Learning technical words through L1 and L2: Completeness and accuracy of word meanings

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ABSTRACT

This paper investigates the quality of knowledge of technical words that high-school students learned from subject reading. In particular, it focuses on similarities and differences between students who learned new words through their L1 and their L2. In the study, 72 students were divided into two groups and asked to read and listen to two expository texts. One group received the texts in their L1 (Slovak) and the other group in their L2 (English). Afterwards the participants were tested on their knowledge of twelve technical words that appeared in the texts. The responses were examined in terms of the completeness of word meaning and the presence of errors. The results showed that compared to the L1-instructed students, the L2-instructed participants provided word meanings that were less complete and less precise. Word meanings from both groups contained errors involving omission of correct meaning components and inclusion of incorrect meaning components. L2-instructed participants made more errors of both kinds. The differences between the two groups are discussed with respect to vocabulary acquisition and subject learning.

1. Introduction

Mastering technical vocabulary is an integral part of subject learning (Bravo & Cervetti, 2009; Woodward-Kron, 2008). As students learn about new concepts, they also acquire new words for communicating and demonstrating this knowledge (Mohan & van Naerssen, 1997). However, for many students, especially those accessing their education through a non-native language, disciplinary vocabulary also remains one of the most challenging areas. Growing research evidence shows that L2-medium educated students struggle with comprehending, learning and using subject-specific terms in the course of their studies (Evans & Green, 2007; Evans & Morrison, 2011; Mežek, 2013; Lessard-Clouston, 2006; Ryan, 2012). This study aims to improve our understanding of the demands that learning disciplinary, technical words places on non-native speakers of the instructional language. In particular, this study focuses on learning of the meanings of new technical words that appear in a written context with explicit clues.

It is becoming increasingly more common for students to study content through a non-native language, whether in bilingual programmes in their home country or as international students abroad. In these educational contexts, teaching is as a rule delivered by subject (not language) specialists who follow the methodology typical of mainstream classes. However, it remains unclear whether these methods are also suitable for L2-medium students as little is known about the difference between learning of specialised vocabulary through L1 and L2.

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To date, most evidence regarding L2 vocabulary acquisition has come from studies that did not use an L1 baseline. This is due to practical difficulties of directly comparing vocabulary acquisition through L1 and L2 (Gablasova, 2014) mainly caused by two factors: First, most words learned by L2 users are already known to L1 speakers of the same age, making it difficult to compare acquisition of the same set of words. Second, learning through L2 usually involves the mapping of a new L2 word form onto an already existing L1 concept or word (Jiang, 2000) rather than acquiring both a new concept and a new form simultaneously, as is common in L1 learning. However, this is not the case with the acquisition of low frequency, subject-specific vocabulary (e.g. coniferous or gnosticism). These words are typically acquired in the study of academic subjects and involve learning of a new word meaning along with a new form. This is true equally of the students learning the subjects through their first as well as their second language, enabling researchers to study L2 vocabulary learning in direct contrast to L1 learning.

Since technical words combine language and subject knowledge (Bravo & Cervetti, 2009), findings from this study will be of interest not only to vocabulary researchers, but also to subject specialists involved in teaching content through students’ second language. By exploring differences or similarities found between native and non-native speakers of the language of instruction this investigation will contribute to more targeted pedagogical approaches to the teaching of subject terminology than has been possible so far.

1.1. Learning specialised vocabulary in academic contexts

Technical words are a special group of vocabulary characterised by several features: they are low frequency words restricted to a particular domain in which they appear with a fairly high frequency (Nation, 2001; Nation & Hwang, 1995; Chung & Nation, 2004; Pearson, 1998); they are part of the taxonomy of knowledge in a particular subject area (Chung & Nation, 2004) with a clear relationship to other terms in that area (Pearson, 1998). Nevertheless, despite a general agreement on these criteria, the distinction between technical and non-technical uses of words is not always clear-cut (e.g. Chung & Nation, 2003; Chung & Nation, 2004; Ryan, 2012; Pearson, 1998). As Chung and Nation (2004) point out, this distinction is often context-sensitive because “technicalness is a functional aspect of a word” (p. 251).

Vocabulary development can be studied with a focus on different dimensions of word knowledge (Nation, 2001), but in the case of technical words it is the semantic dimension that is arguably of particular importance as these words serve to denote concepts with accuracy and precision (Pearson, 1998). So far, several studies have focused on vocabulary learning in the course of academic study (e.g. Haynes & Baker, 1993; Mezek, 2013; Lessard-Clouston, 2006; Parry, 1991, 1993; Vidal, 2003; 2011; Ryan, 2012). Some of these studies (Haynes & Baker, 1993; Lessard-Clouston, 2006; Parry, 1991, 1993; Ryan, 2012) also addressed the quality of word meanings acquired by students in greater detail. For instance, in a longitudinal case study of lexical acquisition by an anthropology student, Parry (1993) found that the student was partly successful at inferring new word meanings from disciplinary texts, but her guesses contained semantic errors: her de

Evidence of the challenges faced specifically by L2 students has come from contrastive studies that compared the gains in specialised vocabulary by L1 and L2 users (Haynes & Baker, 1993; Lessard-Clouston, 2006; Ryan, 2012). These studies report that compared to L1 users, the word meanings acquired and retained by L2 users were of lower quality in terms of the depth of knowledge, and the L2 speakers were able to provide fewer details about the meaning of the technical words. The problems experienced by L2-medium students in these studies were mainly attributed to a lower mastery of the L2, in particular to a limited number of links in the mental lexicon (Lessard-Clouston, 2006) and a smaller vocabulary size (Haynes & Baker, 1993). However, two of these studies (Lessard-Clouston, 2006; Ryan, 2012) were based on a rather small number of L2 speakers (fewer than ten) and, thus, the data allowed for mostly qualitative analysis. Also, the comparison of native and non-native speakers in these studies is not straightforward because the L1 speakers had a relatively large amount of prior knowledge of most of the target words. Indeed, as Haynes and Baker (1993) report, in a special case when both the concept and the form of a target word were equally new to L1 and L2 speakers, both groups of students had a similar difficulty acquiring this word and tended to “focus on one dimension of meaning to the exclusion of others” (p.148), a strategy that appears to be comparable to that observed by Parry (1993). Therefore, to evaluate the effect of the language of acquisition on lexical gains we need to study a greater number of cases where technical words are acquired in parallel through L1 and L2.

1.2. Factors affecting vocabulary learning from reading

Research on vocabulary acquisition from reading has identified several factors that affect the ability to pick up words from context (Huckin & Coady, 1999; Paribakht & Wesche, 1999). Among the most important factors are the degree and type of contextual support (Hulstijn, Hollander, & Greidanus, 1996; Hulstijn, 2003; Swanborn & de Glopper, 1999; Webb, 2008). More specifically, words that appear with explicit and rich clues have a better chance of being learned. This relationship is also reflected in the practice of textbook writers, who are aware of the importance of the context for learning new words. In textbooks, new technical words, therefore, often appear with a pedagogical context, i.e. with a definition or explanation of the word (Haynes & Baker, 1993). This so-called lexical familiarisation is intentionally placed in the text to help the reader with
understanding and acquiring word meanings (Bramki & Williams, 1984). As a result of this ‘strong’ context, when word meanings are inferred, the process is not dependent on random or insufficient textual clues that could lead to incorrect guessing (Frantzen, 2003). Overt clues to word meanings are especially important as the acquisition of specialised vocabulary often involves the most difficult type of lexical learning, i.e. the learning of both a new concept and a label for that concept (Jenkins & Dixon, 1983).

Another group of factors affecting vocabulary learning is related to individual characteristics of readers. Here, overall vocabulary size is crucial as it determines how much information from the context the reader is able to process and use in constructing the meaning of unknown words (Nagy, Anderson, & Herman, 1987; Paribakht & Wesche, 1999; Vital, 2003; Wesche & Paribakht, 2010). According to the research on the effect of glosses on students’ lexical gains, the ability to understand the glosses proved to be an essential pre-requisite of learning previously unknown words (for an overview of this research see Schmitt, 2008). Admittedly, it is L2 users who may be affected most by their limited proficiency and vocabulary size, but when reading subject-specific texts containing lower-frequency vocabulary, native speakers may also encounter unfamiliar words (Nelson-Herber, 1986) and face challenges learning technical vocabulary.

1.3. Research questions

Words are acquired gradually, in a process in which the knowledge of the word and its use is both expanded and refined (Jiang, 2000; Nation, 2001; Sonaiya, 1991). This study examines students’ initial understanding of new word meanings after encountering technical words in a natural context (an expository text from a textbook). The aim is to establish to what extent the acquisition of technical terms in L2 is similar to or different from that in L1. This study provides a description of the word meanings derived from expository texts by L2 users and compares this to a baseline of L1 users who derived the same words from L1 texts. The acquired word meanings are analysed with respect to their completeness and correctness of information. Two specific questions are addressed:

Research question 1: What is the difference in the completeness of technical word meanings acquired through L1 and L2?

Research question 2: Is there a difference in the nature of errors in the technical word meanings acquired through L1 and L2?

2. Method

2.1. Participants

Participants in this study were 72 students recruited from two high schools in Slovakia with a Slovak-English CLIL (Content and Language Integrated Learning) bilingual programme. The participants (17–20 years old) were drawn from among students in the last two years of study and were proficient users of English, having spent a minimum of 3.5 years in a bilingual programme. At the end of their high-school study these students are expected to reach B2/C1 level of English as established by the Common European Framework of Reference for Languages (CEFR). Three tests were used to measure participants’ L2 language proficiency in terms of vocabulary size (X_Lex and Y_Lex) (Meara, 2005) and productive language skills (C-test) (for a more detailed description of the tests and the rationale for using them see Gablasova, 2012). Based on their scores, participants were divided into two groups balanced for L2 proficiency. As can be seen from Table 1, an independent-samples t-test showed no statistically significant difference between the two groups in terms of proficiency.

The first group of participants (referred to as the control group or the L1-instructed participants) received all materials in their L1 and the second group (the L2-instructed participants) received the materials in their L2.

2.2. Materials

The materials in the study were two expository texts approximately 800 words long and audio recordings of those texts. The texts described two topics new to the participating students: the History and the Geography of New Zealand. The first text described the arrival of the Maori to New Zealand and the development of the Maori lifestyle thereafter; the second text described the region of the High Country of the South Island in New Zealand. The reading materials were based on two

| Test | L1-instructed (N = 35) | L2-instructed (N = 37)* | t    | df | Sig. |
|------|------------------------|-------------------------|------|----|-----|
|      | Mean | SD  | Mean | SD  |     |     |
| X_Lex | 4077.1 | 566.8 | 4075.7 | 541.7 | .011 | 70 | .991 |
| Y_Lex | 2101.4 | 714.3 | 2105.6 | 628.1 | -.026 | 69 | .979 |
| C-test | 70.80 | 9.31 | 68.90 | 11.76 | .751 | 69 | .455 |

* Number of participants taking the C-test and Y_Lex was 36.
textbook texts: *A Concise New Zealand History* (Wikibooks, 2007) and *Year 12 Geography Study Guide: NCEA Level 2* (Billing et al., 2008) (see Gablasova, 2012 for more details on the development of the reading materials). A lexical analysis based on the frequency lists from the British National Corpus processed by the RANGE programme (Heatley, Nation, & Coxhead, 2002) showed that about ninety percent of the words in the texts were from the five thousand most frequent words in English (History text: 89.08% of tokens; Geography text: 86.57% of tokens). The texts were first developed in English and translated into Slovak by the researcher and checked by two native speakers of Slovak. Participants in the study both read the texts and listened to them (for the rationale see Section 2.3). The English and Slovak recordings of the texts were made by a female native speaker of English and a female native speaker of Slovak. The full texts can be seen in Gablasova (2012, 2014).

### 2.2.1. Target words

Twelve target words were placed in the texts along with a form of lexical familiarisation (a definition). Where possible, the definitions of the target words were adapted from high-school textbooks in order to ensure they were appropriate for the given age group. The target words in this study can be defined as Steps 3 and 4 of Chung and Nation’s (2004) scale. Following the definition in the scale, these words are closely related either to the domain of history and culture of New Zealand or to the field of geography and do not appear frequently in other domains.

The twelve target words (TWs) were selected according to the following criteria: a) they were all nouns (six abstract and six concrete), b) they were not known to participants either in their L1 or L2 (see Section 2.3.1) and c) they had a similar form and pronunciation in English and in Slovak (e.g. *ampelography* and *ampelografi*ja). Using the same TWs in L1 and L2 allowed us to study the acquisition of the same set of technical words through the two languages in a parallel manner. Each of the two texts contained six target words. The following twelve TWs were used (the number in the brackets signals the number of occurrences of each word in the text): *ampelography* (2), *diastrophism* (1), *ecocentrism* (2), *kumara* (1), *moa* (3), *moko* (3), *pa* (2), *perendale* (1), *rcd* (2), *terroir* (3), *transhumance* (1) and *whanau* (3). The TWs selected were largely words of Latin or Greek origin and thus cognate in the two languages, or loanwords from Maori borrowed both to English and Slovak. Table 2 shows an example of lexical familiarisation which the target words appeared with in the texts (all lexical familiarisations used with the TWs discussed in this article can be seen in the Supplementary data). As shown in the example, all occurrences of the TWs were restricted to the lexical familiarisation of the word.

Although word and textual characteristics (such as frequency of occurrence or length of words) play an important role in the learning of words (Cervetti, Hiebert, Pearson, & McClung, in press), it was not possible to control these features due to the above criteria. However, as the participants in both groups were tested on the same set of words, the differences in their learning gains can with a high degree of likelihood be attributed to the language of learning rather than to individual properties of the words or the contexts in which they were embedded. Moreover, no statistically significant correlations were found between the semantic quality of the acquired words and the number of TW occurrences in the text, their length (measured in number of letters and syllables both in Slovak and in English), or the number of words in the lexical familiarisation of the TWs.

### 2.3. Procedure

The study consisted of a pre-test, a reading session and a post-test. The participants were tested individually. At the beginning, the participants were told that the study focused on content learning by bilinguals and that they would be asked about the content of two texts.

The participants first completed a pre-test assessing their knowledge of the TWs. In the session that followed, the participants were first given 10 min to read the first text after which they listened to it while being able to follow it. The same procedure was repeated with the second text. One group of participants read the texts and listened to them in English (their L2), the other group in Slovak (their L1). Overall, the participants spent about 30 min with the texts. The listening-while-reading modality was employed in addition to reading in order to ensure that the participants paid attention to the whole of the text (cf. Horst, Cobb, & Meara, 1998) as well as to familiarise them with the pronunciation of the TWs. The reading session was followed by a two-minute non-verbal distractor task (a puzzle). After that, the participants completed a post-test in which they were asked to orally answer questions about the texts, including the questions about the target words.

### 2.3.1. Instruments

#### 2.3.1.1. Pre-test. As the purpose of the study was to measure the acquisition of new word meanings, it was important to establish that the participants had no previous knowledge of the TWs either in their L1 or L2. Prior knowledge of the TWs was

| Target word | Lexical familiarisation |
|-------------|------------------------|
| Ampelography | The quality of the wine production and vine disease prevention is now much improved with advances in ampelography (the science which specialises in identification and classification of vines by comparing the shape and colour of the vine leaves and grape berries). |
pre-tested using a vocabulary list asking the participants to indicate their knowledge of the words by ticking one of the options on the following scale (adapted from Paribakht and Wesche (1997)): 1) I have never seen/heard the word, 2) I have seen/heard the word before but don’t know what it means, 3) I know what the word means. Altogether, the list contained 68 words which appeared in the two texts. In order to test the general knowledge of the topics of the two texts, the participants were asked eight open questions each related to a main idea in the texts (cf. Zaki & Ellis, 1999). The pre-test showed that the participants did not have any prior knowledge of the TWs and were not familiar with the selected topics. Both instruments are available in the Supplementary data.

2.3.1.2. Post-test. The post-test was computer-administered. The questions appeared on the computer screen and participants gave the answers orally. The post-test consisted of 36 questions that covered information in the two texts. Twelve of these questions asked about the meaning of the target words (e.g. What is amelophobia?), and the remaining 24 questions asked about other information from the texts. The 36 questions were divided into two blocks with half of the questions being asked in English and the other half in Slovak (the presentation of the blocks was counterbalanced). Each block contained questions about six TWs: thus, participants answered questions about six TWs in their L1 and six questions in their L2. Participants received the same questions, regardless of whether they read the texts in Slovak or in English.

Participants were tested in both of their languages to counterbalance the influence of having to transfer the knowledge from their instructional into their non-instructional language. As they were proficient speakers of L2, this did not result in problems with communication. The data from both parts of the test are therefore presented together.

2.4. Analysis and coding

Previous studies that examined the quality of expressible word knowledge focused on the completeness and restrictiveness of word meanings (e.g. Johnson & Anglin, 1995) as well as correctness of the semantic information (e.g. Fukkink, Blok, & De Glopper, 2001; Parry, 1993). In order to capture the different degrees of semantic knowledge, the coding framework in this study combines the two dimensions. Earlier research also stressed the importance of employing measures sensitive enough to capture the more fine-grained differences between the different degrees of lexical knowledge (Swanborn & De Glopper, 1999).

Participants’ responses were first divided into a) those that showed some evidence of TW learning (altogether 642 definitions) and b) those that did not (i.e. the participant could not recall any information about the TW or gave an incorrect answer) (altogether 222 definitions). Only those answers that showed some evidence of lexical learning were examined further (for the discussion of the number of form–meaning connections formed by each group, see Gablasova, 2012, 2014). The quality of the word meanings provided by the participants was determined with respect to the inclusion of correct and incorrect core and minor meaning components. A list of correct meaning components was made on the basis of the information provided about each TW in the texts. These were divided into core (major) and minor meaning components after consulting a dictionary and also following an analysis of students’ answers. Based on this, a four-point scale (presented in Table 3) was developed and used for scoring participants’ answers. Examples of each scoring category can be seen in Table 4.

All examples in Table 4 are taken from the elicited definitions of transhumance with the exception of 1b which is taken from the definition of ecocentrism. The definition of ecocentrism in the text was as follows: “Ecocentrism is a nature-centred worldview based on the belief that all living organisms are equally important.” Transhumance was defined in the following way: “Transhumance – the seasonal movement (before winter) of stock from exposed, high mountain slopes to the more sheltered foothills and river flats. This avoids large stock-losses due to the bitter cold of winter.” All answers in the table were elicited in English. 3a shows an example in which the component ‘stock’ was replaced by ‘sheep’, thereby somewhat limiting the meaning of the word (as ‘sheep’ are a subset of ‘livestock’). 3b shows an example in which ‘moving’ was substituted by ‘driving out’. As the meaning of the latter expression could be paraphrased as ‘to force to go away’ it adds to the original meaning a component which was not implied in the text. Example 2a demonstrates a response in which a core meaning component (here ‘livestock’) was left out altogether. 2b is an example of a response in which a core component (‘livestock’) was replaced by another component (‘crops’). 1a shows a response in which only a short phrase (‘before winter’) overlapped with the original meaning, the rest being inaccurate. 1b is an example of a vague definition, which did not restrict the meaning of the word sufficiently.

Table 3
Coding scale for the semantic quality of the definitions.

| Score | Category                        | Description of the category                                      |
|-------|---------------------------------|-----------------------------------------------------------------|
| 4 points | Adequate definition           | All core meaning components of the word meaning included         |
| 3 points | Near-adequate definition       | a. Omission of a minor meaning component                        |
|        |                                 | b. Inclusion of a minor incorrect information (e.g. one incorrect meaning component) |
| 2 points | Partially adequate definition  | a. Omission of a core meaning component                         |
|        |                                 | b. Inclusion of a major incorrect information (e.g. an incorrect superordinate) |
| 1 point | Insufficiently adequate definition | a. Includes a correct keyword/phrase from the original definition, but otherwise incorrect |
|        |                                 | b. Vague                                                         |
In order to compare the quality of participants’ definitions, the author first coded all of the data in the post-test. A second coder, a proficient speaker of both Slovak and English, then coded 25 percent of the student responses. Inter-rater reliability was measured by Spearman’s rho. The correlation between the two raters was .83, p < .001, which was deemed sufficient for the rating of semantic quality.

Participants’ answers with scores 1, 2 and 3 were further analysed to determine what type of error contributed to the less-than-full score. As follows from the coding scheme in Table 3, two types of errors were identified and coded: a) a missing meaning component (i.e. a component which should have been included but was left out) and b) inclusion of an incorrect component. To establish the reliability of the error rating, a second coder coded 25 percent of all cases that received scores 1 to 3. Cronbach’s alpha was used to calculate the inter-rater reliability. The analysis yielded an alpha of .898, indicating a high level of reliability.

3. Results

3.1. RQ1: completeness of word meanings

The first research question addressed the quality of the newly learned word meanings. The completeness of the definitions produced by the two groups of participants was compared using a chi-square test. The descriptive statistics are reported in Table 5. The chi-square analysis found a statistically significant difference between the performance of the L1- and L2-instructed groups ($\chi^2 = 14.498$, df = 3, p < .01). Figure 1 shows the quality of TWs’ definitions according to the four-point scale presented in Table 3.

As can be seen from Figure 1, there were both similarities and differences between the two groups of participants. Nearly 70 percent of the definitions from the L1-instructed participants were of high quality (scores 3 and 4). In fact, almost 30 percent of the word meanings were given the highest score and could be considered complete (i.e. the participants formed a good representation of the concept). In comparison, the L2-instructed participants were less likely to reach the highest score: only about one fifth of their word meanings could be considered complete. However, 40 percent of their definitions were judged as nearly complete, the same number as achieved by L1-instructed participants. Over 40 percent of the definitions of the L2-instructed participants contained considerable semantic problems (scores 1 or 2), with omissions of correct components or inclusions of incorrect components resulting in changes to the meanings of the TWs. While fewer definitions from L1 group received a score of 2, the number of word meanings judged as insufficient was very similar to the L2-instructed group.

These findings are in line with the outcomes of previous studies which reported that students learning through their L1 outperformed their peers who learned disciplinary terms through their second language (Haynes & Baker, 1993; Lessard-Clouston, 2006). Building on this earlier research, the four-point scale used in this study allowed us to estimate more precisely the extent and nature of the difference between the knowledge gains of native and non-native speakers.

3.2. RQ2: errors identified in the definitions of the target words

The second research question focused on the nature of errors that appeared in learners’ definitions of the new words. Table 6 reports the distribution of two types of errors: a) errors due to missing components and b) errors due to the inclusion of...
false components. The percentages in the table show the proportion of each type of error out of all answers scored 1 to 4. The chi-square test showed a statistically significant difference between the L1- and L2-instructed groups ($\chi^2 = 24.07$, df = 2, p < .01).

As can be seen from the table, an omission of a meaning component was the most common error in participants’ answers regardless of the language of learning (L1 or L2) and accounted for more than a half of the incomplete answers in both groups. With respect to incorrect components that added elements to the correct meaning of the TWs, these account for one fifth of the answers from the L1-instructed group and for more than one quarter of answers of the L2-instructed group. Whereas the majority of the answers from both groups of participants contained errors, the definitions of the L2-instructed participants contained a higher proportion of errors of both kinds. Word learning can hardly be complete after one exposure only (Nation, 2001), despite support from informative context (Webb, 2008), a fact illustrated by the performance of the L1 baseline. Nevertheless, the L2-instructed students acquired word meanings to a lesser extent than the L1 control group and the possible reasons for this difference are discussed below.

3.2.1. Omission of correct meaning components

An omission of meaning components was responsible for the majority of errors in both groups of participants. While most missing components appeared to be distributed randomly across all definitions in both groups, some systematic omissions were observed in the answers of the L2-instructed students and could account for the higher number of missing components in the answers from this group. These omissions appear to result from specific lexical gaps in the vocabulary of these students, which is especially likely as these meaning components were expressed by words of low frequency in the original English text.

This observation can be illustrated by the examples of transhumance and moa. In the text, moa was defined as a ‘flightless’ extinct bird. Out of 27 acceptable definitions provided by the L1-instructed participants, 16 contained the ‘flightless’ component. On the other hand, it was included only in 7 out of 29 definitions given by the L2-instructed participants. The difference was statistically significant ($\chi^2 = 7.13$, df = 1, p < .01). In the case of transhumance (a seasonal movement of farm animals), ‘stock’, a word from the definition in the text, appeared to be problematic for the L2-instructed participants. Whereas most of the L1-instructed participants included the concept of ‘animals’ in their answers (28 out of 29), this was true only for two thirds (14 out of 20) of the L2-instructed participants. This difference was statistically significant (Log Likelihood = 4.76, p < .05. Log Likelihood rather than chi-square was used here as more than twenty percent of cells had frequency lower than five which can affect the reliability of the chi-square product).

**Table 6**

Between-group comparison of two types of errors.

| Group       | Errors                  | Incorrect component | Error-free definitions | Total |
|-------------|-------------------------|---------------------|-----------------------|-------|
|             | Missing component       |                     |                       |       |
| L1-instructed | N: 175, %: 51.5        | N: 70, %: 20.6       | N: 95, %: 27.9        | 340   |
| L2-instructed | N: 169, %: 56.0        | N: 79, %: 26.2       | N: 54, %: 17.9        | 302   |

![Figure 1. The quality of word meanings.](image_url)
The lack of familiarity with words surrounding the target word has been identified as a cause of incorrect or imprecise guessing before (Parry, 1991; Haynes & Baker, 1993; Wesche & Paribakht, 2010). As the above examples show, even relatively proficient students struggled with some specific low-frequency words (e.g. ‘flightless’ and ‘stock’). However, these particular gaps did not result in incorrect guessing; rather the students were able to construct an incomplete, but correct interpretation of the word. The gaps in the vocabulary knowledge of the L2-instructed participants prevented them from acquiring a more complete lexical and conceptual knowledge of the subject-matter than expected on the basis of the performance of their L1-instructed peers. It seems that at higher levels of L2 proficiency, lexical knowledge of learners is very heterogeneous, depending on individual learning trajectories (Henriksen, Albrechtsen, & Haastrup, 2004) (e.g. while the participants struggled with ‘stock’ and ‘flightless’ they had no problems with other less frequent words such as ‘fortified’, ‘vineyard’ or ‘skeleton’ which appeared in the definitions of some of the other TWs). As a result, the relationship between vocabulary size and the lexical gains may be less predictable for L2- than for L1-instructed students.

### 3.2.2. Inclusion of incorrect meaning components

Whereas omitting a meaning component is something that cannot be avoided if participants have not understood a particular word in the TW’s lexical familiarisation, the reasons for adding incorrect, additional information to the original word meaning are more complex. In this part, therefore, close attention will be paid to the sources of false attributes and the possible reasons for their inclusion in students’ answers.

This type of error was found in the answers of the participants from both groups. As this study investigated students’ lexical gains in terms of expressible word knowledge, a certain portion of minor incorrect components could be attributed to the transfer of information from one language to another as well as to the semantic changes (e.g. extension or narrowing) that can result from paraphrasing and use of one’s own words. While there was no systematic distribution of incorrect components in the definitions of the L1-instructed participants, an interesting pattern of incorrect additions was identified in the answers of the L2-instructed participants. In these cases, false meaning components resulted in major modifications to the meaning of the TWs and could thus not be explained merely by an imprecise word choice. Several examples of such inclusion by the L2-instructed participants are discussed below.

In the first set of examples, taken from the definitions of transhumance, the incorrect component in the answers of the L2-instructed participants appeared in the place of a correct (but missing) meaning component. While in the definitions of moa discussed earlier the component ‘flightless’ was left out altogether, in the case of transhumance the missing component (‘farm animals’) was in several cases replaced by another component, i.e. ‘people’. Example 1 shows a definition which omitted the component, while Examples 2 and 3 show answers with an incorrect component.

1. It’s moving from mountainous areas to more to the places where the rivers are especially before winter.
2. It is a seasonal movement of the **people** from High Country.
3. It is a movement of **people** living in highlands because of bad conditions, it’s seasonal.

It seems that in the search for the missing component, the L2-instructed participants used (in this case, misleading) morphological information and analysed the word as consisting of the following two components:

- **trans** – something to do with movement or change, and
- **humance** – something to do with human beings

*Transhumance* thus appears to be an example of what Laufer (1989) described as a deceptively transparent word and students’ errors could be attributed to their over-reliance on morphological clues. A similar type of error was also found in the definitions of other words. However, in these cases, rather than being misled by textual clues, participants appeared to be shifting their definitions to a concept they were already familiar with. For example, *whanau* (an extended family that makes decisions together) was defined as a ‘leader of a family’ by three L2-instructed students (Examples 4–6, translated from Slovak). The examples show that the students opted for a more common concept of a leader of an organisation rather than the less common notion of a shared leadership.

4. Whanau is a family member who decides about the future of the members of other members of the family
5. Whanau is actually something like a tribal elder who decided about everything and he also gave a permission or he decided about who will marry who [...]  
6. Whanau is a chief of individual tribes who actually is in charge of everything [...]  

Another example of a similar error can be seen in the case of **rcd** (a virus used to reduce the rabbit population in New Zealand). As shown in Examples 7 and 8 (translated from Slovak), three L2-instructed participants shifted the meaning from ‘a virus’ (a rather uncommon way of dealing with pests) to ‘a poison’ or ‘a chemical’. This modification is even more remarkable as the English and Slovak words for ‘virus’ are very similar (Slovak: **vírus**, [víːrus]). It is thus highly unlikely that the change could occur due to a lack of familiarity with this particular word.
4. Discussion

In the examples above, the L2-participants produced several correct meaning components as well as one or more incorrect components in their answers. As a result, the inclusion of an incorrect component modified the meaning of the word which then denoted a related, but different concept. In some definitions students even included additional components to the word meanings, strengthening the shift to a different concept. This could be observed in the definitions of *ampelography*, a botanical science concerned with vines (the definition of *ampelography* as it appeared in the text is shown in Table 2). The definitions of several L2-instructed participants modified (shifted) the meaning of the word to include the notion of wine tasting or wine-drinking. This shift was in several cases signalled by an explicit inclusion of new meaning components, such as ‘taste’ as shown in Examples 9 and 10 (the answers were translated from students’ L1).

(9) It is a science which is concerned with wine, its taste and growing.
(10) It’s a science which is concerned with examining wine, its shape, its colour, its taste in other words it assesses the quality of wine basically dividing it into some categories.

Six L2-instructed participants included ‘taste’ or ‘tasting’ in their answers in the post-test (out of 24 definitions). By contrast, no reference to wine-tasting or wine-drinking was found in the answers of the L1-instructed participants. In some cases the participants themselves acknowledged that the additional meaning components were not consistent with the rest of the interpretation, as shown by a comment made by a participant when discussing the meaning of *ampelography* (the use of italics in the English translation of students’ answers signals that the word was produced originally in English, although the rest of the answer was given in Slovak).

(11) I think that there was shape that some kind of shape I didn’t get it the shape of wine?

Although it is possible that unfamiliarity with a particular lexical item (e.g. mistaking ‘wine’ for ‘vine’) could contribute to the modified word meanings, examples from across different TWs suggest that this is likely to be only a partial explanation.

4. Discussion

4.1. Vocabulary learning

With respect to vocabulary acquisition from a supportive reading context, the results showed that providing explicit clues can result in relatively high lexical gains both for L1 and (proficient) L2 speakers. This is in line with research that found that a rich context supports acquisition of word meanings (Webb, 2008). On the other hand, the findings also confirm that even explicit contextualized clues and the full mastery of the language of input (in the case of the L1-instructed participants) do not necessarily result in a complete knowledge of the new words. Thus, repeated exposures (e.g. Rott, 1999; Webb, 2007) or deeper involvement (e.g. Laufer & Girsai, 2008) with learning may be needed.

The results also showed that lexical development is not always linear in the sense that with every new exposure the knowledge of the word becomes progressively more complete and precise. This was especially the case with the students who learned TWs through their L2. As can be seen from the data, the empty ‘slots’ (missing components) in the word meanings can become replaced by information from other sources and result in a (sometimes) coherent albeit incorrect concept. This evidence supports the dynamic view of lexical acquisition “which consists of both learning and unlearning, i.e. adding other semantic attributes that are not yet included, but also unlearning false attributes that are incorrectly included in the hypothesized word definition” (Fukkink et al., 2001, p. 490). It is important to acknowledge this dimension of developing word knowledge (i.e. the inclusion of erroneous information) in pedagogical practice as incorrect inferences might be retained in the long-term (Parry, 1991), especially if learners are not aware that their knowledge is only partially correct (Laufer & Yano, 2001).

The study showed that contrastive studies of L1 and L2 vocabulary can be valuable for our understanding of the processes involved in vocabulary development, as the L1-instructed students provided an important benchmark for interpreting the performance of the L2-instructed students. Above all, the results from the L1-instructed students showed that not all word meaning errors should be attributed to processing in L2, but may be typical of vocabulary learning in general.

4.2. Reasons for including incorrect components in students’ answers

Previous research showed that in some cases L2 speakers tend to draw on morphological or contextual knowledge rather than on direct textual clues when constructing the meaning of a text (e.g. Grabe, 2009; Koda, 2004). However, this strategy of dealing with a deficiency in one language area by exploiting knowledge in another area can easily result in incorrect or imprecise text comprehension. The reasons for L2 users’ reliance on these sources have often been attributed to insufficient
mastery of the language which prevented these speakers from using the textual clues present in the text. For example, as Koda (2004, p. 59) observed,

[w]hen much of the text is unfamiliar, readers are likely to either give up or draw on their background knowledge – activated through a small collection of familiar words – in making sense of the text, rather than constructing its meaning from the information presented.

However, although this may be a very common as well as a very likely reason for L2 users’ mistakes, it does not seem to fully explain the performance of participants in this study. While some of the erroneous or incomplete answers can most likely be attributed to specific lexical gaps (e.g. insufficient familiarity with words such as ‘flightless’ or ‘vine’), the L2-instructed participants in this research were reasonably proficient users of the second language and their answers showed understanding of most of the words in the text. In some cases they were even aware of the inconsistencies between their interpretation and the textual clues (as shown in Example 11). Despite this, they still modified their interpretation to fit a concept they were already familiar with. If L2 proficiency alone cannot account for the incorrect meaning components, what are other possible explanations?

First of all, in their attempts to construct the word meanings from perhaps not a fully comprehended input, some of the L1-and L2-instructed participants simply omitted the problematic components, while others (mainly the L2-instructed participants) replaced these components with incorrect ones. The latter practice could be motivated by an effort to create a coherent concept since, as pointed out by Anderson and Nagy (1991, p. 705), “[p]eople strive for coherence; they fill slots with the information given when possible, by inference when necessary”. Thus, when a reader fails to construct a model of the meaning of a text, different sources of knowledge interact to “impose a certain degree of coherence on an interpretation that [the reader] may be required to provide” (Grabe, 2009, p. 49). Participants’ ‘strive for coherence’ was perhaps even reinforced by the need to produce the meaning of the word ‘on record’ and the reluctance to produce something vague or lacking in coherence (Roebuck, 1998). However, if this alone were the case, a similar tendency should have also been observed in the answers of the L1-instructed students.

It is possible that the tendency of the L2-instructed students to use information that did not appear in the texts to create a coherent concept is also related to the depth of knowledge activation. We can assume that the superior language mastery of the L1 readers served both to activate the relevant word/concept associations as well as to suppress the less strongly related ones. By contrast, the gaps in the vocabulary of the L2 readers (e.g. ‘stock’) might have resulted in the competing information not being deactivated with sufficient strength. As this study shows, it is equally important that the students learn both what the word meaning includes as well as what it does not (i.e. where the boundaries of words are (Sonaiya, 1991)).

The fact that the L2 users were affected by their prior knowledge in the lexical learning (as indicated by Examples 4–6 and 7–8) could also be the result of resorting to a familiar strategy in L2 vocabulary learning, namely that of mapping the new L2 meaning onto an existing L1 concept or parts thereof (Jiang, 2000; Takáč, 2008). A similar approach to inferring the meanings of words with a familiar form, but a new meaning sense was reported by Haynes and Baker (1993), who observed that the participants preferred to select from among the senses they already knew rather than to create a new entry in their mental lexicon.

The results from this study are not surprising in terms of the sources of the L2-instructed participants’ errors. Rather, it is interesting how strong the competing sources of information can be for L2 users. Even when aware of inconsistencies, the L2-instructed participants did not refine or change the interpretation which they incorrectly based on their prior knowledge or morphological clues.

4.3. Implications for learning of disciplinary words

The findings of this study have some important implications for students and teachers in bilingual programmes such as CLIL (Content and Language Integrated Learning). The technical word knowledge of the L2-instructed participants was less precise and less elaborate than that of the L1-learning group due to the former having a higher number of missing components and a greater tendency to include incorrect components. The purpose of studying an academic subject is to gain new knowledge, which is often more precise and less elaborate than that of the L1-learning group due to the former having a higher number of missing components and a greater tendency to include incorrect components. The latter practice could be motivated by an effort to create a coherent concept since, as pointed out by Anderson and Nagy (1991, p. 705), “[p]eople strive for coherence; they fill slots with the information given when possible, by inference when necessary”. Thus, when a reader fails to construct a model of the meaning of a text, different sources of knowledge interact to “impose a certain degree of coherence on an interpretation that [the reader] may be required to provide” (Grabe, 2009, p. 49). Participants’ ‘strive for coherence’ was perhaps even reinforced by the need to produce the meaning of the word ‘on record’ and the reluctance to produce something vague or lacking in coherence (Roebuck, 1998). However, if this alone were the case, a similar tendency should have also been observed in the answers of the L1-instructed students.

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It is possible that the tendency of the L2-instructed students to use information that did not appear in the texts to create a coherent concept is also related to the depth of knowledge activation. We can assume that the superior language mastery of the L1 readers served both to activate the relevant word/concept associations as well as to suppress the less strongly related ones. By contrast, the gaps in the vocabulary of the L2 readers (e.g. ‘stock’) might have resulted in the competing information not being deactivated with sufficient strength. As this study shows, it is equally important that the students learn both what the word meaning includes as well as what it does not (i.e. where the boundaries of words are (Sonaiya, 1991)).

The fact that the L2 users were affected by their prior knowledge in the lexical learning (as indicated by Examples 4–6 and 7–8) could also be the result of resorting to a familiar strategy in L2 vocabulary learning, namely that of mapping the new L2 meaning onto an existing L1 concept or parts thereof (Jiang, 2000; Takáč, 2008). A similar approach to inferring the meanings of words with a familiar form, but a new meaning sense was reported by Haynes and Baker (1993), who observed that the participants preferred to select from among the senses they already knew rather than to create a new entry in their mental lexicon.

The results from this study are not surprising in terms of the sources of the L2-instructed participants’ errors. Rather, it is interesting how strong the competing sources of information can be for L2 users. Even when aware of inconsistencies, the L2-instructed participants did not refine or change the interpretation which they incorrectly based on their prior knowledge or morphological clues.

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One of the problems with the quality of word meanings acquired by the L2-instructed participants in this study stemmed from difficulties with the language used to define the terms. To increase effectiveness of learning technical terms, the understanding of this ‘pre-requisite vocabulary’ should be assured (Armbruster, 1992; Schmitt, 2008), whether as part of a class activity or in an individual vocabulary-learning task. For example, Mežek (2013) found evidence that when students engage more actively with the words in the definitions of the disciplinary terms (e.g. by rephrasing) their learning of the words improves.

In line with the previous research (Nation, 2001), this study also showed that exposure to TWs limited to one learning occasion even when the TWs are embedded in informative context is in most cases not sufficient for complete acquisition of the word meaning. Similar to the finding reported by Haynes and Baker (1993), students in this study often stressed one aspect of the word’s meaning and ignored or understated other meaning components. Multiple exposures to the target items...
would give students an opportunity to attend to several aspects of the meaning of complex words and would allow them to notice potential inconsistencies in their understanding of the words. Content classes, with their focus on a particular subject, provide an excellent opportunity for repeated engagement of students with key subject terms (Nation & Webb, 2011; Bravo & Cervetti, 2009). Apart from providing opportunities for students to encounter the subject words in subject-related discussion and activities, Flannigan and Greenwood (2007) also encourage subject teachers to introduce direct vocabulary-oriented activities targeting the completeness of students’ understanding of technical words such as semantic feature analysis.

Finally, the awareness of the problem areas in learning subject-specific words should be reflected not only in teaching, but also in assessing knowledge of technical words. Traditional assessment procedures used in L2-medium classes that, for example, elicit only the general class word (What is ampelography? – A science.) or ask the students for a translation into L1 (cf. Dalton-Puffer, 2007) are often not sensitive enough to detect problems with completeness and accuracy of acquired technical vocabulary. If students have a partially correct understanding of the concepts, as was often the case in this study, the problems may remain largely unidentified. A word definition task such as the one used in this study could therefore be used as one of the means of a more thorough assessment of students’ knowledge of technical words.

4.4. Limitations and further research

It should be noted that this study focused only on the lexical knowledge that students were able to verbalise and it is possible that testing receptive knowledge would reveal larger gains in students’ lexical development. However, it should be stressed that subject teachers often rely on (oral) defining for probing into the depth and accuracy of students’ conceptual and linguistic knowledge which makes this method a suitable tool for research with practical educational implications.

Another limitation is that this research focused on establishing the differences between two groups of learners with respect to the language through which they learned the disciplinary words. Having focused on the group performance, the complex interplay of individual characteristics of learners (e.g. working memory) with textual and word characteristics could not be explored in greater depth. There is ample evidence from prior research that some words are harder to learn than others (e.g. Laufer, 1989) and this is true of disciplinary vocabulary as well (e.g. Cervetti et al., in press; Gablasova, 2014; Vidal, 2003).

Future research should therefore address these variables in order to provide a detailed model of the acquisition of technical words from informative context by advanced L2 speakers.

5. Conclusion

The paper contributes to deepening our understanding of the vocabulary needs of students who are considered proficient enough to undertake study of academic subjects through their L2, yet who may face additional cognitive demands as a result of working in a non-native language. The study described in detail several aspects of developing word knowledge, characterised by missing or erroneous information, pointing towards the gap between the L1 and L2-medium students. Given the number of students studying through the medium of their L2, special attention needs to be devoted to developing pedagogical techniques that can help these students as well as their teachers to apply suitable strategies for enhancing this important dimension of subject knowledge.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.esp.2015.04.002

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