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Teaching Keywords and Their Collocational Profiles in Marine Engineering English: A Qualitative and Quantitative Approach

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1. Introduction: the teaching context

1 The present paper focuses on the study carried out at the Higher Technical School of Naval Architecture and Ocean Engineering, Technical University of Madrid, in order to redevelop a course titled *English for Professional and Academic Communication* (EPAC). This is a semester course designed for students of marine engineering and focused on developing their written and oral skills in technical English. The course seeks to prepare the students for their future careers and to master the relevant technical communication skills required for marine engineers in the global economy. Indeed, as determining the "particular language features, discourse practices, and communicative skills of target groups becomes central to teaching English in universities" (Hyland, 2017, p. 5), the need to study the features of the marine engineering professional context becomes crucial. This is mainly because there is an urgency for developing relevant English teaching materials for marine engineering students; materials that are different from those tailored especially for seafarers and professionals of the sea, precisely those based on "Maritime English".

2 There is a well-established research tradition in teaching and testing "Maritime English", also known as *Standard Marine Communication Phrases* (SMCF) and not as many resources of the same for marine engineers and naval architects. The International

Maritime Organisation (IMO) and other international authorities established the SMCF as the common language of seafaring around the world and recommended a wide circulation to all prospective users and all maritime education authorities (IMO: n.d.). Maritime English has become vitally important for the safety of the crew, the efficiency of daily tasks and the integrity of the ship (Saunders, 2020). Marine engineers and naval architects on the other hand are involved in the design, construction, and maintenance of ships, boats, and related equipment (Psarianos, 2006) and may not necessarily interact at sea. These professionals "typically work in offices, where they have access to computer software and other tools necessary for analysing projects and designing solutions" (U.S. Bureau of Labor Statistics, 2020). Their training primarily focuses on the industry of ships and their employers are typically shipyards, marine consultancies, classification societies and engineering firms. Hence, navigational knowledge should be required just in case they join a sailing team. Navigation is not usually included in the core training of marine engineering students, at least not at our school. Therefore, despite some shared educational content with seafarers, marine engineers take training on theoretical scientific knowledge produced and shared by engineering scholars.

3 A field of constant evolution, marine engineering, also known as ocean engineering, includes the engineering of boats, ships and any other marine vessel or offshore structures. Marine engineers share complex, and abstractly structured knowledge about their technological discoveries that is practical, accessible, and capable of having impact and generating change. They communicate mainly in marine journals and various digital platforms, which provide a forum for debate and for the exchange of specific, densely packed information for their professional communities.

4 The main aim of this study is to identify the essential vocabulary of marine engineering documents in English through corpus analysis. We use *ConcGram 1.0* to determine the collocations of high frequency keywords in a 450,000 word-corpus of marine engineering reference books, namely academic textbooks, handbooks and manuals, such as, *The Maritime Engineering Reference Book* (Molland, 2008). The information obtained from the analysis has guided us in the optimization of the content of our English course and the development of teaching materials most appropriate to marine engineering students.

5 This paper is organized as follows: Section 2 defines some of the key concepts and addresses the main theoretical background and previous research related to collocation research and corpus linguistics. Section 3 outlines the research methodology for this study, the corpus and the procedural steps employed Section 4 summarizes our findings and illustrates collocational structures visualized from our corpus data. Section 5 displays the pedagogical applications of the marine engineering corpus analysis and introduces the teaching materials we designed. Section 6 summarizes the findings and provides suggestions for future research.

2. Background

2.1. Keywords and collocations

6 The focus of the present study is to systematically look at keywords in the specialized corpus and detect their collocational behaviour. Keywords have a quantitative

dimension and refer to the words that are "statistically characteristic of a text or set of texts" (Demmen & Culpeper, 2015, p. 90). Keyword analysis is helpful for determining the lexical features of texts, their patterns of co-occurrences. *ConcGram 1.0* is useful for revealing the common collocations found in written maritime textbooks. These patterns have received different names in the literature: collocations, conceived of as a series of words that co-occur more often than would be expected by chance (Halliday, 1966; Gledhill, 2000); multiword units (Wray, 2002); phraseological units (Molina, 2015). Collocation refers to the extent to which the presence and meaning of a word 'coheres' or depends on the presence of another word (or words) in the same stretch of text (Gledhill, 2011, p. 1). In this study, the term *specialized collocations* are those related in some way to different aspects of marine engineering, whether the keyword has high, mid or low frequency (Nation, 2016). Collocations also designate terms, such as formulaic sequences, chunks, multiword units, conventionalized forms, or ready-made utterances (Wray, 2002, p. 9). Corpus analysis allows the scholar to establish the corpus collocation profile, which is "the full spectrum of typical local contexts (higher-order collocations together with the corresponding syntagmatic patterns and related characteristics) associated with a word" (Belica et al., 2010, p. 127).

7 Based on Systemic Functional Linguistics (SFL), lexis and grammar are not different in nature, but rather form a unified stratum in the language: the lexicogrammar (Halliday, 1961; Halliday & Matthiessen, 2004). Lexicogrammar is "fundamentally grammar with a certain amount of attention to lexical patterns within the grammatical frameworks" (Sinclair & Carter, 2004, p. 164). Furthermore, lexico-grammatical (LG) patterns are recurrent sequences of lexical and grammatical elements that serve an identifiable function (Schmid, 2014, p. 254).

8 The lexico-grammatical patterns are varied (Figure 1). As regards their properties, a LG pattern is a predictable but also productive sequence of signs, which shares a stable, coherent frame of reference. A LG pattern may extend over a long stretch of text, and it may be discontinuous. LG patterns distributed throughout a text also contribute to the development of coherence throughout the text. Firth (1957) coined the term 'colligation' for this kind of relation.

Figure 1. – Types of LG patterns (in Benson et al., 2010).

- Adjective+nouns: *particulate functions*, *significant effect*, *etc.*
- Verb+noun: *cause an effect*, *pose a problem*, *demonstrate the presence of*, *create opportunities*, *etc.*
- Noun+noun: *air draft*, *bow thruster*, *starboard bow*.
- Verbs+prepositions*: accumulates in*, *increase in*, *summarized in*, *no evidence of*, *differs between*, *stained with*, *etc*.
- Verbs+adverbs*: whispered softly*, *varies greatly*.
- Adverbs+adjectives*: fully aware*, *highly predictable*.

9 Gledhill (2011, p. 2) argues that the identification of such patterns should be a fundamental step in the systematic analysis of ESP texts. He further explains that the lexico-grammatical resources of a specific speech activity, as well as genres (goal-oriented, culturally specific speech activities, such as exposition in science, etc.) evolve to express specific discourse functions.

2.2. Marine engineering English vocabulary

10 Marine engineering English comprises different registers according to subject-matter and content knowledge of several areas, namely, nautical, technical communications and legal and commercial issues, hence its complexity for outsiders. The pedagogical and lexicographical treatment of this specialized maritime lexis presents a challenge for teachers and learners (Bergenholtz et al., 1995). Although research has been carried out on phraseology and collocations (Howarth, 1998; Sinclair, 1991; Scott & Tribble, 2006; O'Keefe et al., 2007), there are few studies, which cover marine engineering collocations from a qualitative and quantitative perspective (Borucinsky & Kegalj, 2015; Losey-Leon, 2020).

11 Categorizing technical keywords and their collocational patterns is important for learners, teachers and for the design of teaching materials (Chung & Nation, 2004; Nation, 2016; Watson-Todd, 2017). Marine English students need to know these word patterns for their professional development in order to handle marine engineering transfers well. This knowledge transfer is, often associated with knowledge management, knowledge sharing, innovation and entrepreneurship (University of Cambridge, 2009, n.p.).

12 This knowledge transfer involves a good mastery of collocations (such as the verb+object noun type: *slacken/let go/heave on/haul in a line*). Marine English learners are not often aware that words occur in these patterns, according to Cole et al. (2007, p. 136). Collocations may include two words, strings of three or more words together, and frames, which contain slots for words to fit in, such as *the XXX of* (as in *the definition of*). In fact, this lexical knowledge includes not only the literal meaning of collocations, such as *maritime engineering*, but also other semantic references of the same words when they are used in different technical contexts. The knowledge of these collocations affects the outcome of L2 comprehension and writing in B2-level English students onwards (Bonk, 2000).

13 Noun+noun (N+N) collocations may evolve into a compound word (*shipyard*), hyphenated words (*double-hull*), or remain a series of words separated by spaces (*fore peak tank*, *forecastle deck*). This study pays particular attention to the third type of multi-word compounds, two-to-three syntagmatic units because even advanced level learners seem to experience problems in relation to using and developing L2 collocational knowledge (Nesselhauf, 2005). We focus on V+N (*carry out ballasting operations*), Adj+N (*steering gear*, *bulbous bow*) and N+N (*bow thrusters*). Collocations may also be classified by keywords. Typical keywords in maritime engineering are *industry*, *marine*, *boating*, *engineering*, *retailers*.

14 Lewis (2000) includes a list of twenty different types of collocations ranging from Adj+N combinations to incomplete fixed phrases, including grammatical collocations. We are mainly interested in lexical noun phrases, which are very common in maritime engineering writing. The idea is to remind students of the importance of collocational knowledge because some students conceive words as separate single units and consequently do not store them as collocations.

15 Students face three basic problems when trying to learn relevant marine collocations. First, they soon discover that the combinations listed in glossaries are usually different from their expectations. The same combination type will sometimes be listed in the

base and sometimes in the collocate entry, which slows down the search considerably. Second, the amount of relevant collocational material included in individual entries need not be connected with a lexeme's frequency or typicality in the language, and third, few manuals or textbooks explicitly mention collocations (Alcaraz Varo, 2000; Borucinsky & Kegalj, 2015).

16 Language competence involves knowledge of collocations in different discourse communities which members use these collocations to blend in discipline norms. Learning to recognize these discourse specific collocations will also help students to increase their range of English vocabulary. At an advanced level, familiarity with discipline collocations can be also helpful in terms of appreciating and conveniently comprehending expert writers' work in marine engineering journals and technical reports. We believe that the area has not received proper attention and research is necessary to evaluate disciplinary variation across several engineering areas (Borucinsky & Kegalj, 2015). Collocational competence in ESP courses is one of the most neglected areas in vocabulary study and English language teaching/learning. This negligence is the underlying reason for carrying out this research.

3. Data and research methodology

17 The data used in this study comprise a corpus consisting of different texts from academic and professional marine engineering reference sources collected to identify keywords and common clusters for this specific specialized discourse. These are reference books, namely handbooks, user manuals and international institutions publications, mainly covering the areas of marine environment, marine vehicle types, flotation and stability, ship structures, powering, marine engines and auxiliary machinery, manoeuvring, and marine safety. The corpus consists of a 450,000 word-compilation of marine engineering academic and professional reference publications that we named MARENGDOC.

18 The analysis of the MARENGDOC is carried out using the n-gram method operated by *ConcGram 1.0*. This software performs a fully automatic search for the co-occurrences of words in a text or corpus irrespective of variation and with no prior search commands and reveals all the word association patterns in it. Concgrams are repeated sequences of words that may be discontinuous and in any order, and this allows the user to find possibly interesting phraseological patterns in text (Rayson, 2015, p. 41). The findings and gathered information from the analysis are then used to create teaching materials, which help to familiarize students with these marine engineering specialized words and phrases and their use in context, as increased awareness is useful for L2 marine engineering English learners (Schmidt, 2001).

19 The following basic procedure was used to determine what vocabulary is important in marine engineering documents, how to increase our knowledge of them, and how this knowledge can be operationalized in collocation exercises for students, adapting part of the procedure established by Breeze (2015, p. 47). In particular, we are interested in:

1. Identifying keywords from frequency word counts in the corpus;
2. Determining collocations and common word clusters based on concgramming;
3. Designing teaching activities based on keywords in context and their collocation patterns.

20 Hence, starting with the *ConcGram 1.0* frequency count tool allowed us to obtain a wordlist that reflects the specialized nature of the marine engineering language. This tool generates a wordlist ranked by frequency and referred to as unique words (UW). We used the built-in exclusion list function, which excludes the 50 most frequently occurring grammatical words (e.g. the, of, to, in, a) from the search (Greaves, 2009, p. 35). We compared the top frequent words from our list with the top frequent words in the Hong Kong Engineering Corpus (HKEC). The HKEC is comprised of 9,224,384 words drawing on a large collection of engineering texts and genres (manuals, reports, guidance, articles, etc.) and is made available at the website of the Research Centre for Professional Communication in English in Hong Kong <www.engl.polyu.edu.hk/RCPCE/>. Despite the fact that this reference corpus is much larger than our study corpus, this was not a problem since many scholars argue that reference corpora are typically the same size as the target corpus, or very much larger (Demmen & Culpeper, 2015, p. 97). The second step consisted of using the list of unique words to determine word co-occurrences within the corpus and generate concgram lists. The software guarantees a comprehensive search for all word co-occurrences and the concordances examined (Greaves, 2009, p. 3). In the third step, concgramming was used to look at collocations more broadly and to capture more contextual information. *ConcGram 1.0*, in its fully automatic mode, begins by finding all the two-word concgrams, and then builds up iteratively to five-word concgrams. The analysis generates the lists of the co-occurrences of two or more words irrespective of constituency and/or positional variation, which fully account for phraseological variation.

21 Finally, the last step consisted of designing a number of classroom activities that would help our students to become familiar with common clusters in marine engineering and the way they link together to form phrases. These materials serve the purpose of improving the content of the EPAC course and take into account the students' specific needs and their level of English. Indeed, before the course development in 2010, we had conducted a learning needs analysis, which we often update, using questionnaires and other relevant tools in order to determine the most appropriate way to meeting the target needs of our engineering profession. Our students have a higher intermediate level of English, as holding a B2 level of general English certificate is a prerequisite for the course enrolment. Therefore, the materials we seek to create and add to the course content are catered for an advanced level of English, sustaining that students need exposure to authentic specialized resources in English and initiation to their language patterns. We created a collection of print-based learning material first and then accommodated them into the digital interactive language learning platforms such as *Quizlet*. Digital learning platforms have the potential to be effective learning tools as they keep students engaged and enable teachers to track their progress more easily.

4. Data analysis and relevant findings

4.1. Wordlists and frequency counts

22 Frequency wordlists are used to establish which words are important in MARENGDOC. As Flowerdew (1993) points out, frequency data provide a basis for establishing the relative importance of vocabulary items, which is essential information for course

design and creation of didactic material. Table 1 shows the top 50 words (UW) in the corpus and their frequencies, compared with the top 50 words in the Hong Kong Engineering Corpus (HKEC). The two lists display radically different results even though both contain technical vocabulary. While the top 50 words in the HKEC include eleven nouns, including two proper nouns, the list in the study corpus contains 29 potential nouns (some of which may conceivably also be verbs (ship, design, control, etc.). Surprisingly enough, HKEC does not feature some of the highly predictable key terms of engineering corpora, such as the word *engine*, not even in its top 200 most frequent word list. However, the main reason for the difference between the two corpora may be due to the exclusion of function and grammar words in MARENGDOC, which yielded higher frequency of "content words" and more visibly reflected the specialized nature of the vocabulary of marine engineering.

Table 1. – Top 50 words in MARENGDOC and in HKEC.

Top 50 UW in MARENDOC						Top 50 UW in HKEC					
Rank	Word	frequency	Rank	word	frequency	Rank	Word	frequency	Rank	Word	frequency
1	ship	2851	26	engine	599	1	the	582345	26	an	24902
2	figure	1668	27	section	594	2	of	335784	27	it	22542
3	water	1369	28	its	580	3	and	265948	28	which	21855
4	design	1292	29	some	574	4	to	204088	29	system	19781
5	propeller	1221	30	one	572	5	in	168786	30	water	19711
6	wave	956	31	into	571	6	a	132195	31	was	18796
7	ships	950	32	rudder	571	7	for	117318	32	building	18654
8	may	930	33	other	557	8	be	95221	33	no	18217
9	these	911	34	resistance	557	9	is	84318	34	all	17862
10	speed	905	35	should	555	10	on	59914	35	has	17765
11	system	796	36	sea	551	11	with	58875	36	can	17523
12	hull	789	37	no	550	12	by	53057	37	energy	17163
13	safety	763	38	between	549	13	or	51860	38	have	16888
14	used	743	39	number	548	14	as	51412	39	may	16264
15	when	742	40	marine	537	15	are	45190	40	any	15722
16	also	736	41	data	515	16	at	42835	41	construction	15505
17	control	721	42	model	506	17	that	38881	42	other	15426
18	such	713	43	high	504	18	from	37522	43	design	15276
19	pressure	710	44	form	495	19	Hong	34000	44	works	15111
20	more	709	45	length	494	20	Kong	32808	45	also	14503
21	surface	699	46	use	493	21	should	27911	46	such	14358
22	than	676	47	then	476	22	this	27796	47	environmental	14108
23	stability	656	48	area	475	23	shall	26990	48	than	13772
24	power	631	49	two	470	24	will	25730	49	air	13591
25	where	624	50	angle	468	25	not	25356	50	control	13256

23 Using the record of the most frequent words, we created a list of the most frequent "content words" or keywords in the corpus (Table 2). These words, mostly nouns, guided our inspections of the lists generated from the 2-3- and 4-word concgrams processed by *ConcGram 1.0*. When concgramming, we refrained this time from including the exclusion list and chose to run the search using grammatical words. The software authors recommend this action; as grammatical words frequently combine with content words to create collocational framework (Greaves, 2009, p. 24). Table 2 shows the 20 keywords under focus, each of which was inspected to determine their word clusters and most frequent collocation patterns.

Table 2. – Top 20 keywords in MARENGDOC.

1. ship	11. surface
2. propeller	12. stability
3. water	13. power
4. design	14. engine
5. speed	15. maritime
6. system	16. rudder
7. hull	17. resistance
8. safety	18. marine
9. control	19. engineer
10. pressure	20. cavitation

24 These high-frequency words play a key role in the comprehension and mastery of maritime engineering language, mainly those scoring high in frequency, such as *ship*, *propeller*, *design*, *system*, *hull* and *safety*. These are core words in maritime engineering and the source of concern for experts. So here we explore a selection of these unique words and refer to the kinds of word clusters featured in the present corpus.

4.2. Researching common word clusters

25 In this section, a selection of useful collocations for marine engineering is discussed. We take into account our corpus findings related to lexical collocations to find out the most frequent and useful collocations in maritime engineering and we select examples that are pedagogically valuable and constructive. The most productive types are (N+N); (Adj+N) and (V+N) collocations.

26 **Ship**, in the first position, occurs around 4,200 times and frequently partners, obviously, with *container*, *cargo*, *passenger*, as they are ship types. It is equally frequent in compounds such as *shipboard*, *shipyard* and *amidships*. In more complex collocation strings, it presents different word class combinations, for instance, *ship at sea* and *zero ship speed*, *twin-screw ship* or the 5-word concgrams such as *twin-screw midship-rudder ship* as shown in Table 3, which illustrates a sample concgram list generated by the search of words concgramming with *ship*.

Table 3. – Sample 3-word concgram collocations with *ship*.

1	twin-rudder ships, but for **twin-screw midship-rudder ships** the wake effect dominates for
2	ships, but for **twin-screw midship-rudder ships** free-running has a wake dominating effect
3	is also the case for **twin-screw twin-rudder ships**, but for **twin-screw midship-rudder ships** the
4	importance for single-, **twin- or triple-screw ships**. It is of interest to note how the parameter.
5	the case of a high speed, **twin-screw passenger ship** when undertaking berthing manoeuvring
6	extensively in **single and twin-screw merchant ships** of all sizes and some warships. In the
7	performance of **single- and twin-screw merchant ships**. The theme of statistical prediction
8	trial performance of **twin screw merchant ships**. Trans. RINA. Searle, T. (1998).
9	**single-screw ships** K 0.20, but for **twin-screw ships** it varies within the range K 0 for fast
10	from one of the propellers of **a twin-screw ship** when operating at full shaft speed and reduced
11	If the problem exists for **a twin-screw ship** at the tip, then the blades should turn in the
12	inaugurations for both a **single- and twin-screw ship**. As previously discussed, in general,
13	(1968). The Effective Horsepower of **Twin-Screw Ships** – Best Modern Attainment for Ferries and
14	applied to **conventional single and twin-screw ships** is that the weights and axial distribution of
15	as shown in (LCB). **For twin-screw ships,** there are other considerations in E P
16	like rudders and shafts. For **typical twin-screw ships with shafts**, one pair of I-brackets and one
17	through to K 0.1 for **the slower twin-screw ships**. Both the Burrill and Keller methods have been
18	of the wake coefficient for **twin-screw ships** (D L 0.03) (Reproduced with permission from
19	or deadwood: Typically **applied to twin-screw ships** with a single rudder. Tends to have been
20	such as the case of some **small twin-screw ships.** Flow conditions and Velocity, in the case of

27 **Water** takes on specific collocates in maritime engineering language as opposed to everyday and non-specialist texts. Water in marine engineering is tackled from a scientific perspective with the study of hydrodynamics and hydrostatics. One of the most frequent collocations are *sea water*, *water stream* (N+N), *pollute water* (V+N), *water flows steadily* (N+V+ADV), *choppy/rough/stormy water*, *dangerous/safe water/s* (Adj+N). It is also interesting to note that water in the plural is associated with the sea and some frequent collocations are *territorial/coastal waters*, *home waters*, *foreign/international waters*.

28 **Design** scores 1,327 occurrences in the corpus and collocates with an extensive number of other keywords in our list, namely *ship*, *propeller*, *system and hull*, among many others. The lexical noun phrase, *ship design* has 52 occurrences. A frequent collocation is also *structural design* with 38 occurrences. A case in point is found in the following example: "One of the major items of weight requiring distribution is the hull itself, and this will be required before *detailed structural design bending moment* is completed". Structural design is an important area in shipbuilding because it provides an understanding of the structural behaviour of the ship and recognition of the unit problems.

29 Another keyword is **safety**. *Safety* as a keyword is prominent: 780 tokens. We have found the following patterns: *passenger/ crew safety* (N+N); *ensure/ guarantee/ improve safety* (V+N) and *safety controls/ improvements/ measures/ procedures/ precautions/ legislation* (N+V). More recurrent words clustering with safety observed in the 4-word concgram lists are for example, *safety management of ship stability* (occurring 324 times). Safe maritime transport is essential for passengers, crew and goods, hence mastering this expertise and equally the adequate use of its linguistic designations are important.

30 Other areas in marine engineering are related to relevant issues in shipbuilding and their mastery is essential for adequate motion and safety of vessels. Some of these words along their frequencies are for instance: *control* (721), *pressure* (710), *power* (631) and *engine* (599). These keywords are congruent with specific patterns that could be recognized as collocates (*ship control room*, *ship control system*, *ship power supply*, *ship*

engine parts), but other complex noun phrases are more difficult for students, such as, *ship power distribution diagram*. We have also uncovered frequent noun phrase collocations in the corpus, such as: *air compressor*, *air-fuel ratio*, *assembly station*, *bearing cap/load*, *bulk cargo*, *bursting cap/disc*, *cargo handling*, *combustion chamber*, *contra-rotating propeller*, *drum cable engine*, *engine efficiency*, etc. These examples reveal that lexical collocations within MARENGDOC consist of different variations of adjectives, nouns and verbs.

31 Words with lower frequency also deserve the attention of marine engineering English learners and teachers. Some examples include those related to sub-areas, such as, *mechanical/oceanographic/offshore engineering* and challenges specific to marine engineering, as in *hydrodynamic loading*, or finally, keywords and collocations related to major engineering professions: *problem/s come from*, *main problems*, *make recommendation/s*, *provide solution/s*, etc. These clusters provide insights into the aspects of phraseology used the field under focus.

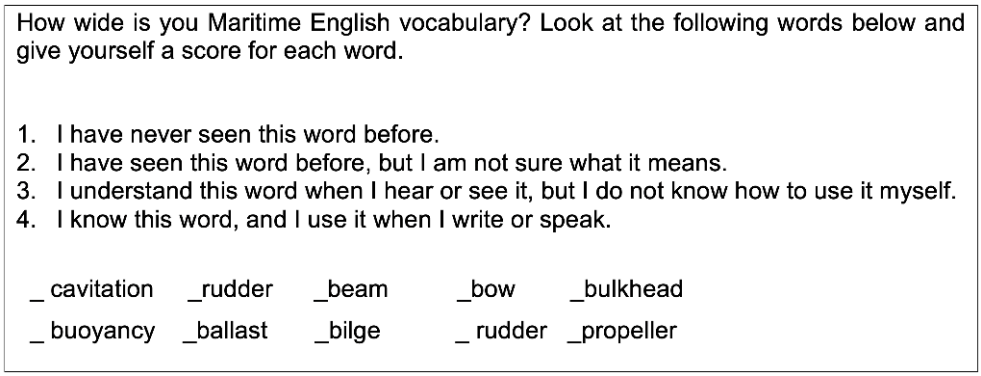
5. Pedagogical application

32 This section details the pedagogical application of the study, notably how we developed teaching materials based on the corpus analysis findings. In the process of our material design, we attempted to take advantage of all the kinds of analyses made available by *ConcGram 1.0*, from the initial extraction of unique words to the examination of word co-occurrences and concordances along with other useful statistics. The lists of concgrams (example extract in Table 3) indicate how key elements in the text create a dense network of inter-collocation, including both continuous and discontinuous phraseological patterns. The lists have not only been extremely insightful for corpus interpretation, but also fundamental for the invention of content in our teaching materials. Indeed, they have inspired the design of preliminary tasks, then a set of instructional materials we named the study set for which we created a digital learning version.

5.1. Preliminary task

33 Frequency lists are a starting point for researching and teaching vocabulary. We initiated the instructional material design with some preliminary tasks to check students' degree of familiarity with keywords and their collations, as shown in Figure 2.

Figure 2. – Exercise 1: Frequent words in maritime engineering.


How wide is you Maritime English vocabulary? Look at the following words below and give yourself a score for each word.

1. I have never seen this word before.
2. I have seen this word before, but I am not sure what it means.
3. I understand this word when I hear or see it, but I do not know how to use it myself.
4. I know this word, and I use it when I write or speak.

_ cavitation _rudder _beam _bow _bulkhead

_ buoyancy _ballast _bilge _ rudder _propeller

34 The first task, Exercise 1, is a simple awareness-raising activity that may be useful at the start of an initial lesson focusing on the basic anatomy of ships.

5.2. The study set

35 We took the top 20 keywords (Section 4, Table 2) along with the output of the concgram lists created for corpus analysis, and employed them in the design of a set of instructional materials we titled the *study set*. The set is composed of 20 topics where each keyword characterized a topic around which the vocabulary exercises were constructed.

36 We set off with examining the findings obtained from the analysis of the keywords' concgrams and clusters and determining the subtopics branching off within the main overarching topics. As we looked at concordance lines of the two-word or three-word concgrams as in, for instance, *ship/speed*, the recurring combinations finally guided us in determining the subtopics and settling the content of each topic. The concgrams and concordance lists contributed to the setup of the exercises and helped nourish their content.

37 Figure 3 indicates the contents of the study set listing the topics adopted from the top twenty keywords in the findings. The ranking order of the keywords from highest frequency to lowest was maintained.

Figure 3. – The study set contents based on the top 20 keywords in MARENGDOC.

CONTENTS	
1. SHIP ship design; ship dynamical stability; ship type; ship speed positions; ship movement.	11. SURFACE line lifting surface; low surface energy; surface piercing; wave surface.
2. PROPELLER accelerate propeller; propeller design; rudder-propeller interaction.	12. STABILITY directional stability; intact stability; stability assessment; transverse stability.
3. WATER deep water; high density water; sea water; pressure water surface.	13. POWER(ING) mechanical power; propulsion power; power-to-volume; powering propulsion.
4. DESIGN concept design model; design stage; off-design conditions; overall design process; structural design.	14. ENGINE engine management; engine room; engine shaft; multi-engine vessel; stroke-cycle engine.
5. SPEED maximum speed; low rotational speed; slow speed.	15. MARITIME maritime classification society; maritime engineering; maritime freight forwarder.
6. SYSTEM control system; dynamic positioning system-propulsion system-safety management system.	16. RUDDER rudder amidships; auxiliary rudder; balanced rudder; flat plate rudder; spade rudder; rudder maneuvering forces.
7. HULL hull fittings-hull shape- hull structural design-	17. RESISTANCE insulation resistance; lateral resistance; loading resistance; wave-making resistance; tow-rope resistance; wave-resistance.
8. SAFETY auxiliary safety program- marine safety- safety equipment- safety standards.	18. MARINE marine engineering; marine engineering projects; marine engines; marine engineering research; marine safety.
9. CONTROL control cabin-control points-control radar- quality control- weight control.	19. ENGINEER marine engineer; maritime engineer; mechanical engineer.
10. PRESSURE pressure distribution-	20.CAVITATION ship cavitation; cavitation treatment.

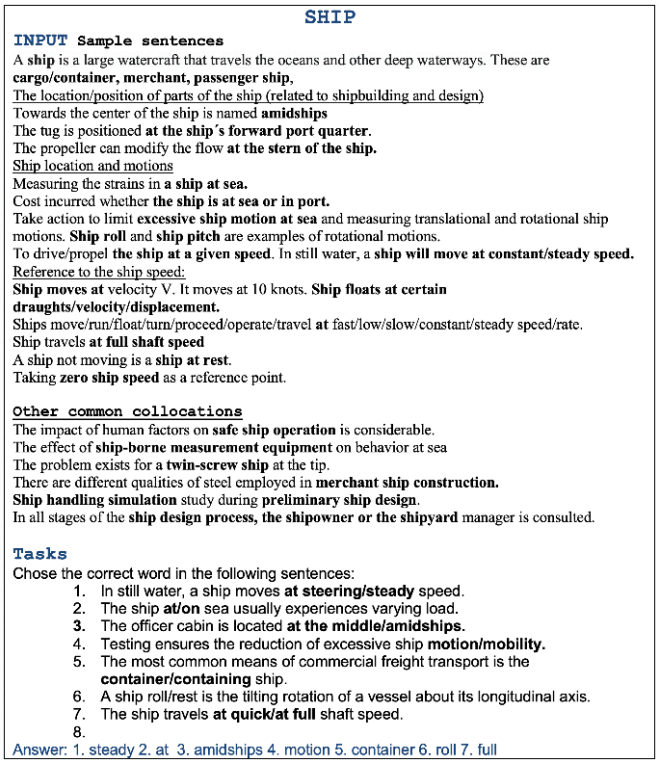
38 The study set consists of 20 topics each of which contains a section with input and another section with exercises. The layout of each individual topic material is illustrated in Figure 4. In the input section, we created sample sentences to show the language forms in use, namely the keywords and their most representative collocations and word clusters in sentence constructions. The samples are followed by an explanation and some description of the uses of these forms. The second section, dedicated to practice, presents three types of standard vocabulary exercises. The first exercise aims to familiarize the students with the language forms and consists of matching words and their collocates, matching concepts with their definitions or labelling diagrams. The second exercise provides a controlled task to check how the students apply the language form and provides sentences to complete with an appropriate word/cluster option. The third exercise asks the students to use the language form around a practical context such as filling the gaps in an authentic text extract, as it is the case with cloze tests.

Figure 4. – Layout of each topic entry in the study set.

Input	Tasks
A. Sample sentences B. Explanation/description C. Illustration (if relevant)	1. Exercise 1 matching concepts 2. Exercise 2 sentence completion 3. Exercise 3 cloze test

39 Let us examine the topic section “Ship”—it being the most frequent word and cluster node word in our corpus—to illustrate the content of the input section and the exercise section.

Figure 5. – Input and exercises with the key word *ship* and collocates.



SHIP

INPUT Sample sentences

A **ship** is a large watercraft that travels the oceans and other deep waterways. These are **cargo/container, merchant, passenger ship,**
The location/position of parts of the ship (related to shipbuilding and design)
Towards the center of the ship is named **amidships**
The tug is positioned **at the ship´s forward port quarter.**
The propeller can modify the flow **at the stern of the ship.**
Ship location and motions
Measuring the strains in **a ship at sea.**
Cost incurred whether **the ship is at sea or in port.**
Take action to limit **excessive ship motion at sea** and measuring translational and rotational ship motions. **Ship roll** and **ship pitch** are examples of rotational motions.
To drive/propel **the ship at a given speed**. In still water, a **ship will move at constant/steady speed.**
Reference to the ship speed:
Ship moves at velocity V. It moves at 10 knots. **Ship floats at certain draughts/velocity/displacement.**
Ships move/run/float/turn/proceed/operate/travel **at** fast/low/slow/constant/steady speed/rate.
Ship travels **at full shaft speed**
A ship not moving is a **ship at rest**.
Taking **zero ship speed** as a reference point.

Other common collocations

The impact of human factors on **safe ship operation** is considerable.
The effect of **ship-borne measurement equipment** on behavior at sea
The problem exists for a **twin-screw ship** at the tip.
There are different qualities of steel employed in **merchant ship construction.**
Ship handling simulation study during **preliminary ship design**.
In all stages of the **ship design process, the shipowner or the shipyard** manager is consulted.

Tasks

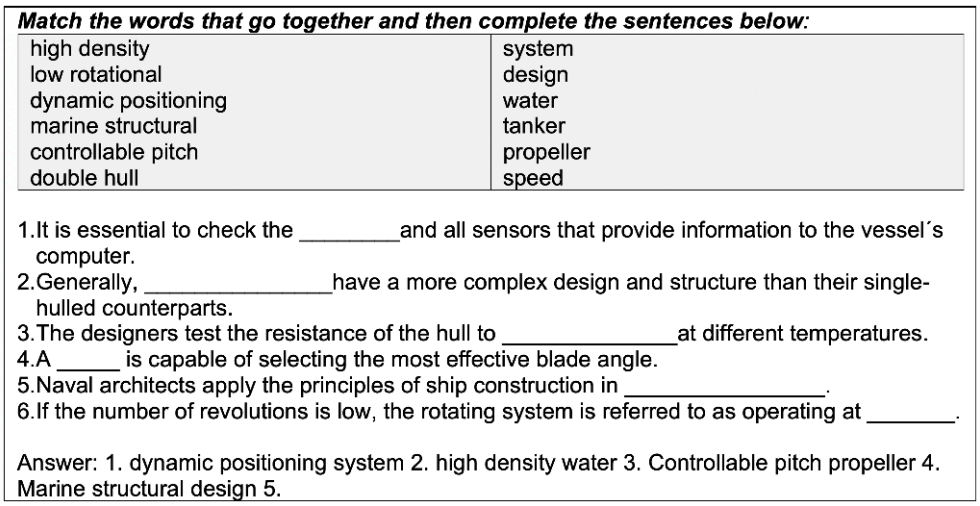
Chose the correct word in the following sentences:

1. In still water, a ship moves **at steering/steady** speed.
2. The ship **at/on** sea usually experiences varying load.
3. The officer cabin is located **at the middle/amidships.**
4. Testing ensures the reduction of excessive ship **motion/mobility.**
5. The most common means of commercial freight transport is the **container/containing** ship.
6. A ship roll/rest is the tilting rotation of a vessel about its longitudinal axis.
7. The ship travels **at quick/at full** shaft speed.
8.

Answer: 1. steady 2. at 3. amidships 4. motion 5. container 6. roll 7. full

40 A comprehensive vocabulary section was included at the end of the study set with the purpose of practicing and testing the learning of the whole body of words and cluster introduced. Figure 6 presents a sample matching exercise covering a variety of maritime knowledge areas, ranging from design to marine engineering solutions.

Figure 6. – Exercise testing vocabulary learning from 20 topics study content.



Match the words that go together and then complete the sentences below:

high density	system
low rotational	design
dynamic positioning	water
marine structural	tanker
controllable pitch	propeller
double hull	speed

1.It is essential to check the _____and all sensors that provide information to the vessel´s computer.
2.Generally, _____have a more complex design and structure than their single-hulled counterparts.
3.The designers test the resistance of the hull to _____at different temperatures.
4.A _____ is capable of selecting the most effective blade angle.
5.Naval architects apply the principles of ship construction in _____.
6.If the number of revolutions is low, the rotating system is referred to as operating at _____.

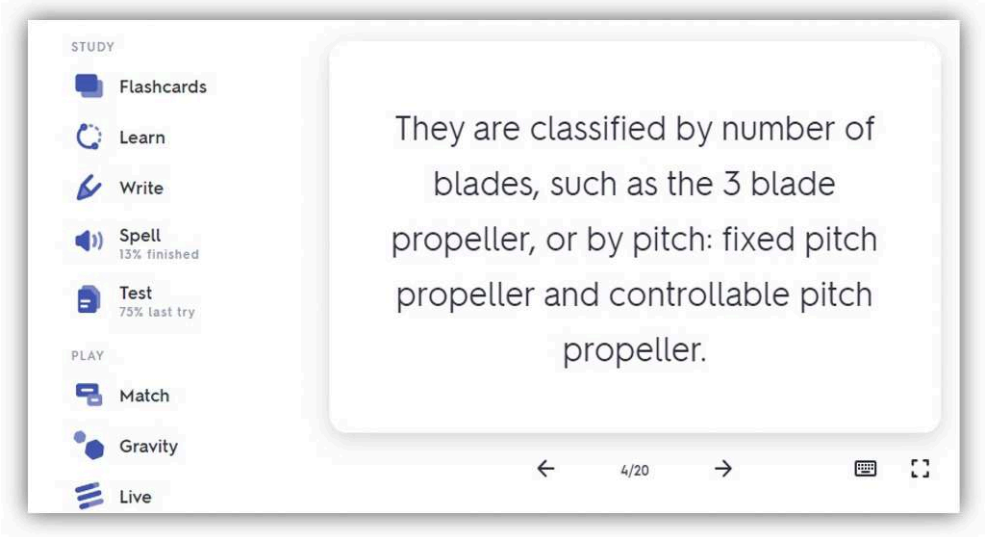
Answer: 1. dynamic positioning system 2. high density water 3. Controllable pitch propeller 4. Marine structural design 5.

41 The study set was initially designed as a traditional teaching material to be used in its print or soft format as a support resource for the course main textbook. Once this material took its final shape, we produced a digital interactive version of these study sets with the aim of making them more versatile and easily accessible to learners. For this purpose, we used *Quizlet* as a digital learning platform with responsive design

features. The content of our study material was uploaded with the aim of benefitting from *Quizlet* features, such as audio options, which are good for enhancing spelling and pronunciation, and automatic tests creation and grading. Digital flashcards are effective for learning technical vocabulary. They are made available in *Quizlet* on modes named studying/learning mode.

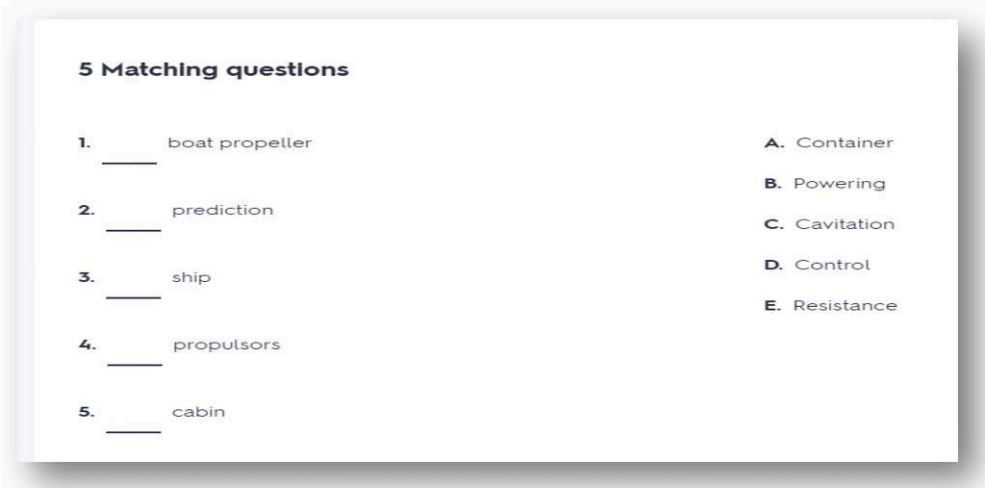
42 Figure 7 shows an interactive flash card from the *Quizlet* study set which we labelled: Maritime engineering vocabulary. The flash card presents a keyword on the front side, and a corresponding explanation/definition or sample sentence in context on the backside.

Figure 7. – A sample input section of the keyword *propeller*.



43 Apart from the studying mode, *Quizlet* is endowed with a test mode. It automatically generates tests and quizzes based on the input made available by teachers. In Figure 8, a sample vocabulary-matching question, also from *Quizlet* illustrates a practice exercise of word collocations.

Figure 8. – Sample cluster words matching question from *Quizlet*.



44 This small-scale study demonstrates that even short data driven investigations can be valuable for designing teaching activities focusing at learning N+N, Adj+N and V+N collocations in the maritime engineering L2 setting.

45 To sum up, we have studied keywords and collocations to define learning goals for marine engineering vocabulary in curriculum design of the subject *English for Professional and Academic Communication*. This decision-making process focuses on the most frequent vocabulary to ensure better return for our students' learning effort. It is relevant to take actual occurrence of these keywords in context for guiding the learning of specialized keywords and their collocates.

46 MARENGDOC data indicates that experts' writing uses a wide range of lexico-grammatical patterning for expressing marine engineering contents and the problem and solution elements typically found on shipbuilding. This study attempts to advance the field of lexico-grammatical patterning in marine engineering through examining this phraseology within a discourse-based framework. In order to interpret these lexico-grammatical patterning sets, we have taken into account the role that contextual features play in shaping the discourse of marine engineering.

6. Summary and future applications

47 This study uses a systematic data-driven, skills-based approach to researching and teaching the language of a highly specific academic and professional area, namely, English for marine engineers. The various tools provided by the *ConcGram 1.0* corpus analysis software assisted the inspection of specific aspects of marine engineering language in the corpus. The 450,000-word corpus (MARENGDOC) was compiled using reference texts such as handbooks, textbooks and manuals. The analysis focused on the corpus main keywords and their collocation patterns, generated through concgramming. The information obtained from the corpus analysis guided the design of a collection of teaching materials that we intended to integrate in the EPAC course content. The benefits of having a readily available specialized corpus and appropriate processing tools are obvious (Flowerdew, 1993, p. 239; Flowerdew, 2015), as the information from the corpus analysis made it possible to generate several practice exercises based on real examples from the corpus. We are eager to using these teaching materials in the classroom and assess the learners' receptions of the instructional activities.

48 This study is an example of how marine engineering English teachers can bridge the gap between corpus and classroom in English for specific purposes. This specialized corpus in marine engineering has been instrumental in revealing the structural identity of the different maritime reference resources, heavily consulted by students and experts alike. From our practical experience, learners need to experience collocations a minimum number of times before they actually "learn" them. Studying the distribution of the most frequent collocations in marine engineering areas can help us better understand the language in these specific contexts. Corpora studies such as this one may be an example of how corpus analysis software provide excellent tools for exploring collocations in marine engineering academic texts (Nesselhauf, 2005; Cobb & Horst, 2015) and devise relevant engineering phraseology tasks.

49 Future directions for the study of collocations in Maritime English include developing a fine-grained qualitative approach. Interviews, questionnaires, and in-class observations in oral presentations can bring to light issues in research which can potentially help learning and teaching for productive collocation use. Taking the Spanish cultural context of learners and teachers into account can also lead to a better understanding in vocabulary and ESP, focusing on these collocations that are less transparent for L2 students. Finally, we wish to develop a Vocabulary and Lexical Collocations Levels Test to assess learners' knowledge of Marine engineering vocabulary and collocations before and after the course of EPAC. Receptive and productive tests of lexical collocations are also future avenues of research.

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ABSTRACTS

This study describes a systematic approach to identify the essential vocabulary of marine engineering reference texts (handbooks, manuals) using *ConcGram 1.0* (Greaves, 2009). The aim is to identify the most frequent words and word clusters (collocations and set phrases) in a 450,000-word corpus of authentic marine engineering documents (MARENGDOC), and then to categorize frequent noun and verb phrases for teaching purposes. This study applies a computer-mediated research methodology, *concgramming*, in order to determine how individual marine engineering keywords can help to reveal the features of marine engineering discourse, and to design more relevant teaching materials for students of marine engineering English. For practical purposes, this study covers the top 20 keywords and analyses them with specific attention to their main collocates.

Cet article présente une étude qui porte sur l'utilisation d'une approche systématique pour l'analyse du corpus des textes d'ingénierie marine, à des fins didactiques. L'étude utilise le logiciel *ConcGram 1.0* (Greaves, 2009) dans l'analyse du corpus intitulé MARENGDOC comprenant 450 000 mots, compilé à partir des ressources de références en anglais en ingénierie marine. Notre objectif est de déterminer les mots les plus fréquents, les groupes de mots (*word clusters*), ainsi que les collocations distinctes du corpus. L'application pédagogique s'est focalisée sur les 20 mots-clés les plus fréquents, pour extraire leurs collocations et approfondir leur analyse. Les résultats obtenus ont orienté la création des outils didactiques conçus pour les apprenants de l'anglais spécialisé en ingénierie marine. La méthodologie de recherche assistée par ordinateur, le *concgramming*, nous a permis d'apprécier le rôle que l'analyse des mots-clés et de leurs collocations joue dans la révélation des caractéristiques du discours de l'ingénierie marine et la conception de supports pédagogiques pertinents.

INDEX

Keywords: "concgramming", collocations, corpus analysis, ESP, Marine engineering English
Mots-clés: « concgramming », collocations, analyse de corpus, anglais à des fins spécifiques, anglais de l'ingénierie marine

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