh: Edinburgh Textbooks in Empirical Linguistics.

O'Keeffe, A., McCarthy, M., & Carter, R. (2007). *From Corpus to Classroom: Language Use and Language Teaching.* Cambridge: Cambridge University Press.

Orr, T., & Takahashi, A. (2002). Constructing a Corpus of Fundamental Engineering English for Nonnative Speakers. In *Proceedings of IEEE International Professional Communication Conference*, 403-409.

Ördem, E. (2005). Retention and use of lexical collocations (verb + noun and adjective + noun) by applying lexical approach in reading course. Unpublished master's thesis. Muğla University, Turkey.

Paivio, A. (1986). Mental Representations: A Dual-Coding Approach. Oxford University Press, New York.

Paivio, A. (1991). Dual coding theory: Retrospect and current status. *Canadian Journal of Psychology, 45*(3), 255-287.

Paquot, M., & Bestgen, Y. (2009). "Distinctive words in academic writing: A comparison of three statistical tests for keyword extraction", in A. H. Jucker, D. Schreier, and M. Hundt (eds) *Corpora: Pragmatics and Discourse*. Papers from the 29th International Conference on English Language Research on Computerized Corpora (ICAME29). Amsterdam: Rodopi, 247-269.

Paribakht, T. S., & Wesche, M. (1996). Enhancing vocabulary acquisition through reading: A hierarchy of text-related exercise types. *The Canadian Modern Language Review, 52* (2), 155-178.

Paribakht, T.S., & Wesche, M. (1997). Vocabulary enhancement activities and reading for meaning in second language vocabulary acquisition. In J. Coady & T. Huckin (Eds.), *Second language vocabulary acquisition: A rationale for pedagogy* (pp. 174-200). Cambridge: Cambridge University Press.

Pawley, A., & Syder, F. H. (1983). Two puzzles for linguistic theory: nativelike selection and nativelike fluency. In Jack C. Richards and Richard W. Schmidt (eds.), *Language and Communication*, (pp. 191-226). London: Longman.

Peacock, M. (2012). High-frequency collocations of nouns in research articles across eight disciplines. *Iberica, 23*, 29-46.

Pellicer-Sánchez, A. (2017). Learning L2 collocations incidentally from reading. *Language Teaching Research, 21*(3), 381-402.

Peters, E. (2009). Learning collocations through attention-drawing techniques: A qualitative and quantitative analysis. In Barfield, A., Gyllstad, H. (Eds.), *Researching collocations in another language: Multiple perspectives* (pp. 194−207). Basingstoke: Palgrave Macmillan.

Pojanapunya, P. & Todd, R. W. (2018) Log-likelihood and odds ratio: keyness statistics for different purposes of keyword analysis. *Corpus Linguistics and Linguistic Theory 14*(1), 133-167.

Pritchard, R. M., & Nasr, A. (2004). Improving reading performance among Egyptian engineering students: principles and practice. *English for Specific Purposes*, *23*(4), 425-445.

Puangmali, S. (1976). A study of engineering English vocabulary. *RELC Journal, 7*(1), 40-52.

Read, J. (2000). *Assessing Vocabulary.* Cambridge: Cambridge University Press.

Rodriguez, M. C. (2005). Three options are optimal for multiple-choice items: A meta-analysis of 80 years of research. *Educational Measurement: Issues and Practice, 24*, 3-13.

Salager, F. E. (1980). Compound words in technical Russian and technical English literature: a comparative study. *Russian Language Journal, 34*(118), 45-50.

Salager, F. E. (1983). The lexis of fundamental medical English: classificatory framework and rhetorical function (a statistical approach). *Reading in a Foreign Language, 1*(1), 54-64.

Salager, F. E. (1986). Reading medical English literature: cognitive strategies vs translation. *Medical education, 20*(6), 535-538.

Salkind, N. J. (2010). *Encyclopedia of research design.* Thousand Oaks, CA: Sage.

Schmitt, N., Jiang, X., & Grabe, W. (2011). The percentage of words known in a text and reading comprehension. *The Modern Language Journal, 95*(1), 26-43.

Schmidt, R. (1990). The role of consciousness in second language learning. *Applied Linguistics, 11*, 129-158.

Schmidt, R. (1993). Awareness and second language acquisition. *Annual Review of Applied Linguistics, 13*, 206-226.

Schmidt, R. (1994). Implicit learning and the cognitive unconscious: Of artificial grammars and SLA. In N. C. Ellis (Ed.), *Implicit and explicit learning of languages* (pp. 165-210). San Diego, CA: Academic Press.

Schmidt, R. (2001). Attention. In P. Robinson (Ed.), *Cognition and second language instruction* (pp. 3-32). Cambridge: Cambridge University Press.

Schmitt, N. (2000). Vocabulary in language teaching. Cambridge: Cambridge University Press.

Schmitt, N. (2008). Review article: Instructed second language vocabulary learning. *Language Teaching Research, 12*(3), 329-363.

Schmitt, N. (2010). *Researching Vocabulary: A Vocabulary Research Manual.* Basingstoke: Palgrave Macmillan.

Schmitt, D., & Schmitt, N. (2005). *Focus on Vocabulary: Mastering the Academic Word List*. Longman Press.

Schmitt, N., Schmitt, D., & Clapham, C. (2001). Developing and exploring the behaviour of two new versions of the Vocabulary Levels Test. *Language Testing 18*(1), 55-88.

Schreiber, J., & Asner-Self, K. (2011). *Educational Research: The Interrelationship of Questions, Sampling, Design, and Analysis.* Hoboken, NJ: Wiley.

Scott, M. (1997). PC analysis of key words and key key words. *System, 25*(1), 1-13.

Scott, M. (2010). 'Problems in investigating keyness, or clearing the undergrowth and marking out trails' in M. Bondi and M. Scott (eds) *Keyness in Texts*, pp. 43-57. Amsterdam, John Benjamins.

Scott, M., & Tribble, C. (2006). *Textual Patterns: keyword and corpus analysis in language education.* Amsterdam: Benjamins.

Serrano, M. P. (2018). "Which type of instruction fosters chunk learning? Preliminary conclusions". *Revista de Lingüística y Lenguas Aplicadas, 13,* 133-143.

Shin, D., & Nation, P. (2008). Beyond single words: the most frequent collocations in spoken English. *ELT Journal, 62*(4), 339-348.

Simpson-Vlach, R., & Ellis., N.C. (2010). An academic formulas list: new methods in phraseology research. *Applied Linguistics, 31,* 487-512.

Siyanova, A., & Schmitt, N. (2008). L2 learner production and processing of collocation: a multi-study perspective. *Canadian Modern Language Review, 64*(3), 429-458.

Snoder, P. (2017). Improving English Learners' Productive Collocation Knowledge: The Effects of Involvement Load, Spacing, and Intentionality. *TESL Canada Journal, 34*(3), 140-164.

Sonbul, S., & Schmitt, N. (2009). Direct teaching of vocabulary after reading: is it worth the effort? *ELT Journal, 64,* (3), 1-8.

Sonbul, S., & Schmitt, N. (2013). Explicit and implicit lexical knowledge: Acquisition of collocations under different input conditions. *Language Learning, 63,* 121-159.

Spada, N., & Tomita, Y. (2010). Interactions between type of instruction and type of language feature: A meta-analysis. *Language Learning, 60,* 263-308.

Sun, Y., & Wang, L. (2003). Concordancers in the EFL classroom: cognitive approaches and collocation difficulty. *Computer Assisted Learning, 16,* 83-89.

Swales, J. (1974). *Writing Scientific English.* London: Thomas Nelson and Sons.

Szudarski, P. (2012). The role of language corpora in teaching English as a foreign language in Poland, *Jezyk - Kultura - Komunikacja 5*, 37-47.

Szudarski, P., & Carter, R. (2016). The role of input flood and input enhancement in EFL learners' acquisition of collocations. *International Journal of Applied Linguistics, 26* (2), 245-265.

Szudarski, P., & Conklin, K. (2014). Short- and long-term effects of rote rehearsal on ESL learners' processing of L2 collocations. *TESOL Quarterly, 48*, 833- 842.

Tarantino, M. (1991). English for science and technology: A quest for legitimacy. *English for Specific Purposes, 10*(1), 47-60.

The British National Corpus, version 3 (BNC XML Edition) (2007). Distributed by Oxford University Computing Services on behalf of the BNC Consortium. URL : http://www.natcorp.ox.ac.uk/.

Tongpoon-Patanasorn, A. (2018). Developing a frequent technical word list for finance: A hybrid approach. *English for Specific Purposes, 51*, 45-54.

Trimble, M. T., Trimble, L., & Drobnic, K. (Eds.). (1979). *English for specific purposes: sciences and technology.* Oregon State University.

Uzun, L., & Salihoğlu, U. M. (2009). English-Turkish cognates and false cognates: Compiling a corpus and testing how they are translated by computer programs. *Poznan Studies in Contemporary Linguistics, 45*(4), 569-593

Valipouri, L., & Nassaji, H. (2013). A corpus-based study of academic vocabulary in chemistry research articles. *Journal of English for Academic Purposes, 12*(4), 248-263.

Walter, E., & Woodford, K. (2010). *Using Collocations for Natural English*. Delta Publishing: Peaslake, Surrey, UK.

Wang, J., Liang, S., & Ge, G. (2008). Establishment of a medical academic word list. *English for Specific Purposes, 27*, 442-458.

Wang, J., Liang, S. L., & Ge, G. C. (2008). Establishment of a medical academic word list. *English for Specific Purposes, 27*(4), 442-458.

Ward, J. (1999). How large a vocabulary do EAP engineering students need? *Reading in a Foreign Language, 12*(2), 309-324.

Ward, J. (2007). Collocation and technicality in EAP engineering. *Journal of English for Academic Purposes, 6*, 18-35.

Ward, J. (2009a). A basic engineering English word list for less proficient foundation engineering undergraduates. *English for Specific Purposes, 28*, 170-182.

Ward, J. (2009b). EAP reading and lexis for Thai engineering undergraduates. *Journal of English for Academic Purposes, 8*, 294-301.

Webb, S. (2005). Receptive and productive vocabulary learning. *Studies in Second Language Acquisition, 27*, 33-52.

Webb, S., & Kagimoto, E. (2009). The effects of vocabulary learning on collocation and meaning. *TESOL Quarterly, 43*, 55-77.

Webb, S., & Kagimoto, E. (2011). Learning collocation: Do the number of collocates, position of the node word, and synonymy affect learning? *Applied Linguistics, 32*, 259-276.

Webb, S., Newton, J., & Chang, A. (2013). Incidental learning of collocation. *Language Learning, 63*(1), 91-120.

Wilkins, D. A. (1972). *Linguistics in Language Teaching.* Cambridge, MA: MIT Press.

Wesche, M., &Paribakht, T. S. (2000). Reading-based exercises in second language vocabulary learning: An introspective study. *Modern Language Journal, 84(ii),* 196-210.

Wood, D. (2002). Formulaic language in acquisition and production: Implications for teaching. *TESL Canada Journal, 20,* 1-15.

Yang, M. N. (2015). A nursing academic word list. *English for Specific Purposes, 37,* 27-38.

Yunus, K., &Awab, S. (2012). The effects of the use of module-based concordance materials and data-driven learning (DDL) approach in enhancing the knowledge of collocations of prepositions among Malaysian undergraduate law students. *The International Journal of Learning, 18*(9), 181-198.

Zahar, R., Cobb, T., & Spada, N. (2001). Acquiring vocabulary through reading: Effects of frequency and contextual richness. *The Canadian Modern Language Review, 57*(3), 541-572.

Zarei, A. A. and Tondaki, N. (2015). The Effects of explicit and implicit instructional techniques on Iranian EFL learners' comprehension and production of lexical collocations. *Academie Royale des Seances Doutr-Mer Bulletin des Seances, 4*(2), 122-131.

Zhang, X. (2017). Effects of receptive-productive integration tasks and prior knowledge of component words on L2 collocation development. *System, 66,* 156-167.

Zimmerman, C. (1997). Do reading and interactive vocabulary instruction make a difference? An empirical study. *TESOL Quarterly, 31,* 121-140.

APPENDICES

Appendix 1: A full list of books used for Corpus Compilation

REFERENCE BOOKS

Agardy, F. J., & Nemerow, N. L. (2010). *Environmental Solutions: Environmental Problems and the All-inclusive global, scientific, political, legal, economic, medical, and engineering bases to solve them*. Elsevier

Bartram J, Ballance R, (Eds.), 1996. *Water quality monitoring, A practical guide to the design and implementation of freshwater quality studies and monitoring programs*. London, E & FN Spon.

Baumbach, G. (2012). *Air Quality Control: Formation and Sources, Dispersion, Characteristics and Impact of Air Pollutants-Measuring Methods, Techniques for Reduction of Emissions and Regulations for Air Quality Control*. Springer Science & Business Media.

Blackman, W. C. (2013). *Basic hazardous waste management*. Florida, CRC Press.

Bradstreet, J. W. (1996). *Hazardous Air Pollutants: Assessment, Liabilities and Regulatory Compliance*. Elsevier.

Bell, F. G. (2014). *Engineering treatment of soils*. Florida, CRC Press.

Campbell, G. S., & Norman, J. M. (2012). *An introduction to environmental biophysics*. Springer Science & Business Media.

Cheremisinoff, N. P. (2002). *Handbook of air pollution prevention and control*. Elsevier.

Chin, D. A. (2012). *Water-quality engineering in natural systems: fate and transport processes in the water environment*. John Wiley & Sons.

Colls, J., Tiwary, A., (2009). *Air Pollution: Measurement, Modelling and Mitigation*, 3rd Ed. Routledge, New York.

Corbitt, R. A. (1999). Standard handbook of environmental engineering. In *Standard handbook of environmental engineering*. McGraw-Hill.

Cunningham, W., & Cunningham, M. A. (2010). *Principles of environmental science*. McGraw-Hill Higher Education.

Davis, M. L. (2010). *Water and wastewater engineering*. McGraw-Hill.

Donald, I. W. (2010). *Waste immobilization in glass and ceramic based hosts: radioactive, toxic and hazardous wastes*. John Wiley & Sons.

Doyle, B. (2001). *Hazardous gases underground: Applications to tunnel engineering*. Florida, CRC Press.

Dunnivant, F. M., & Anders, E. (2006). *A basic introduction to pollutant fate and transport: an integrated approach with chemistry, modelling, risk assessment, and environmental legislation*. John Wiley & Sons.

Franzle S, Markert B & Wünschmann S (2012). *Introduction to Environmental Engineering.* Weinheim, Wiley.

Gaur, R. C. (2009). *Basic environmental engineering*. New Age International Pvt Ltd Publishers.

Gertsen, N., & Sønderby, L. (2009). Water Purification (Air, Water and Soil Pollution Science and Technology Series. NY, Nova Science Publishers.

Golinska, P., Fertsch, M., & Marx-Gómez, J. (Eds.). (2011). *Information Technologies in Environmental Engineering: New Trends and Challenges*. Springer Science & Business Media.

Goudie, A. (2006) *The human impact on the natural environment, 4th edn.*, Oxford, Blackwell.

Gurjar, B. R., Molina, L. T., & Ojha, C. S. P. (2010). *Air pollution: health and environmental impacts*. Florida, CRC Press.

Hanna, A. S., (1999). *Concrete formwork systems*. New York: Marcel Dekker.

Harrison, R. M. (Ed.). (2007). *Understanding our environment: an introduction to environmental chemistry and pollution*. London, Royal Society of chemistry.

Hill, M. K. (2010). *Understanding environmental pollution*. Cambridge University Press.

Hillel, D. (2003). *Introduction to environmental soil physics*. Elsevier.

Innocenzi P, Zub YL, Kessler VG (eds) (2007) *Sol–Gel methods for materials processing: focusing on materials for pollution control. Water purification, and soil remediation.* Berlin, Springer.

Jain, S. K., & Singh, V. P. (2003). *Water resources systems planning and management* (Vol. 51). Elsevier.

Kaushik, C. P., Bhavikatti, S. S., & Kaushik, A. (2010). *Basic civil and environmental engineering*. New Delhi, India: New Age International.

Kennes, C., & Veiga, M. C. (Eds.). (2013). *Air pollution prevention and control: bioreactors and bioenergy*. Chichester: Wiley.

Koprivanac, N., & Kušić, H. (2009). *Hazardous organic pollutants in colored wastewaters*. Nova Science Publishers, Inc.

Kumar De, A. & Kumar De, A. (2009). *Environmental engineering*. New Delhi, New Age International.

Lippitt, J., Webb, P., & Martin, W. (Eds.). (2000). *Hazardous waste handbook*. Elsevier.

Liu, D. H.F., & Liptak, B.G. (Ed.). (1999). *Environmental Engineers' Handbook*. Chapman and Hall, CRC Press.

Maczulak, Anne E. (2009) *Environmental Engineering: Designing a Sustainable Future (Green Technology)*. New York, Infobase Publishing.

Matsuo, T., Hanaki, K., Takizawa, S., & Satoh, H. (Eds.). (2001). *Advances in Water and Wastewater Treatment Technology: Molecular Technology, Nutrient Removal, Sludge Reduction, and Environmental Health*. Elsevier.

McKinney, R. E. (2004). *Environmental pollution control microbiology: a fifty-year perspective*. Florida, CRC Press.

Meuser, H. (2010). *Contaminated urban soils* (Vol. 18). Springer Science & Business Media.

Mirsal, I. (2008). *Soil pollution: origin, monitoring & remediation*. Springer Science & Business Media.

Momtaz, S., & Kabir, Z. (2013). *Evaluating environmental and social impact assessment in developing countries*. Newnes.

Nag, A.& Vizayakumar, K. (2005). Environmental Education and Solid Waste Management, New

Naimpally, A. V., & Rosselot, K. S. (2013). *Environmental Engineering: Review for the Professional Engineering Examination*. New York, Springer.

Nemerow, N. L., Agardy, F. J., & Salvato, J. A. (Eds.). (2009). *Environmental engineering: water, wastewater, soil and groundwater treatment and remediation*. Hoboken, NJ: Wiley.

Nemerow, N. L., Agardy, F. J., & Salvato, J. A. (Eds.). (2009). *Environmental Engineering: Prevention and Response to Water-, Food-, Soil-, and Air-borne Disease and Illness*. Hoboken, NJ: Wiley.

Nemerow, N. L., &Agardy, F. J. (2009) *Environmental Engineering: Environmental Health and Safety for Municipal Infrastructure, Land use and Planning, and Industry*. Wiley, Hoboken, NJ.

Noyes, R. (1995). *Unit Operations in Environmental Engineering.* Noyes Publication, Park Ridge, New Jersey

Oh, C. H. (2001). *Hazardous and radioactive waste treatment technologies handbook*. Florida, CRC Press.

Ozkaraova Güngör, E.B. (Ed.). (2009). *Environmental Technologies, New Developments.* Vienna, I-Tech Education and Publishing,

Patnaik, P. (2010). *Handbook of environmental analysis: chemical pollutants in air, water, soil, and solid wastes*. Florida, CRC Press.

Pawlowski, L., Dudzinska, M. R., & Pawlowski, A. (Eds.). (2010). *Environmental Engineering III*. Florida, CRC Press.

Pence, M. (2012). *Handbook of Air Pollution Control Systems and Devices*. University Publications.

Pfafflin, J. R., & Ziegler, E. N. (Eds.). (2006). *Encyclopaedia of environmental science and engineering*. Taylor & Francis.

Ramalho, R. (2012). *Introduction to wastewater treatment processes*. Elsevier.

Rao, D. G., Senthilkumar, R., Byrne, J. A., & Feroz, S. (Eds.). (2012). *Wastewater treatment: advanced processes and technologies*. Florida, CRC Press.

Rao, P.V. (2005). *Textbook of environmental engineering.* New Delhi, Prentice-Hall of India.

Reible, D. D. (Ed.). (2014). *Processes, assessment and remediation of contaminated sediments* (pp. 365-391). New York: Springer.

Reis, S. (2005). *Costs of air pollution control. Analyses of Emission Control Options for Ozone Abatement Strategies* Springer-Verlag Berlin.

Rom, W. N. (2011). *Environmental policy and public health: air pollution, global climate change, and wilderness* (Vol. 14). John Wiley & Sons.

Russell, D. L. (2006). *Practical wastewater treatment*. John Wiley & Sons.

Salvato, J. A., Nemerow, N. L., & Agardy, F. J. (2003). *Environmental engineering*. John Wiley & Sons.

Sharma, S. K., & Sanghi, R. (Eds.). (2012). *Wastewater Reuse and Management*. Springer Science & Business Media.

Spence, R. D., & Shi, C. (Eds.). (2004). *Stabilization and solidification of hazardous, radioactive, and mixed wastes*. Florida, CRC Press.

Sportisse, B. (2009). *Fundamentals in air pollution: from processes to modelling*. Springer Science & Business Media.

Stegmann, R., Brunner, G., Calmano, W., & Matz, G. (Eds.). (2013). *Treatment of contaminated soil: fundamentals, analysis, applications*. Springer Science & Business Media.

Tchobanoglous, G., & Kreith, F. (2002). Handbook of solid waste management. McGraw-Hill, New York.

Twardowska, I., Allen, H. E., Haggblom, M. M., & Stefaniak, S. (Eds.). (2006). *Soil and Water Pollution Monitoring, Protection and Remediation. NATO Science Series* (p. 662). Krakom: Springer.

Twardowska, I., Allen, H. E., Kettrup, A. F., & Lacy, W. J. (2004). *Solid waste: assessment, monitoring and remediation* (Vol. 4). Gulf Professional Publishing.

Václavíková, M., Vitale, K., Gallios, G. P., & Ivanicová, L. (Eds.). (2009). *Water treatment technologies for the removal of high-toxity pollutants*. Springer.

Vallero, D. A. (2014). *Fundamentals of air pollution*. Academic press.

Velasquez, H. R. (2011). *Pollution Control: Management, Technology and Regulations*. Nova Science Publishers

Vesilind, P. A., Morgan, S. M., & Heine, L. G. (2009). *Introduction to Environmental Engineering-3rd Edition.* Cengage Learning.

Vesilind, P. A., Peirce, J. J., & Weiner, R. F. (2013). *Environmental pollution and control*. Elsevier.

Vesilind, P. A., Worrell, W. A., Reinhart, D. R., & Vesilind, A. (2011). *Solid waste engineering*. Pacific Grove, CA: Brooks/Cole.

Villanyi, V. (Ed.). (2010). *Air Pollution*. Intech, Sciyo Publishers. Rijeka.

Voudouris, K., & Voutsa, D. (2012). *Water quality monitoring and assessment*. Rijeka, InTech Publisher.

Voudouris, K., & Voutsa, D. (2012). *Ecological water quality - water treatment and reuse*. Rijeka, In Tech Publisher.

Wang, L. K., Hung, Y. T., Lo, H. H., & Yapijakis, C. (Eds.). (2004). *Handbook of industrial and hazardous wastes treatment*. Florida, CRC Press.

Wang, L. K., Hung, Y. T., & Shammas, N. K. (Eds.). (2005). *Physicochemical treatment processes*. Humana Press.

Wang, L. K., Hung, Y. T., & Shammas, N. K. (Eds.). (2007). *Advanced physicochemical treatment technologies*. Humana Press.

Wang, L. K., Hung, Y. T., & Shammas, N. K. (Eds.). (2008). *Handbook of Environmental Engineering: Biosolids Engineering and Management; Volume 7*. Humana.

Wang, L. K., Hung, Y. T., Shammas, N. K., & Chen, J. P. (2009). *Heavy metals in the environment*. Florida, CRC Press.

Wang, L. K., Hung, Y. T., Tay, S. T. L., & Tay, J. H. (Eds.). (2010). *Handbook of Environmental Engineering: Environmental Bioengineering; Volume 11*. Springer.

Wang, L. K., Ivanov, V., Tay, J. H., & Hung, Y. T. (Eds.). (2010). *Environmental biotechnology* (Vol. 10). Springer Science & Business Media.

Wang, L. K., Pereira, N. C., & Hung, Y. T. (Eds.). (2004). *Air pollution control engineering* (Vol. 1). Totowa, NJ: Humana press.

Wang, L., K. Pereira, N. C., & Hung, Y. T. (Eds.). (2006). *Advanced air and noise pollution control.* Totowa, NJ,, USA: Humana press.

Wang, L. K., Shammas, N. K., & Hung, Y. T. (Eds.). (2008). *Advanced biological treatment processes* (Vol. 9). Springer Science & Business Media.

Wang, L. K., Shammas, N. K., & Hung, Y. T. (Eds.). (2010). *Advanced biological treatment processes* (Vol. 9). Springer Science & Business Media.

Wang, L. K., Shammas, N. K., Selke, W. A., & Aulenbach, D. B. (Eds.). (2010). *Flotation technology*. New York: Humana Press.

Williams, P. T. (2005). *Waste treatment and disposal*. John Wiley & Sons.

Appendix 2: The list of first 100 keywords

	Keyword	Frequency	Loglikelihood		Keyword	Frequency	Loglikelihood
1	water	100242	230.230.927	51	oxidation	8033	28.372.458
2	waste	61924	189.887.120	52	bacteria	9288	27.448.695
3	treatment	44014	109.973.104	53	design	17113	27.296.275
4	air	45102	95.148.139	54	filter	9645	27.020.810
5	sludge	25709	93.912.588	55	ozone	9064	26.133.853
6	wastewater	24548	91.911.995	56	metal	11759	25.705.176
7	soil	29985	88.250.562	57	activated	8194	25.700.950
8	environmental	33006	84.603.180	58	quality	18305	25.616.251
9	mg	24029	79.242.937	59	combustion	7527	25.571.686
10	organic	23092	72.487.130	60	pollutant	6969	25.274.498
11	gas	26656	65.417.285	61	contaminants	6855	24.841.295
12	concentration	22874	64.864.953	62	volume	11820	24.390.469
13	wastes	18501	64.070.427	63	data	18500	24.300.835
14	chemical	23037	63.119.118	64	bod	6488	23.732.733
15	process	34199	59.370.749	65	emission	7288	23.019.200
16	flow	22585	58.868.349	66	material	15586	22.857.629
17	epa	16029	57.900.218	67	soils	7302	22.699.897
18	hazardous	16828	57.242.500	68	reactor	7351	22.507.303
19	pollution	20704	56.345.968	69	plants	12151	22.425.010
20	removal	17543	53.044.370	70	toxic	7809	22.175.899
21	solids	14796	52.384.937	71	solution	11656	21.634.884
22	surface	21253	45.486.289	72	contaminated	6910	21.582.871
23	temperature	17618	45.254.192	73	chlorine	6442	21.088.344
24	processes	18006	43.909.091	74	sewage	6861	20.915.901
25	carbon	15484	43.758.017	75	engineering	10253	20.706.439
26	solid	15997	42.196.705	76	tank	9163	20.535.341
27	compounds	12925	41.529.038	77	reduction	10078	20.531.282
28	concentrations	13910	40.494.248	78	adsorption	5725	20.498.826
29	pollutants	11532	40.261.241	79	gases	6834	20.426.105
30	oxygen	13492	39.545.362	80	sources	11010	20.204.349
31	materials	16385	35.688.000	81	industrial	13718	19.999.068
32	metals	11077	34.801.483	82	site	12822	19.865.216
33	disposal	12221	34.386.087	83	conditions	15160	19.612.769
34	anaerobic	9472	33.990.349	84	monitoring	8303	19.543.537
35	biological	11831	33.556.108	85	environment	13855	18.972.533
36	source	17180	33.455.860	86	aeration	5261	18.926.369
37	plant	16539	33.119.264	87	dissolved	6469	18.925.495
38	groundwater	9494	33.068.042	88	aerobic	5442	18.581.104
39	emissions	10890	32.351.320	89	biomass	5350	18.482.033
40	systems	21061	31.930.251	90	method	11645	18.393.761
41	figure	21211	31.915.224	91	sediment	5844	18.112.549
42	particles	11005	31.901.729	92	hydrogen	6567	18.047.861
43	effluent	9078	31.468.769	93	municipal	6128	17.846.847
44	energy	18319	31.101.708	94	membrane	6137	17.777.241
45	nitrogen	9847	30.911.940	95	microbial	4984	17.771.577
46	system	32014	30.712.762	96	pressure	12857	17.647.636
47	biosolids	8045	30.146.936	97	phase	9084	17.496.180
48	liquid	11325	30.095.155	98	storage	7780	17.492.193
49	landfill	8365	29.296.472	99	leachate	4700	17.484.594
50	acid	13067	28.799.418	100	particle	5814	17.456.684

Appendix 3: Technical Words Rating Scale

Type 1: Words such as function words that have a meaning that has no particular relationship with the field of engineering that is, words independent of the subject matter. Examples are: *the, is, between, it, by, amounts, common, commonly, directly, constantly, early,* and *especially.*
Type 2: Words that have a meaning that is minimally related to the field of engineering in that they describe the procedures or features. Examples are: *part, forms, pairs, structures, surrounds, supports, associated,*
Type 3: Words that have a meaning that is closely related to the field of engineering. Such words are also used in general language. The words may have some restrictions of usage depending on the subject field. Words in this category may be technical terms in a specific field like engineering and yet may occur with the same meaning in other fields and not be technical terms in those fields.
Type 4: Words that have a meaning specific to the field of engineering and are not likely to be known in general language. These words have clear restrictions of usage depending on the subject field.

Table adapted from (Chung & Nation 2003, p. 105; Chung & Nation 2004, p. 254).

Appendix 4: Easy Distractors

Distractors	
1-acid rain	5- soil erosion
2-air pollution	6- environmental engineering
3- heavy industry	7- waste recycling
4- wastewater management	8- geothermal energy

Appendix 5: Test of Productive Knowledge of the Form and Meaning of Collocations

AAAAAAAAAAAAAAAAAAAA**AAAAAAAA**AAAAAAAAAAAAAAAAAA

Name Surname :

Please translate the words from Turkish to English. If don't know the right answer, you may leave the box blank.		
1	asit yağmuru	
2	hava kirliliği	
3	kaba çakıl	
4	uçucu bileşikler	
5	çözünemeyen çökelek	
6	titrasyon eğrisi	
7	ana kanalizasyon hattı	
8	ağır sanayi	
9	gözenekli ortam	
10	atıksu yönetimi	
11	yanma kalıntıları	
12	müteakip yüzeyden salma	
13	yakma fırını	
14	serbest sutaşır	
15	lağım suyu bertarafı	
16	sızıntı suyu geçişi	
17	dairesel öğütücü	
18	geçirimsiz şilte	
19	baca dumanı yükselmesi	
20	kum tutucu	
21	piston akışlı	

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22	atık geridönüşümü	
23	toz haznesi	
24	nem muhafazası	
25	sıyırıcı kalıntıları	
26	ham çamur	
27	depolama sahası sızıntısı	
28	çevre mühendisliği	
29	yumaklaştırma haznesi	
30	aşırı sızma	
31	pıhtılaştırma katkı maddesi	
32	kapalı varil	
33	sönmüş kireç	
34	askıda katılar	
35	iz besin maddesi	
36	doğal ıslah	
37	reaktif yüzeye tutunumu	
38	eylemsizlik etkisi	
39	yüzer köpük	
40	demirdışı hurda	
41	jeotermal enerji	
42	tarımsal akış	
43	toprak erozyonu	

Appendix 6: Test of Productive Knowledge of the Form of Collocations

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Name Surname:

Fill in the blanks with suitable words.

Example: We ……… lunch at 12:30. (We ***have*** lunch at 12:30)

1-	The introduction of particulates and harmful materials into the atmosphere is **air** ………………….. .
2-	Land use decisions related to **wastewater**………………….. also affect water quality.
3-	A motor mixes the water and chemicals in the **flocculation** ………………….. to form larger pieces.
4-	During heavy rains and snow, a(n) ………………….**. infiltration** of water into soil can happen.
5-	Clay minerals are used as a **coagulant ....** to remove particles from drinking water.
6-	Highly radioactive liquid waste can be stored in the **enclosed ....** in the ground.
7-	Caustic soda, sodium carbonate and **..................... lime** can neutralize acidic industrial water.
8-	Particulate matter is a complex mixture of **suspended** ………………….. and liquid particles.
9-	Nitrogen, phosphorus and **trace**…………………..in waste, are necessary for biological growth.
10-	Natural processes are used in ………………….. **remediation** to remove waste from groundwater or soil.
11-	Hydrogen bonding can be the major force for …………………..**adsorption** on minerals.
12-	A method for collection of micro particles in the size of 1-5 micrometers is i**nertial** …………………..
13-	There are usually greases and oils in the **floating** ………………….. on the water.
14-	Aluminium and bronze that come from old cars and household wastes are called ………………….. **scrap.**
15-	Land application of large volumes of water creates **soil** ………………….. .
16-	The water leaving farm fields because of rain is ………………….. **runoff.**
17-	Processing used materials into new, useful products is w**aste** …………………..
18-	Crushed stone or ………………….. **gravel** can carry the surface water away easily.
19-	Chemicals that change into gas and affect the environment are **volatile** …………………..
20-	Oxygenated iron and manganese make a(n) ………………….. **precipitate** with phosphorus.
21-	For designing an alkaline wastewater neutralization system, the **titration** ………………….. is very necessary.
22-	Wastewater from many other lines is received by a(n) ………………….. **sewer** in a large area.
23-	The goal of **environmental** ………………….. is the integration of sciences and principles to make the natural environment better.
24-	Liquid or gas can pass through spaces between hard areas in a **porous** ………………….. .
25-	A clean source of electricity and hot water from the earth is **geothermal** …………………...
26-	The type of waste that is left over after burning waste is called **incinerator** …………………..
27-	Steam, ammonia, nitrogen or hydrogen generally help the ………………….. **desorption**.
28-	A temperature of 927°C is needed in a **combustion** ………………….. for a good performance.
29-	A rock or sand that does not have a limiting layer on the top is a(n) ………………….. **aquifer**.
30-	The carrying away and discharging of liquid wastes is ………………….. **disposal.**
31-	Heavy metals in soil may show the possibility of **leachate ....** from the dumping site.
32-	Hard materials are cut into small pieces of about 3 millimetres in the ………………….. **grinder.**
33-	The bottom of dumping site is covered by an **impermeable..................** made of plastic and sand.
34-	In a wind speed of 10 m/s, a **plume** ………………….. of 220 metres is ideal for a power station.
35-	The sand and small stones are cleaned in a **grit.....................** to protect the equipment in the treatment system.

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36-	When a body of water moves through without mixing with the rest of the water a **plug** …………………. happens in reactors.
37-	Sulfur dioxide and nitrogen cause **acid** …………………. which damages trees and soil.
38-	The particles collected from the air should be emptied from the …………………. **hopper** about once a week.
39-	The black soil needs less watering because of its high capacity for **moisture** ………………….
40-	Waste materials remaining in the air pollution device after the gas is cleaned are …………………. **effluents.**
41-	A form of wet mud waste before any treatment is called …………………. **sludge.**
42-	The ground water quality and surface water lines can be badly affected by **landfill** ………………….
43-	China has a very big …………………. **industry** sector for making steel and cement products.

Appendix 7: Test of Receptive Knowledge of the Form of Collocations

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Name Surname:

Choose the correct option

Example: Students do not like to ……… **homework**. a) make **b**) do c) solve d) perform e) don't know

You can choose the "don't know" option if you are not sure.

1-	The introduction of particulates and harmful materials into the atmosphere is **air ....** .			
a) recession	b) abuse	c) pollution	d) corruption	e) don't know
2-	Land use decisions related to **wastewater ....** also affect water quality.			
a) leadership	b) management	c) executive	d) directorship	e) don't know
3-	A motor mixes the water and chemicals in the **flocculation ....** to form larger pieces.			
a) box	b) sink	c) basin	d) container	e) don't know
4-	During heavy rains and snow, a(n)**..................... infiltration** of water into soil can happen.			
a) additional	b) severe	c) greater	d) excessive	e) don't know
5-	Clay minerals are used as a **coagulant ....** to remove particles from drinking water.			
a) aid	b) care	c) support	d) assistance	e) don't know
6-	Highly radioactive liquid waste can be stored in the **enclosed ....** in the ground.			
a) bowl	b)drum	c) bucket	d) vat	e) don't know
7-	Caustic soda, sodium carbonate and **..................... lime** can neutralize acidic industrial water.			
a) quenched	b) cooled	c) relaxed	d) slaked	e) don't know
8-	Particulate matter is a complex mixture of **suspended ....** and liquid particles.			
a) pastes	b) blocks	c) solids	d) stuffs	e) don't know
9-	Nitrogen, phosphorus and **trace ....** in waste are necessary for biological growth.			
a) fats	b) supplements	c) calories	d) nutrients	e) don't know
10-	Natural processes are used in **.....................remediation** to remove waste from groundwater or soil.			
a) intrinsic	b) real	c) spatial	d) true	e) don't know
11-	Hydrogen bonding can be the major force for **..................... adsorption** on minerals.			
a) additive	b) supplement	c) stuff	d) reagent	e) don't know
12-	A method for collection of micro particles in the size of 1-5 micrometers is i**nertial ....**			
a) packing	b) compression	c) impaction	d) shock	e) don't know
13-	There are usually greases and oils in the **floating ....** on the water.			
a) rubbish	b) crust	c) filth	d) scum	e) don't know
14-	Aluminium and bronze that come from old cars and household wastes are called **..................... scrap.**			
a) hard	b) nonferrous	c) inflexible	d) metallurgical	e) don't know

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15-	Land application of large volumes of water creates **soil ....**			
a) spoiling	b) erosion	c) recession	d) disintegration	e) don't know
16-	The water leaving farm fields because of rain is **........................ runoff.**			
a) primary	b) private	c) agricultural	d) recreational	e) don't know
17-	Processing used materials into new, useful products is **waste ....**			
a) treating	b) saving	c) recycling	d) rescuing	e) don't know
18-	Crushed stone or **..................... gravel** can carry the surface water away easily.			
a) straight	b) ragged	c) coarse	d) plain	e) don't know
19-	Chemicals that change into gas and affect the environment are **volatile ....**			
a) ingredients	b) compounds	c) synthesis	d) fusions	e) don't know
20-	Oxygenated iron and manganese make an **..................... precipitate** with phosphorus.			
a) inseparable	b) insoluble	c) unbreakable	d) indivisible	e) don't know
21-	For designing an alkaline wastewater neutralization system, the **titration ....** is very necessary.			
a) curve	b) line	c) profile	d) cycle	e) don't know
22-	Wastewater from many other lines is received by a **..................... sewer** in a large area.			
a) stem	b) block	c) trunk	d) head	e) don't know
23-	The goal of **environmental ....** is the integration of sciences and principles to make the natural environment better.			
a) constructing	d) computing	c)maintenance	d) engineering	e) don't know
24-	Liquid or gas can pass through spaces between hard areas in a **porous ....** .			
a) medium	b) object	c) setting	d) instrument	e) don't know
25-	A clean source of electricity and hot water from the earth is **geothermal ....** .			
a) supply	b) force	c) strength	d) energy	e) don't know
26-	The type of waste that is left over after burning waste is called **incinerator.....................**			
a) residue	b) substance	c) element	d) matter	e) don't know
27-	Steam, ammonia, nitrogen or hydrogen generally help the **..................... desorption**.			
a) subsequent	b) continuous	c) secondary	d) ongoing	e) don't know
28-	A temperature of 927°C is needed in a **combustion.....................** for a good performance.			
a) cooker	b) warmer	c) furnace	d) grill	e) don't know
29-	A rock or sand that does not have a limiting layer on the top is an **..................... aquifer**.			
a) unlocked	b) unconfined	c) unrestricted	d) unsecured	e) don't know
30-	The carrying away and discharging of liquid wastes is **...................... disposal.**			
a) filth	b) earth	c) dirt	d) sewage	e) don't know

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31-	Heavy metals in soil may show the possibility of **leachate ....** from the dumping site.				
	a) motion	b) migration	c) expansion	d) progress	e) don't know
32-	Hard materials are cut into small pieces of about 3 millimetres in a **..................... grinder.**				
	a) flat	b) cross	c) round	d) circular	e) don't know
33-	The bottom of dumping site is covered by an **impermeable..................** made of plastic and sand.				
	a) course	b) liner	c) cushion	d) blanket	e) don't know
34-	In a wind speed of 10 m/s, a **plume ....**of 220 metres is ideal for a power station.				
	a) advance	b) rise	c) lift	d) climb	e) don't know
35-	The sand and small stones are cleaned in a **grit.....................** to protect the equipment in the treatment system.				
	a) house	b) reservoir	c) tube	d) chamber	e) don't know
36-	When a body of water moves through without mixing with the rest of the water a **plug ....** happens in reactors.				
	a) flow	b) stream	c) rate	d) flood	e) don't know
37-	Sulfur dioxide and nitrogen cause **acid ....** which damages trees and soil.				
	a) tear	b) shower	c) wind	d) rain	e) don't know
38-	The particles collected from the air should be emptied from the ……………………. **hopper** about once a week.				
	a) smoke	b) gas	c) dirt	d) dust	e) don't know
39-	The black soil needs less watering because of its high capacity for **moisture ....**				
	a) collection	b) dilution	c) retention	d) compilation	e) don't know
40-	Waste materials remaining in the air pollution device after the gas is cleaned are **................. effluents.**				
	a) duster	b) scrubber	c) collector	d) remover	e) don't know
41-	A form of wet mud waste before any treatment is called **..................... sludge.**				
	a) raw	b) rough	c) flat	d) hard	e) don't know
42-	The ground water quality and surface water lines can be badly affected by **landfill ....**				
	a) seepage	b) circulation	c) breakage	d) wastage	e) don't know
43-	China has a very big **.................. industry** sector for making steel and cement products.				
	a) bulky	b) loaded	c) heavy	d) weighted	e) don't know

Appendix 8: Test of Receptive Knowledge of the Form and Meaning of Collocations:

AAAAAAAAAAAAAAAAAAAA**AAAAAAAA**AAAAAAAAAAAAAAAAAA

Name Surname :

Please translate the words from Turkish to English. If don't know the right answer, you may leave the box blank.		
1	acid rain	
2	air pollution	
3	porous medium	
4	scrubber effluents	
5	raw sludge	
6	sewage disposal	
7	heavy industry	
8	unconfined aquifer	
9	grit chamber	
10	coagulant aid	
11	leachate migration	
12	slaked lime	
13	suspended solids	
14	wastewater management	
15	incinerator residue	
16	reagent adsorption	
17	inertial impaction	
18	floating scum	
19	excessive infiltration	
20	soil erosion	
21	agricultural runoff	

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22	titration curve	
23	dust hopper	
24	trace nutrient	
25	coarse gravel	
26	volatile compounds	
27	environmental engineering	
28	intrinsic remediation	
29	trunk sewer	
30	nonferrous scrap	
31	flocculation basin	
32	geothermal energy	
33	impermeable liner	
34	subsequent desorption	
35	combustion furnace	
36	insoluble precipitate	
37	landfill seepage	
38	waste recycling	
39	circular grinder	
40	moisture retention	
41	plume rise	
42	enclosed vat	
43	plug flow	

Appendix 9: Sample Worksheet for Implicit Group

Soil Pollution Week 1:

Please listen to the audio and follow the text

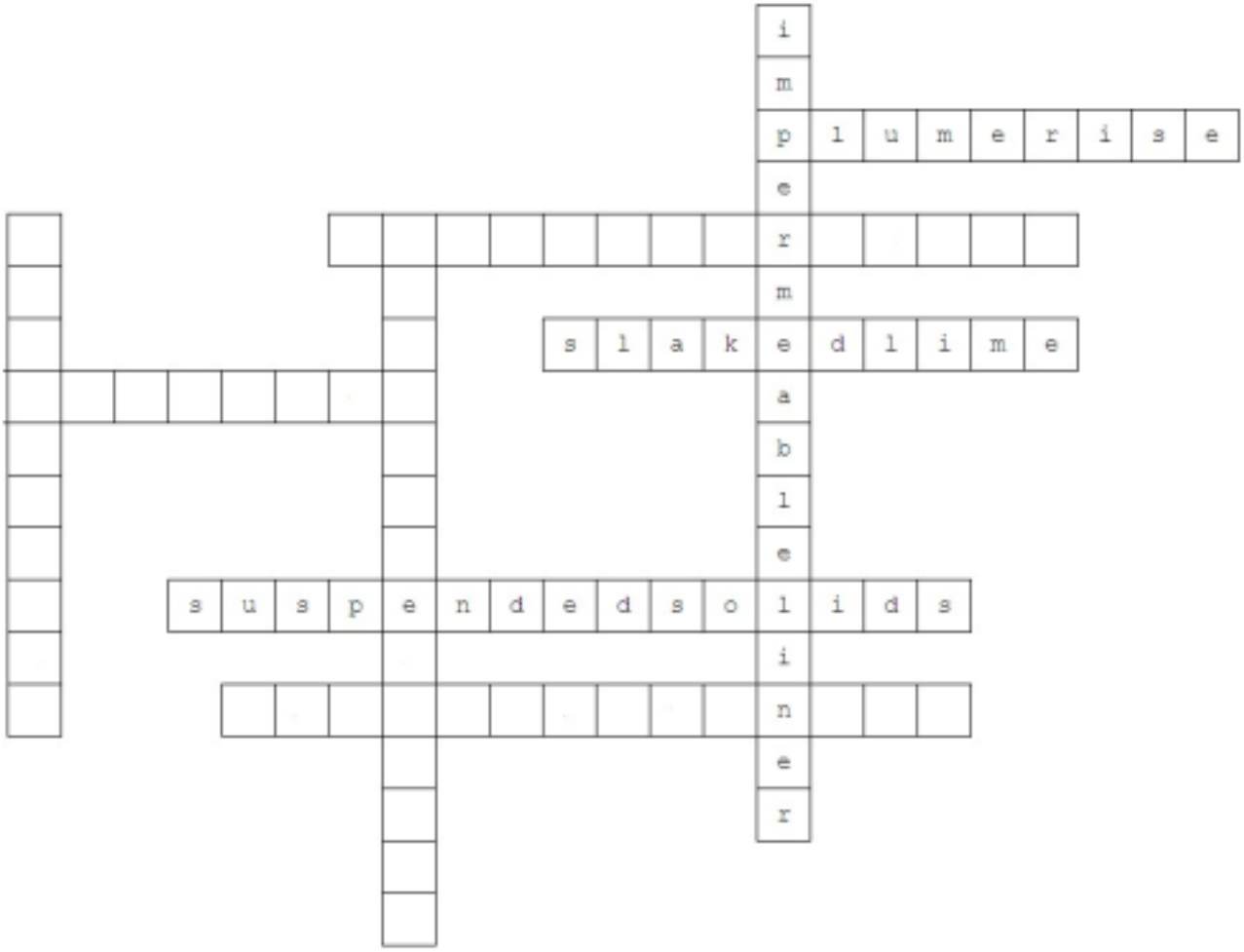
Subsurface flow wetlands are also known as vegetated submerged bed, gravel bed, reed bed, and root zone wetlands. These systems are used to replace septic systems. Because the wastewater is kept below the surface of the medium (which ranges from coarse gravel to sand), these systems reduce mosquito and odor problems. A hybrid system, with both subsurface and surface flow, can also be used. Constructed wetlands are considered attached-growth biological reactors. The major components of constructed wetland systems are the plants, soils, and microorganisms. The plants serve as support media for microorganisms, provide shade (which reduces algal growth), insulate the water from heat loss, filter solids and pathogens, and provide dissolved oxygen.

Biopiles: Synonyms for biopiles include biocells, bioheaps, biomounds, compost cells, heap pile bioremediation, and static-pile composting. This treatment involves the piling of contaminated soils into piles or heaps and then simulating aerobic microbial activity by aeration and the addition of minerals, nutrients, and moisture. Heat and pH can also be controlled to enhance biodegradation. Treatment areas are often covered with an impermeable liner to reduce the amount of leachate entering the uncontaminated soil. These piles, which have an underground system through which air passes, can be up to 6m high (this height is not recommended) and may be covered to prevent runoff, evaporation and volatilization, and to promote solar heating.

The dumping field scarps have been formed from a layer of construction debris covered with a layer of cultivable soil of 1m in thickness, seeded with a mixture of grass. Because the B and C dumping fields had been full, municipal waste was temporarily placed in the A field again. While the A dumping field was functioning, liquid outflows (leachates) from the scarps, sometimes forming small streams, were observed. In order to limit the leachate migration, circumferential drainage around the scarp foot of the A field was built. This drainage collects: - leachates flowing out from the scarp of the A field landfill - precipitation water or meltwater flowing down the waste hill surface - surface run-off. The collected surface run-off is directed to the retention reservoirs where it is mixed with the leachates from the remaining two dumping fields.

Appendix 10: "Writing target collocations in puzzles" sample activity

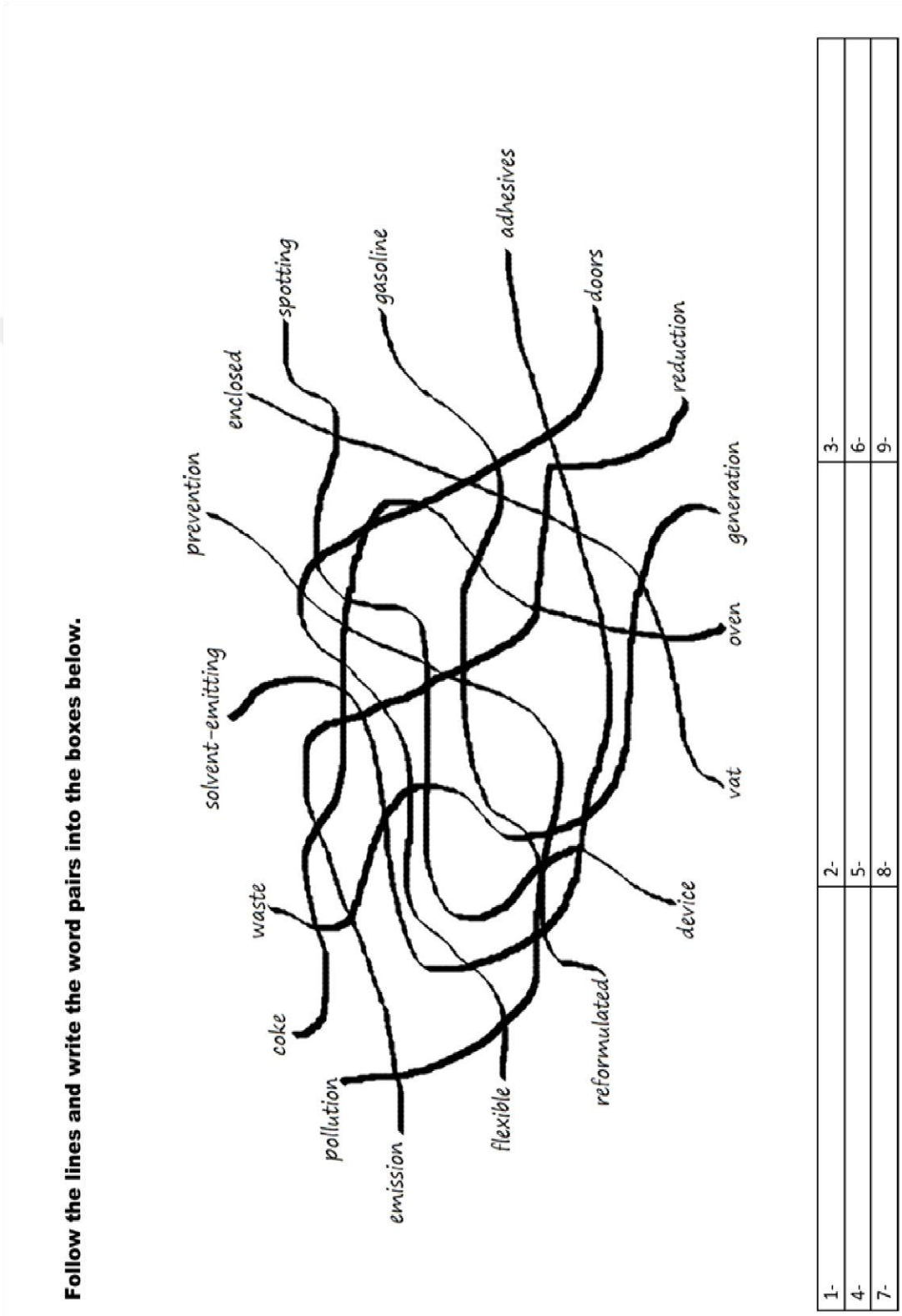
Puzzle



Across	**Down**
2. A visible ..... forms as pollutants are being emitted from a smokestack. **4.** ..... is a colourless, odourless, tasteless, relatively nontoxic gas. **6.** the efficiency of wet systems is affected by the limited solubility of lime and ..... in water. **7.** ..... is the dissolution and wearing away of metal caused by a chemical reaction. **8.** The..... trapped within the filter are released and escape with the wash water. **9.** ..... may cause sanitary sewer overflows during wet weather.	**1.** Treatment areas are often covered with a(n) ..... to reduce the amount of leachate **3.** ..... is a process that collects gaseous materials on a solid surface. **5.** ..... is produced in large quantities as a result of the incomplete combustion of fossil fuels.

Appendix 11: Explicit Group Sample Worksheet 1

Air Pollution Week 1:



Appendix 12: Explicit Group Sample Worksheet 2

Soil Pollution Week 1:

Please rearrange the following phrases and words into sentences

1- **[**the uncontaminated soil**] [**are often covered**] [**the amount of leachate**] [**to reduce**] [**entering**] [**impermeable liner**] [**with an**] [**treatment areas**]**

2- **[**these systems**] [**reduce mosquito and odour problems**] [**because the wastewater is**] [**of the medium**] [**the surface**] [**coarse gravel**] [**which ranges from**] [**to sand**] [**kept below**]**

3- **[**was built**] [**limit**] [**in order to**] [**circumferential drainage**] [**the scarp foot of**] [**the leachate migration**] [**the A field**] [**around**]**

4- **[**and microorganisms**] [**are**] [**constructed wetland systems**] [**the plants, soils,**] [**the major components of**]**

5- **[**were observed**] [**forming small streams,**] [**sometimes**] [**while the dumping field**] [**liquid outflows**] [**from the scarps**], [**was functioning,**]**

6- **[**from a layer of**] [**of 1m in thickness**] [**the dumping field scarps**] [**covered with**] [**construction debris**] [**have been formed**] [**a layer of cultivable soil**]**

7- **[**into piles or heaps**] [**the piling of**] [**simulating aerobic microbial activity**] [**this treatment involves**] [**and then**] [**contaminated soils**]**

8- **[**are used**] [**these systems**] [**septic systems**] [**to replace**]**

9- **[**was temporarily placed**] [**municipal waste**] [**had been full,**] [**in the A field again**] [**because the other dumping fields**]**

10- **[**root zone wetlands**] [**reed bed, and**] [**subsurface flow wetlands**] [**vegetated submerged bed,**] [**are also known as**] [**gravel bed,**]**