Analysing the Lexical Demands of Subject Textbooks Used in Irish Post-Primary Education to Facilitate Immigrant Students' Curriculum Access

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Abstract

This research uses a corpus-based methodology to analyse the lexical features of textbooks used in six curriculum subjects of Irish post-primary education (namely, English, History, Civic, Social and Political Education, Mathematics, and Science) to inform the English language support that is provided to immigrant students. The empirical analysis illuminates the commonest words, collocations and 4-word clusters in subject-specific registers, demonstrating the lexical variation that is manifested across subjects. From a pedagogical perspective, the discussion describes important features of students' target linguistic repertoire. Although the results are context-specific, the research methodology becomes relevant to any other context with similar pedagogical needs.

1. Introduction

The principal goal of English language support provided to immigrant students in Irish post-primary (secondary) education is to help them master the language of school subjects for curriculum access and integration into the mainstream classroom. Gaining control of the lexical resources required in the different content areas is fundamental to this end, considering the instrumental role that vocabulary (i.e. single words) and lexis (i.e. linguistic units that tend to co-occur) play in successful second language learning (e.g. Nattinger and DeCarrico 1992; Lewis 1993). The specialised vocabulary (and particularly lexical words) of school subjects has a gate-keeping function for students because it provides access to entire knowledge categories (Corson 1985). Collocations, i.e. 'combination[s] of two words [or, more precisely,

of word types] that exhibit a tendency to occur near each other in natural language' (Evert 2008: 1214), and word clusters, i.e. recurrent strings of two or more words that appear more frequently than expected by chance in a particular linguistic register, are equally important. Both are pervasive in natural language and they have been found to contribute to the fluency and naturalness of linguistic production by native and non-native speakers of a language (e.g. Pawley and Syder 1983; Howarth 1998; Hyland 2008). They further function as fundamental building blocks of academic discourse (Biber et al. 1999; Biber et al. 2004; Biber 2006) and shape context-specific meanings (Hyland 2008).

Despite their importance, however, it appears that subject-specific vocabulary and lexis, but also more broadly curriculum language, fail to receive their due attention in the language support class. Research into current practices (Lyons and Little 2009; Smyth et al. 2009) reveals that English language instruction is inappropriately or insufficiently linked to the specialized language demands of the post-primary curriculum, failing, as a result, to effectively address immigrant students' needs. This failure can be attributed to the lack of a clear understanding of the language students encounter in the subject classroom, as there has been no empirical research into this area.

To bridge this knowledge gap, the present research aims to provide an empirical description of the lexical features of six post-primary curriculum subjects - namely English, Geography, History, Civic, Social and Political Education (CSPE), Mathematics, and Science - as these are manifested in commonly-used textbooks of Junior Cycle education (i.e. the first three years of post-primary education). The methodology used to address this aim is described in the following section.

2. Research Methodology

To make curriculum language more visible, this research conducts a frequency analysis of six corpora that were designed to represent the language of commonly used textbooks used in six Irish post-primary curriculum subjects: English, Geography, History, CSPE, Mathematics and Science. Each subject-specific corpus comprises the full contents of four widely used textbooks. The 24 textbooks were scanned and converted into electronic files which were edited (graphic and visual elements were removed) and stored as text files. As can be seen in Table 1 below, their size may not be very large, compared to the corpora of billion words that can be built today. It is, nevertheless, appropriate for the aims and purposes of this research as this examines specialised language registers rather than general English language (cf. for example O'Keeffe et al. 2007: 198; Bowker and Pearson 2002: 48).

Table 1.

Composition of the six corpora built on Junior Cycle subject textbooks¹

Subject corpus	# of textbooks	# of tokens
English	4	451,784
Geography	4	330,257
History	4	367,708
CSPE	4	213,340
Mathematics	4	336,738
Science	4	328,426

The corpora in question are also multi-author, i.e. comprising textbooks written by different authors, in order to neutralise idiosyncratic language use by individual writers.

The frequency analysis of the six corpora focused on content words, significant collocations and 4-word clusters and it was facilitated by the WordList of WordSmith tools (Scott 2004). Frequency information can be used as an important criterion in prioritising what language should be taught the assumption being that, the more times students encounter a word, the more easily and faster they will understand it in their textbooks and might learn how to use it productively (see Milton 2009: 25-43 for a frequency model of vocabulary learning). To single out content words from the frequency wordlists computed by WordSmith, Nation's (2001: 430-431) function word list was used as a stop-list filter. Statistically significant collocations limited to occurrences within a five-word span were computed based on the log-likelihood ratio (G^2 ; Dunning 1993). This is a statistical measure of calculating the significance of word co-occurrence to filter out idiosyncratic collocations, i.e. frequently-used word pairs formed by chance.

For reasons of practical manageability, a relatively high cut-off point of frequency of occurrence was set (a minimum frequency of 40 times per million words) for the analysis of lexical features. In addition to minimal frequency requirements, range (i.e. consistency of use across texts in a corpus) was also used as a criterion for selecting the words and clusters to be closely examined, setting an occurrence in at least 75% of the texts that comprise a single corpus (i.e. in at least three out of four textbooks) as a minimum. This was essential to ensure that the idiosyncratic language use of individual textbook authors does not influence the results. Finally, abbreviations, numbers and symbols were excluded from the study. To facilitate a qualitative treatment of corpus data, numerical information

¹ The hash symbol (#) refers to number.

on frequency and range does not form part of this discussion. Due to space restrictions, the three types of high frequency lexical features in all six corpora are presented and discussed together in the next section.

3. Presentation and Discussion of Findings

From a close examination of the commonest content words, collocations and 4-word clusters in the six subject-specific corpora, displayed in Tables 2, 3 and 4, two major conclusions can be drawn. What can be immediately observed is the topic-specificity of the commonest lexical features in the six corpora. Regardless of the unit of analysis, i.e. word, collocation, 4-word cluster, the lexical choices of individual corpora seem to be largely influenced by the thematic content and communicative needs of the corresponding curriculum subjects.

Therefore, the commonest features in the English corpus mainly highlight the literary dimension of the subject (e.g. *story, write, poem, words, read*) and the emphasis that is placed on answering questions and justifying personal opinions (e.g. *answer questions, give reasons, what do you think*, etc.). In the Geography and History corpora, the most frequent words and collocations directly reflect the focus of study on people and the environment (e.g. *countries, city, map, water, population density, acid rain*) and on past issues, events, and historical figures (e.g. *Irish, world war, De Valera, Fianna Fáil, international relations*) respectively. The notion of time is also prominently featured by history-specific lexical words and collocations (e.g. *time, middle ages, twentieth century*). Clusters in the Geography corpus are mainly associated with references to visual aids (e.g. *a sketch map of, the ordnance survey map, shown on the map*) while clusters in the History corpus describe issues and time periods of historical significance (e.g. *the War of Independence, agricultural and industrial revolutions, in the twentieth century, during the middle ages*).

Table 2.

The 20 most frequent content words in the six textbooks-based corpora (cut-off frequency point - 40 per million words, range - 100%).

English	story, like, write, said, think, answer, poem, words, people, time, make, read, good, give, see, writing, just, use, new, well
Geography	people, map, population, areas, water, area, countries, city, river, land, following, figure, South, world, sea, large, photograph, new, high, explain
History	people, war, Irish, government, century, British, new, world, became, used, made, called, year, land, army, great, church, time, following, work
CSPE	people, action, community, rights, local, world, work, school, government, project, European, make, Irish, class, children, council, day, group, groups, think
Mathematics	find, centimetres, number, calculate, line, area, value, equation, point, example, given, following, solution, angle, sides, length, graph, diagram, solve, sine
Science	water, energy, used, light, air, food, test, heat, experiment, called, plants, oxygen, tube, gas, place, method, carbon, plant, acid, current

Table 3.

The top 20 most significant collocations in the six subject textbooks corpora ranked by descending order of significance based on G^2 scores (frequency threshold $F \geq 10$, minimum range 75%).

Textbooks corpus	Collocations
English	at the, do you, from the, what is, do think, your answer, what do, give reasons, what you, will be, have been, answer questions, write a, out of, would be, look at, had been, if you, going to, questions follow
Geography	such as, ordnance survey, per cent, have been, grid reference, more than, your answer, can be, what is, case study, may be, inner city, has been, acid rain, number of, they are, between and, these are, population density, sketch map
History	twentieth century, such as, set up, world war, De Valera, Northern Ireland, during the, Home Rule, international relations, Fianna Fáil, more than, junior history, middle ages, prime minister, did not, relations century, how did, between and, political in, what was
CSPE	action project, human rights, United Nations, young people, find out, by the, has been, set up, there are, European Union, number of, answer questions, will be, do think, can be, right to, do you, more than, this is, asylum seekers
Mathematics	calculate the, value of, on the, how many, area of, both sides, write down, number of, each following, calculate of, correct to, standard rate, surface area, image under, under symmetry, at the, image of, Venn diagram, average speed, tax paid
Science	carbon dioxide, test tube, can be, Bunsen burner, experiment to, as shown, such as, set up, higher level, this is, what is, apparatus used, number of, used to, retort stand, living things, at the, result conclusion, centre gravity, through the

Several words and patterns that refer to people, individuals and organizations can be found in the CSPE corpus (e.g. *children, young people, asylum seekers, government United Nations, European Union*). The concept of rights, which is fundamental to the discourse of CSPE, also occurs among the top lexical features of CSPE textbooks (e.g. *human rights, rights of the child, has the right to*). As regards the commonest items in the corpora of the two more technical subjects of Mathematics and Science, these reveal major concepts and issues of mathematical and scientific study (e.g. *number, value, equation, surface area and energy, current, carbon dioxide* respectively). They further express instructions and tasks in which students engage in the classroom; these concern the practices of counting and measurement in mathematics (e.g. *find the value/image/equation of, divide both sides by*) and conducting experimental work in science (e.g. *set up the apparatus, experiment to show that*). Overall, the lexical variation that exists across the subject-specific corpora of Irish post-primary textbooks adds further evidence to the existing research evidence about the linguistic variation that exists across disciplines (e.g. Biber et al. 1999; Hyland 2008, etc.).

Another tendency that can be discerned based on the frequency results of the lexical analysis of the six subject-specific corpora is the recycling of the commonest features within the commonest word patterns. Examples of frequent content words and collocations which are embedded within some of the commonest 4-word clusters in the six corpora include the following:

English: *think, give-reasons, answer-questions, do-think, questions-follow*

Geography: *map, grid-reference, ordnance-survey, sketch-map*

Table 4.
The 20 most frequent 4-word clusters in the six corpora in a descending frequency order (minimum frequency - 40 per million words, minimum range - 75%, N = rank order, italics = cluster in all 4 textbooks)

N	English	Geography	History	CSPE	Mathematics	Science
1	<i>give reasons for your</i>	<i>each of the following</i>	<i>in the twentieth century</i>	<i>has the right to</i>	<i>each of the following</i>	<i>shown in the diagram</i>
2	<i>reasons for your answer</i>	<i>draw a sketch map</i>	<i>international relations</i>	<i>and answer the questions</i>	<i>find the value of</i>	<i>as shown in the</i>
3	<i>the questions that follow</i>	<i>the west of Ireland</i>	<i>in Ireland in the</i>	<i>the work of the</i>	<i>the values of x</i>	<i>set up the apparatus</i>
4	<i>answer the questions that</i>	<i>a sketch map of</i>	<i>write an account of</i>	<i>why do you think</i>	<i>values of x for</i>	<i>the apparatus as shown</i>
5	<i>and then answer the</i>	<i>the ordnance survey map</i>	<i>the end of the</i>	<i>of the action project</i>	<i>the area of the</i>	<i>is made up of</i>
6	<i>of the following questions</i>	<i>sketch map of the</i>	<i>each of the following</i>	<i>answer the questions that</i>	<i>the value of x</i>	<i>can be used to</i>
7	<i>what do you think</i>	<i>the area shown on</i>	<i>answer the following</i>	<i>the questions that follow</i>	<i>the equation of the</i>	<i>what is meant by</i>
8	<i>the end of the</i>	<i>to support your answer</i>	<i>the treaty of Versailles</i>	<i>social and political</i>	<i>find the image of</i>	<i>the bottom of the</i>
9	<i>two of the following</i>	<i>area shown on the</i>	<i>the age of revolutions</i>	<i>as part of the</i>	<i>at the end of</i>	<i>the centre of gravity</i>
10	<i>do you think the</i>	<i>shown on the map</i>	<i>at the end of</i>	<i>a member of the</i>	<i>find the equation of</i>	<i>a form of energy</i>
11	<i>at the end of</i>	<i>with the aid of</i>	<i>the war of independence</i>	<i>civic social and political</i>	<i>of x for which</i>	<i>for the presence of</i>
12	<i>fill in the gaps</i>	<i>per cent of the</i>	<i>the agricultural and</i>	<i>of the European Union</i>	<i>divide both sides by</i>	<i>a small amount of</i>
13	<i>one of the following</i>	<i>study the ordnance</i>	<i>the league of nations</i>	<i>declaration of human</i>	<i>correct to the nearest</i>	<i>is a form of</i>
14	<i>the rest of the</i>	<i>in the west of</i>	<i>agricultural and industrial</i>	<i>what do you think</i>	<i>standard rate cut off</i>	<i>experiment to show that</i>
15	<i>each of the following</i>	<i>tick the correct box</i>	<i>of the twentieth century</i>	<i>the rights of the</i>	<i>equation of the line</i>	<i>the mass of the</i>
16	<i>at the beginning of</i>	<i>map of the area</i>	<i>during the middle ages</i>	<i>was set up in the</i>	<i>the length of the</i>	<i>carbon dioxide and</i>
17	<i>in the middle of</i>	<i>the population of the</i>	<i>per cent of the</i>	<i>do you think the</i>	<i>the radius of the</i>	<i>the boiling point of</i>
18	<i>and answer the questions</i>	<i>of the area shown</i>	<i>the Home Rule party</i>	<i>the European court of</i>	<i>axial symmetry in the</i>	<i>the density of a</i>
19	<i>give a reason for</i>	<i>is one of the</i>	<i>the Irish free state</i>	<i>universal declaration of</i>	<i>the end of the</i>	<i>the top of the</i>
20	<i>this is a very</i>	<i>in the form of</i>	<i>in the middle ages</i>	<i>rights of the child</i>	<i>the volume of the</i>	<i>find the mass of</i>

History: *century, international-relations, twentieth-century, industrial-revolution, home-rule, middle-ages*

CSPE: *rights, action-project, European-Union, human-rights, universal-declaration*

Mathematics: *value, standard-rate*

Science: *energy, carbon-dioxide, experiment-show, centre-gravity*

Interestingly, even when these high-frequency words and collocations are not embedded within 4-word clusters, concordance lines show that they are manifested as their complementation items, i.e. the words that follow or precede them. The following are some illustrative examples from the six corpora (content words are underlined and enclosed in parentheses and collocations are simply enclosed in parentheses; intervening words are placed within square brackets):

English:

*end/rest of the (story)
this is a very good (answer)
do you think the (poet)
give a reason for (your answer)
one of the following (words [or] phrases)*

Geography:

*per cent of the (population)
with the aid of (a diagram/reference grid)
the population of the (West [of] Ireland)*

History

*write an account of [the] (people)
the end of the (war)
per cent of the (land)
at the end of the/international relations in the (twentieth century)*

CSPE

*the rights of the (child)
(as part) of the action project
a member of the (European Union/Parliament, Defence Forces)*

Mathematics

*the equation of the (line)
(calculate) the area of the (triangle)
find the image of [the/each] (point)
(length of) the radius of the*

Science

*is made up of (water)
the density of a (liquid)
the bottom of the (tube)
(test) for the presence of (starch/food/carbon dioxide)*

The above patterns attest to Sinclair's argument that: 'by far the majority of text is made of the occurrence of common words in common patterns or in slight variants of these patterns' (1991: 108). This observation about the lexical patterning of texts challenges the compositional view of language and supports the idiom principle according to which 'the language user has available to him a large number of preconstructed or semi-constructed phrases that constitute single choices, even though they appear to be analysable into segments' (ibid.: 110).

The two conclusions that emerge from the analysis of the six subject-specific corpora carry direct pedagogical implications for the provision of English language support to immigrant students in Irish post-primary schools. The subject-specific nature of lexical features clearly demonstrates that curriculum language is not a single uniform register but a constellation of diverse language varieties that correspond to the different subjects. This conclusion calls for an English for Specific Purposes approach in the language support class and, more specifically, for language teaching and learning which are firmly embedded within the mainstream curriculum. Therefore, at a practical level, the descriptions of the lexical preferences of the six subjects provided here can be profitably used to facilitate thematically-based vocabulary teaching and learning and help teachers and students appreciate the lexical 'uniqueness' of subject-specific texts, that is, 'what makes [one subject-specific] text different from all other texts' (Nation 2001: 205).

The repeated use of high frequency lexical words in the most frequent collocations and the recycling of the commonest words and collocations within or adjacent to several highly frequent 4-word clusters highlight, on the one hand, the 'power' and 'utility' of the commonest words (Willis 1990) and the pre-patterned nature of subject-specific language, on the other. From a pedagogical perspective, this suggests that it is worthwhile teaching and learning the most frequent subject-specific words identified by this research due to their increased usefulness (the more often students encounter these words, the greater their need is to understand and use them). In addition, the lexical patterning that underpins subject-specific texts points to the need for a lexical approach (Lewis 1993) to language teaching and learning which takes lexis as its starting point viewing language as a phraseological system (Sinclair 1991). To this end, the repeated patterns of word co-occurrence described in the present discussion can be used to facilitate students' training in 'pedagogical chunking', that is 'breaking continuous text into useful component "bits"' (Lewis 1993: 120) within the meaningful communicative context of authentic subject-specific texts.

4. Conclusion

This discussion described the commonest lexical words, collocations and 4-word clusters manifested in commonly used textbooks of six curriculum subjects of Irish Junior Cycle education. Although it was possible to present only a limited sample of findings², the discussion has drawn two pedagogically useful conclusions about the nature of the lexical features that repeatedly occur in subject-specific texts. The first conclusion is that subject-specific texts value distinct sets of interrelated lexical words and phrases, and that these lexical preferences are highly determined by the information content of particular texts. The second conclusion is that subject-specific texts are underpinned by lexical patterning which is built upon the most frequent content words favoured by individual subjects.

Taken together, corpus-based data and descriptive insights into the nature of curriculum language can have multiple applications in the English language support classroom. The present empirical findings can, first of all, inform the content of a principled and explicit teaching agenda for language support teachers and facilitate decisions about the vocabulary component (selection, sequence, gradation, etc.). The corpus-based lexical inventories for the six subjects can also be directly exploited in the development of context-specific materials and language tests so that these can accurately reflect students' authentic language learning needs. In short, if learning, teaching and assessment are underpinned by the same corpus-based language specifications, then a coherent and effective language pedagogy can be promoted and multiple links can be established between English language support and the mainstream subject classroom.

Overall, this research addresses the lack of empirical information on the language of the Irish post-primary curriculum and the demands this imposes on immigrant students. At a more general level, the research responds to the calls for more applied corpus linguistics studies which are motivated by an interest in second language education specifically in the context of secondary education (e.g. Coxhead 2010: 466; Flowerdew 2009: 345). Moving beyond the Irish context, and considering that the linguistic integration of immigrant students is, and will remain, a common challenge for all educational systems, the design and methodology of this research has the potential to be adapted for use in other migrant education settings with similar pedagogical needs.

² See Kostopoulou 2012 for a detailed discussion of the language of Irish post-primary subject textbooks and examination papers.

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