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Pedro A. Fuertes-Olivera / Sven Tarp

A window to the future: Proposal for a lexicography-assisted writing assistant

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Abstract: The paper initially discusses some of the challenges posed to contemporary lexicography and stresses the need to move upstream in the value chain to guarantee future work. Today’s lexicographers must accept that their product par excellence is not dictionaries, but lexicographical data that can either be presented to the users in the form of dictionaries or be integrated into various types of tools, platforms, and services. From this perspective, the paper describes the functionalities of various digital writing assistants and focuses on one of them, namely the Spanish-English *Write Assistant*. It illustrates some decisions that have to be taken to prepare a database to feed both this tool and a series of online dictionaries. A proposal on how a big amount of lexicographical data can be presented in a small pop-up window without resorting to data overload will be discussed. In this connection, alternative ways of doing user testing in a digital environment are introduced. Finally, the paper stresses the importance of a human-centered design and terminology.

Keywords: Fourth Industrial Revolution, disruptive technologies, artificial intelligence, business model, value chain, writing assistants, L2-text production, language model, lexicographical databases, lexicographical data, pop-up windows, test-driven development

“He has an uncanny ability to cook up gadgets that we didn’t know we needed, but then suddenly can’t live without.” (Lyons 2010)

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0 Introduction

When discussing current technological developments, journalists and scholars from different research areas are increasingly referring to a so-called Fourth Industrial Revolution. We have already become so used to this term that it may seem strange for some of us that it was only coined four years ago by Schwab (2015). The author characterises the phenomenon as “a fusion of technologies that is blurring the lines between the physical, digital, and biological spheres”. Schwab, who is also the founder and executive chairman of the World Economic Forum, believes that there is no historical precedent to the speed, scope, and complexity of the current breakthroughs:

“When compared with previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace. Moreover, it is disrupting almost every industry in every country. And the breadth and depth of these changes herald the transformation of entire systems of production, management, and governance. The possibilities of billions of people connected by mobile devices, with unprecedented processing power, storage capacity, and access to knowledge, are unlimited.” (Schwab 2015)

Among the disciplines disrupted by this phenomenon is lexicography. Whether we like it or not, lexicographers have to adapt to this new Industrial Revolution and find their ways in the emerging technology breakthroughs that characterise it. If we take a panoramic look at the-state-of-the-art of the discipline, we can easily identify three recent tendencies that are shaping current lexicography and pointing to the future.

- The first tendency is the increasing use of new disruptive technologies in almost all aspects of the discipline, from the empirical data sources over the retrieval, elaboration and storing of these data to their presentation to the end-users. All these aspects of the practical lexicographical work have witnessed seismic changes over the past few years due to the introduction of new technologies. The process has far from stopped. Especially the gradual application of artificial intelligence heralds turbulent times for the millennial discipline.
- The second tendency is the growing obsolescence of the business model which, by and large, has financed the compilation of dictionaries since the introduction of the printing technology more than five hundred years ago. This development has now reached a critical point with only a handful of publishing houses earning money from their online dictionaries which have almost completely replaced the printed dictionary in the technologically most advanced countries. The rapid decline in revenue seriously affects both the production of new dictionaries and the continuous actualisation of the existing ones. As a result, dictionary compilation as a cultural practice is under attack.
- The third tendency is growing competition from other information sources such as search engines (Google, Baidu, Yahoo ...), machine translation programs (Google Translate ...) and webpages like Linguee, to which should be added some applications downloaded on smartphones and tablets. This development is a natural

consequence of the highly information-loaded, technological environment in which modern users move and may also be interpreted as a silent criticism of existing dictionaries in terms of their quality, relevance, and availability to the users in a specific context.

The three tendencies are interrelated with the first one being the ultimate cause and the second one the trigger of a situation which little by little is taking the form of a crisis that touches the very fundament of the discipline. The third tendency is, in one way or another, a consequence of the former, i.e. dictionaries that have not been developed accordingly and adapted to the new user habits, basically because of an ailing business model. In our understanding, the three tendencies point to a growing identity crisis which challenges the self-understanding of the discipline and once more actualises the old question: What is lexicography? We will return to this question below.

1 Current challenges to lexicography

The merger of lexicography and technology is not a new issue in the scholarly literature which contains a relatively big body of contributions dealing with various aspects of this interaction, among them De Schryver (2003), Hanks (2010, 2013), Rundell/Kilgarriff (2011), Rundell (2012), Nielsen (2013) and Fuertes-Olivera et al. (2018). By contrast, the important question of the underpinning business model has received much less scholarly attention. The reflections by Rundell (2007), Winestock/Jeong (2014), Nesi (2015), Simonsen (2017), Fuertes-Olivera (2019), Maldonado (2019) and a few other authors are exceptions within a discipline that does not seem very intent on discussing the financial model that feeds it.

In this respect, we completely agree with Simonsen (2017) who suggests that lexicography should move upstream in the value chain to solve its current financial challenges. According to Gereffi/Fernandez-Stark (2016), the value chain can be defined as follows:

“The value chain describes the full range of activities that firms and workers perform to bring a product from its conception to end use and beyond. This includes activities such as research and development (R&D), design, production, marketing, distribution and support to the final consumer. The activities that comprise a value chain can be contained within a single firm or divided among different firms.” (Gereffi/Fernandez-Stark 2016:7)

What does it mean concretely that lexicography should move upstream in the value chain? It means above all that lexicographical products should be integrated into high-tech tools, applications, assistants, platforms, and services in the broad sense of the word. To be competitive in terms of availability, relevance and quality, all this

software should furthermore be designed to provide the optimum service directly in the context where the users experience their needs. Apart from finding a partner with financial muscles, such a move upstream in the value chain requires open-mindedness, creativity, and willingness to collaborate with experts from other fields.

Our experience, after working with a high-tech company for several years, tells us that we should not be hesitant to enter this kind of interdisciplinary collaboration and integrate our products into different kinds of software. In a certain sense, lexicographers are much better prepared to do so than other actors that are basically technological newcomers. They should not forget that they represent an extremely rich cultural tradition that goes back thousands of years. If this tradition is internalised in all its breadth and depth, lexicography as a discipline surely has a lot to contribute to the current technological landslide. There is no reason why its practitioners should not self-confidently pick up the gauntlet and fully integrate themselves into the Fourth Industrial Revolution. However, before doing so they may need to put their own house in order. This takes us back to the question: What is lexicography?

Johnson (1755) defined lexicography as the “art and practice of writing dictionaries” and the lexicographer as “a writer of dictionaries“. These definitions from his classical *Dictionary of the English Language* have been repeated countless times in dictionaries and scholarly works on lexicography and are still the most common answers when the above question is asked. But do they pay complete justice to the discipline? Nobody denies that the compilation of dictionaries is central to practical lexicography, but are Johnson’s definitions sufficiently comprehensive to fully reflect what lexicographers are doing – and have been doing – since the dawn of their discipline?

In one of his thesis after studying the lexicographical business model, Simonsen (2017: 422) suggests a change of focus from the traditional “dictionary to lexicographic data in software, artificial intelligence and augmented reality“. Similarly, Fuertes-Olivera/Tarp (2018: 157) observe “an irresistible move away from the dictionary as such to lexicographical data for different uses“.

However, from a historical perspective there is nothing new under the sun. McArthur (1986) and Hanks (2013) describe how Greek scribes, at the dawn of European lexicography, inserted glosses into manuscript copies of old texts two hundred years before these glosses, in the third century B.C., were compiled into glossaries, i.e. prototype dictionaries, by scholars at the library in Alexandria. Although neither of the two authors specifies to which century they precisely date the birth of European lexicography, it is worth remembering that the very term *lexicography* is originally Greek and means ‘writing about the lexicon’. This was precisely what the scribes did when they – long before the first European dictionaries saw the light – produced lexicographical data (glosses or snippets) addressed to difficult words in old works. More recently, Tarp/Gouws (2019) have argued that this tradition of inserting lexicographical data into different types of text continued up to our time, i.e. even after the introduction of the printing technology and parallel with the publication of dictionaries.

The disciplinary consequences of all this are far-reaching. It implies that lexicography as a discipline has to be redefined. A more comprehensive and up-to-date definition is required where the focus is shifted from the compilation of dictionaries to the production of lexicographical data without the former being ignored. Contemporary and future lexicographers must be conscious of the fact that their product par excellence is not dictionaries, but lexicographical data that can either be presented to the users in the form of dictionaries or be integrated into various types of tools, applications, assistants, platforms, services, etc.

Such an updated understanding of lexicography is a good starting point to bring it back on the rails. However, it is important not to reduce lexicographers to mere producers of raw materials, i.e. data, as this would keep them in the low end of the value chain. Just as they cared for the design of dictionaries, they should also, as a collective, take responsibility for the various types of software in which their data are used. This implies that they also engage in research and development (R&D) and participate directly in the design of the software. These activities are placed at the absolute top of the value chain (see Figure 1). Our experience shows that lexicography has important things to contribute even within these areas. It is not just a question of providing data to software developers. It is much more a question of determining what exact data types are required, raising the quality of these data, and developing more efficient methods to generate them. And last but not least it is a question of finding completely new ways of personalisation and contextualisation so that the exact amount and types of lexicographical data are prescribed to the users in the exact moment and context where they are needed; cf. Gouws/Tarp (2017) and Tarp/Gouws (2019).

In this perspective, the challenge is to make full use of the interdisciplinary collaboration with information engineers, designers, and other experts to “synthesize new things” and not just come up with “linear solutions without a broad perspective” as Steve Jobs once pointed out; cf. Wolf (1996).

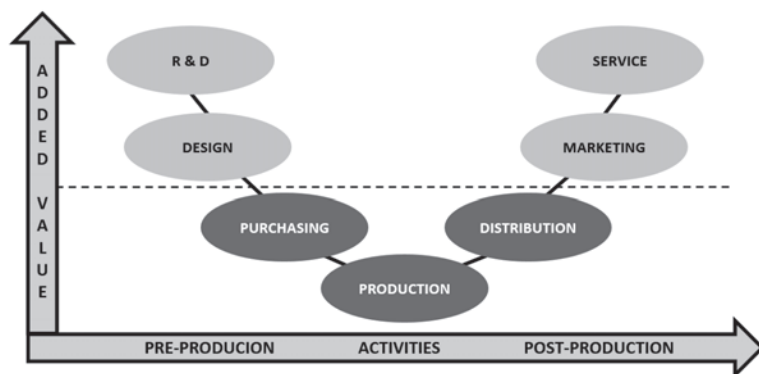


Figure 1: High and low-value activities in the value chain
(Based on Gereffi/Fernandez-Stark 2016: 14)

2 Different approaches to writing assistants

A value chain can also be established for traditional dictionaries, but it does not make much sense to try to squeeze money out of a product that only a few customers will pay for. In spite of this, we assume that high-quality dictionaries still have a role to play, albeit not as a source of revenue. Communication and access to reliable information are increasingly important in contemporary society, and the demand for easily accessible and updated quality dictionaries will probably continue, at least for the time being. It is therefore urgent to find alternative ways to finance them. A good point of departure could be to integrate lexicographical data into high-tech software like the one mentioned in the previous section. In this respect, one class of products that may qualify for a position in the high end of the value chain is the digital writing assistant. This kind of tool is generally based on cutting-edge technology such as natural language processing (NLP), statistical programming, and artificial intelligence.

The past ten years have seen a growing number of academic contributions on different types of writing assistant, among them Verlinde (2011), Paquot (2012), Wanner et al. (2013), Granger/Paquot (2015), Allen et al. (2016), Tarp et al. (2017), Frankenberg-García (2018), Lew et al. (2018), Alonso-Ramos/García-Salido (2019), Frankenberg-García et al. (2019), Strobl et al. (2019), and Tarp (2019, 2020). This literature deals with a variety of theoretical and practical aspects of existing and projected writing assistants such as their purpose, functionality, usage, empirical basis, technology, and consequences for language learning. It reflects a branch of language tools that is developing at a fast speed and appears to have a great future.

“Writing assistant” is a generic term that covers a range of products designed to assist users with written text production in their mother tongue or a foreign language. Apart from Microsoft’s *Spelling and Grammar Checker* which most people know, we can here mention *AWA* (Academic Writing Assistant), *ColloCaid*, *Ginger*, *Grammarly*, *HARenEs*, *ProWritingAid*, *WhiteSmoke*, *Write Assistant*, and *Writefull*. These products are available as software packages, web-based applications, apps, or add-ins. Most of them are free to use (at least for the moment) whereas a few require subscription (e.g. *WhiteSmoke*). Some products, like *ColloCaid* and *HARenEs*, are embedded in academic research groups and do not seem to have much business potential. Others, like *Grammarly*, have already become a goldmine.

An analysis shows that the products have very different purposes, functionalities, and characteristics. Some are mainly designed as didactic tools aimed at language learning. Others aspire to assist their users with academic writing, while a third group “just” wants to improve the written text. Some writing assistants, like *ProWritingAid* and *WhiteSmoke*, deal with general problems related to grammar, syntax and lexical choice whereas others focus on a specific linguistic category such as collocations (e.g. *ColloCaid* and *HARenEs*). Some of them, like Microsoft’s *Spelling and Grammar Checker*, can be used almost intuitively whereas others require much more effort from their users (e.g. *Writefull*).

In this article, we are not interested in how the different writing assistants perform, but only how they work. A meticulous study of the cited tools (except for *ColloCaid* which we could not access) discloses the following eight functionalities:

1. **Detection:** The tool detects and highlights mistakes and possible problems in terms of lexis, grammar, syntax or style. The main advantage of this technique is that it can call the users' attention to problems which they may not be aware of. The function is well-known from Microsoft's *Spelling and Grammar Checker*, but it has also been incorporated in several writing assistants like *AWA*, *Grammarly*, *ProWritingAid*, and *WhiteSmoke*.
2. **Correction:** The tool suggests alternative solutions to the detected problems or it may even autocorrect the text. All the tools mentioned under the previous point have this function.
3. **Prediction:** The tool predicts word completions when the first letters of a word have been typed, as well as the words that are most likely to be next in the sentence. This function has the potential to speed up the writing process. It is already known from smartphones and tablets, at least when writing in some of the major international languages like English and Spanish, and has also been incorporated in *Write Assistant*.
4. **Transformation:** The tool provides suggestions to improve, enrich or vary the text, even when there are no mistakes in the narrow sense of the word. Some of the mentioned writing assistants, like *AWA* and *Grammarly*, already have this function incorporated, at least to a certain extent. It will undoubtedly become more important in the future where artificial intelligence is expected to allow for a more general change of style, e.g. from "normal" to academic writing.
5. **Translation:** This function can be displayed in two different variants. The first is the traditional one known from tools that translate whole sentences or texts (e.g. *Google Translate*). The second one allows word-to-word translation, e.g. providing L2 equivalents to L1 words typed by the user. *WhiteSmoke* and *Ginger*, for instance, offer both types of translation whereas *Write Assistant* "only" provides equivalents.
6. **Consultation:** The tool allows its users to look up in a lexicographical database. *HARenEs*, for instance, contains a search engine which allows the users to look for collocates to nouns, verbs, and adjectives.
7. **Implementation:** The tool allows its users to introduce suggestions directly into the text which they are writing by means of a simple click instead of retyping them. Both *Grammarly* and *Write Assistant* have this function which is also known from Microsoft's *Spelling and Grammar Checker*.
8. **Integration:** The tool is integrated into the respective programs (e.g. Word) and works directly in the document which the user is writing. This allows the user to save time and maintain the functional options in the text-processing program. A few writing assistants work in this way (e.g. *ProWritingAid*). In most cases, however, the user has to choose between two "evils", i.e. either write the text

directly in the software or use the tradition copy-and-paste method. Both are inconvenient and may disturb the writing process.

Each of the writing assistants which we have studied has its specific combination of the above functionalities. The variety reflects not only the different approaches which aim at serving various types of needs related to the writing process. It also reflects an incipient struggle of the fittest where only the most user-oriented and user-friendly may survive. In the long run, their fate will be determined by a combination of talent, innovative thinking, technological strength, an appropriate business model, and last but not least, the ability to grasp the moment. In the next section, we will look at a writing assistant that may or may not find itself in the running.

3 Presentation of *Write Assistant*

Write Assistant is a good example of both the new horizons opened by recent technological breakthroughs and the challenges posed to contemporary lexicography because of this development. The authors of this article have in various ways participated in the development of this tool. We have not only contributed lexicographical data where we are the experts. We have also given lexicographical input to improve the design and even the marketing of the product where we, much to our surprise, proved to have relevant knowledge which none of the other experts have.

The brand consists of a series of bilingual writing assistants developed by the Danish company Ordbogen A/S (whose name translated into English means “Dictionary Ltd.”). The company was founded by self-taught computer programmers in 2001 and soon replaced the traditional publishing houses as the main provider of online dictionaries in Denmark. Today, it is also a leading provider of language services and online didactic materials. Because of its peculiar business model, it is one of the few European publishers that obtain revenue from its online dictionaries. However, this model which was introduced at the right moment in its country of origin can no longer be reproduced in other European countries. To expand on the international market, it is, thus, necessary to develop another cutting-edge product. *Write Assistant* is the answer to this challenge.

Write Assistant is a tool under continuous development in interaction with its target users. It was originally designed with one main function, namely to provide different types of assistance to writers who are producing texts in a second language. In the future, a didactic dimension is also foreseen. In its current version, it has five of the eight functionalities listed above, namely prediction, translation, consultation, implementation, and integration. More functionalities can be expected in the future. *Write Assistant*'s main characteristics have already been described in detail by Tarp et al. (2017). In the following, we will concentrate on the most relevant aspects.

Different from most of the tools referred to in the previous section, *Write Assistant* has been conceived to assist its users directly in the documents and texts which they write in Word, Outlook, Gmail, WeChat, WhatsApp, Facebook, Twitter, and a long number of other programs and applications. The assistance is instantaneous and automatic. This entails that users who experience problems in the writing process do not have to leave the documents they are working on and look for help in external resources. The objective is to reduce the number of interruptions to a minimum and guarantee a more fluid writing process without the writer losing his or her focus and concentration. This objective, which allows the writer to zoom in on the content of the text, distinguishes *Write Assistant* from all the other writings assistants we have studied.

Write Assistant connects its users to big data that have been taken from a digital corpus and a lexicographical database, respectively. It was originally the plan to use the British National Corpus, but now a much bigger corpus has been composed by texts from Wikipedia. The data contained in the database has been taken from Ordbogen's online dictionaries as well as other bilingual dictionaries that have been licensed. *Write Assistant's* power center is a language model that has been trained on the corpus. The training was originally based on statistic programming. Currently, the use of artificial intelligence is being tested in order to obtain an even better language model (see Figure 2). All this means that *Write Assistant* is fed by data imported from different sources and generated with different methods. According to Tarp (2019), who bases himself on the reflections by Rundell/Kilgarriff (2011), all these data can be considered lexicographical data irrespective of their origin.

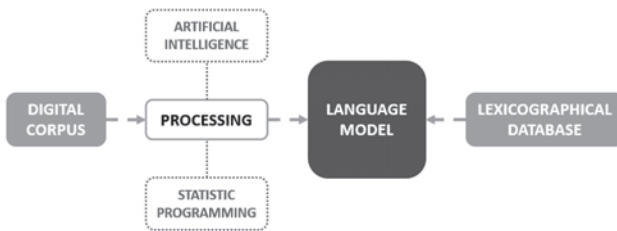


Figure 2: The language model and its empirical sources

The current version of *Write Assistant* has two pop-up windows. The first one is the suggestion window that appears as default when the user starts writing. It offers three types of data, namely L2-word completions, next-words, and L2 equivalents, all of them presented in a prioritized, context-aware order by the language model (see Figure 3). The L2-word completions are created instantaneously when the writer types one or more letters, whereas the next-words appear after the typing of a full word. These suggestions which the language model automatically generates are ephemeral

as that they can only be recreated if the user repeats the same sequence of words. By contrast, the L2 equivalents, which are provided when the writer types an L1 word, are imported from the lexicographical database and structured by the language model.



Figure 3: Suggestion windows with L2-word completions and L2 equivalents

The second window is the consultation window which we also nickname “lexicography’s window to the future”. This window, which we will discuss in detail in Section 5, allows the writer to access lexicographical data such as meaning, inflection, grammar, synonyms, etc. It may be activated from two different positions. It can be displayed by clicking on one of the words provided in the suggestion window when the writer does not know which of the suggested words to use, or how to use it (see Figure 4). But it can also open by a click on any word in the text, e.g. if the writer wants to use a synonym or confirm its meaning (see Figure 5).

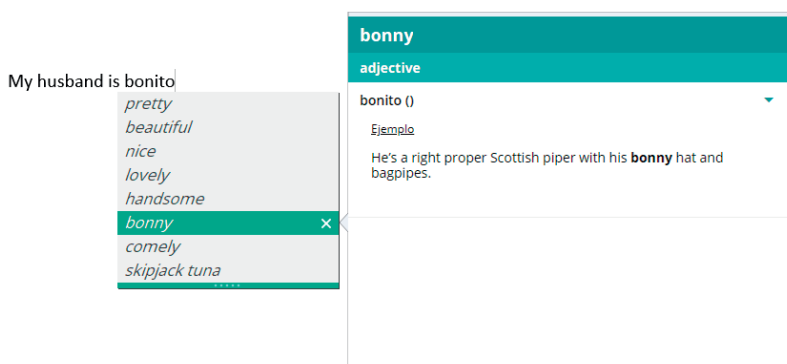


Figure 4: Consultation windows activated from the suggestion window

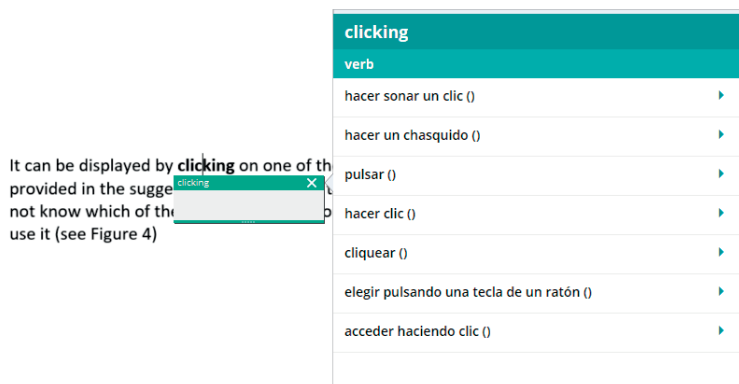


Figure 5: Consultation windows activated from already typed text

The third window is the alert window. It has still not been designed, but it is foreseen to notify the writer when he or she types a word that may pose linguistic or cultural challenges. Figure 6 shows the data flow from the empirical sources to the three windows. The dotted lines indicate future developments. As can be seen, it is envisaged that the language model may also determine the types of lexicographical data to be presented in the consultation window as well as their structuring.

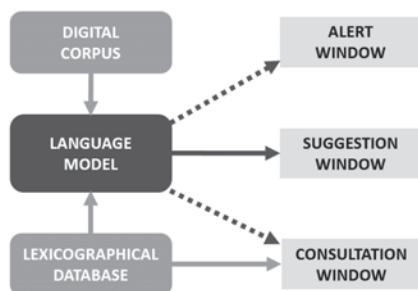


Figure 6: Data flow from empirical sources to the three windows

Today, *Write Assistant* can be downloaded and used free of charge. But the plan is to develop a premium version that can generate revenue in three to four years. Before that can happen, the designers have to overcome a number of hurdles. These may be of technological, linguistic and lexicographical nature. In our opinion, the quality and presentation of the lexicographical data are among the biggest challenges. As can be seen in figures 4 and 5, the consultation window leaves much to be desired. And the alert window has still not been designed.

The problems that can be observed in the consultation window begin in the existing lexicographical databases. These databases were originally compiled to sustain printed or digital dictionaries. The experience so far indicates that they are less suited to feed a tool like *Write Assistant*. They may not contain the required data types. They may not have them in the necessary quantity, or they have stored them in such a way that they cannot be used properly. In any case, it seems necessary to restart almost from scratch. Among the questions that have to be asked are:

- What are the lexicographical data required to feed a writing assistant like the one described above?
- What are the words requiring linguistic and cultural alerts?
- What are the lexicographical data needed to support these alerts?
- What lexicographical data are required if the tool should also be designed as a learning tool?
- How can traditional lexicographical data interact with data that are automatically generated by machine learning?
- How should future lexicographical databases be designed to serve a writing assistant with the described characteristics?
- How can lexicographical data in existing databases be used or reused?
- How can a big quantity of lexicographical data be presented in the small consultation window without creating data overload?

All these questions require a profound analysis that incorporates lexicographers, information engineers, designers, and language teachers, among others. In the next section, we will treat some of the challenges to the database. In Section 5, we will try to answer the last question, although we are aware that we have not yet reached the end of the journey.

4 Presentation of the database Valladolid-UVa

The problems observed in existing digital dictionaries between English and Spanish made it pressing to look for alternative solutions. The lexicographical database *Valladolid-UVa* is an answer to this challenge. As such, it is one of the two empirical sources from which the Spanish-English *Write Assistant* will receive its data (see Figure 2). Together with the in-house *Lexicographic Data Treatment System* (similar to a dictionary writing system), it has been designed in close interdisciplinary collaboration between lexicographers, IT experts, and web-based system developers; cf. Tarp/Fuertes-Olivera (2016), and Fuertes-Olivera (2019).

The database can be used in different ways. Apart from feeding the different windows of *Write Assistant*, it is also designed to sustain a series of monolingual and bilingual online dictionaries with English and Spanish. Here, we will focus on some

of its innovative features in terms of the *Write Assistant* project. The features reflect, in one way or another, our basic philosophy which aims at determining the exact types of data required, raising the quality of these data, developing more efficient methods to generate them, and finding completely new ways of personalisation and contextualisation so that the exact amount and types of lexicographical data are prescribed to the users in the exact moment and context where they are needed.

This implies that we intend to store as much lexicographical data as possible in the database. The data will then be used dynamically and adapted to systems, user situations, technological possibilities, and so on. They are therefore organized in three main categories, namely (a) data required by all, (b) data required by most, and (c) data required by some users, systems, and situations. The practical implementation of this categorization is that definitions and inflections are default data, whereas data on valency, examples, collocations, compounds, external links, synonyms and antonyms are additional data that will be required in most cases. By contrast, notes on style, usage, lexis, and other aspects of particular words and expressions are classified as data that only occasionally will be relevant.

The database consists of 68 different slots. Each slot is designed to accommodate a specific type of lexicographical data. There is a slot for definitions, a slot for equivalents, a slot for synonyms, etc. The slots are independent components. Their data can be accessed and extracted in different ways. For instance, we can choose only to extract definitions (single choice), inflections and definitions (binary choice), and definitions, inflections, equivalents, and synonyms (multiple choice). The programmers will then code for the three choices. This requires a system with a very powerful storing and processing capacity. In theory, there are up to 4,489 possible combinations of searching and extracting, although we currently work with “only” 1,089 possible combinations. If a user of *Write Assistant*, for instance, types the Spanish word *labia*, the suggestion window will immediately furnish two English equivalents, namely *patter* and *glibness*. A click on any of them will provide access to a page containing part of speech, inflection, and two senses. A further click on one of the senses will offer synonyms, collocations, geographic and diaphasic variations, as well as examples addressed to the specific sense.

The 68 slots are divided into two groups of 34. Each group is prepared for storing lexicographical data related to either English or Spanish words and expressions. Hence, programmers are currently coding for extracting either one or the other type of data depending on the target users’ mother tongue. Figure 5 showed a partial Spanish description of *clicking* (which was not taken from the database *Valladolid-UVA*). In due course, when the latter is ready, there will be a similar English description of the Spanish word *cliqueo*, this time aimed at English native speakers who need assistance when writing in Spanish.

We use a grammar feature to individualize the lexicographical description of each word or expression. When a grammar category behaves very differently in the two languages, it will get a differentiated treatment. For instance, there are five classes

of English nouns but only four classes in Spanish because the distinction between countable and uncountable is practically irrelevant in this language.

Table 1: Types of nouns and their distribution in the two parts of the database

English Part	%	Spanish part	%
Noun: Countable	24.7	Noun	43,0
Noun: Plural	1.3	Noun: Plural	0.9
Noun: Proper	0.8	Noun: Proper	0.6
Noun: Singular	3.4	Noun: Singular	0.3
Noun. Uncountable	21.8		

Table 1 shows the percentage of each type of noun in the English and Spanish parts of the database, respectively. As can be seen, 43% of all the Spanish words and expressions stored in November 2019 were coded as *nouns*, whereas 24.7% of the English lemmas were classified as *countable* and 21.8% as *uncountable*. The different meanings that correspond to the two categories are reflected in the definitions (see Examples 1 and 2). The future alert window may also be used to call the writers' attention to this specific phenomenon. User testing will inform us of the need for this option (see Section 6). In Example 1, the countable *flooding* refers to the literal situation where water covers normally dry land. On the other hand, Example 2 indicates that the uncountable *flooding* can either refer to the literal process of submerging normally dry land under water, or have various figurative meanings (due to space constraints, we only show one of these):

- ocupación por parte del agua de un espacio físico que normalmente está seco; se usa para referirse a casos en los que un espacio físico como por ejemplo una calle está llena de agua, por ejemplo porque se ha desbordado un río, porque ha llovido mucho y muy fuerte, por una subida de la marea o del nivel del mar, etc.; se usa en sentido literal
[situation in which water covers normally dry land, e.g. a street submerged under water due to torrential rain, an overflown river, high tides, and so on; it is used literally]

Example 1: Definition of countable *flooding*

- acción provocada por el agua que consiste en anegar tierras o lugares que normalmente están secos; se usa en sentido literal
[the process of submerging normally dry land under water; it is used literally]
- abundancia excesiva de personas o cosas en un lugar en el que normalmente no hay tal cantidad exagerada de cosas o personas; se usa en sentido figurado

[a large quantity of people or things in a place where there is not usually such large quantity; it is used figuratively]

Example 2: Definitions of uncountable *flooding*

We also use meaning or usage potential to individualize each of the words or expressions included. This entails that the traditional category of lemma is not only populated by single words (existing Spanish dictionaries typically include single orthographic words or constructs such as “*professor, ra*” as lemmas). Multi-word expressions that have meaning and/or usage potential are also lemmatized when they refer to an entity that can be individualized because of either its specific meaning(s) or its particular usage. Table 2 shows the distribution of lemmas formed by a single orthographic word or by two or more orthographic words in each part of the database.

Table 2: Types of lemmas and their distribution in the database

Types of lemmas	English part	Spanish part
Single-word	55 %	65 %
Multi-word	45 %	35 %

Table 3 shows various English and Spanish multi-word expressions that are lemmatized in the database Valladolid-UVa. By contrast, they cannot be found in Oxford’s *Lexico*, the Royal Spanish Academy’s *Diccionario de la Lengua Española* (DLE), or any other current English or Spanish dictionary that we have consulted.

Table 3: Multi-word lemmas in Valladolid-UVa not found in *Lexico* or in *DLE*

English	Spanish
all right reserved	alojamiento y comida
common mode rejection rate	caerse a pedazos
family authorization	contraer matrimonio
rise to the challenge	como era de esperar
set a trap for	hombre de familia
	no saber ni jota

The meaning or usage potential is very relevant as it compels lexicographers to prepare very precise descriptions of each word and expression. For instance, we have not followed the practice of providing a general definition together with several equivalents that is used in many dictionaries. Instead, we have opted for making very precise and specific definitions and limit the number of equivalents to one (although there may

be two or three equivalents if they represent cases of total synonymy). *WordReference*, for example, offers two senses of *malicious* with four and two Spanish equivalents, respectively. Two of these equivalents, *malicioso* and *maligno*, are the same for both senses. We have opted for a different strategy and added a third sense that refers to an infected computing program, code, system, etc. This means that we offer three precise definitions and three Spanish equivalents. These are *malintencionado* (referring to a person), *doloso* (referring to an act) and *malicioso* (referring to computing). *Doloso* is never applied to a person or computing program. *Malintencionado* is rarely applied to an act and never to a computing program; and *malicioso* is rarely applied to a person or act in general Spanish.

Table 4 lists the number of senses addressed to 100 words and expressions containing the letter sequences “ab” (e.g. *able*), “cad” (e.g. *arcade*), “def” (e.g. *go down in defeat*), “fav” (e.g. *abdicate in favour of*) and “do” (e.g. *do a favour*). The table shows that almost 80% of the words and expressions analysed contain from one to three senses, something that goes very well with our windows (see Section 5).

Table 4: Number of senses per word and expression

Number of senses	%
One sense	49
Two senses	19
Three senses	9
Four senses	4
Five senses	11
More than five senses	8

The database Valladolid-UVa has a slot for storing all inflectional forms of each word and expression, or at least a representative section of these forms. For the verb *seal*, for instance, the forms *seals*, *sealed* and *sealing* have also been stored. And for Spanish nouns, we also include the words and expressions with their articles and inflections (e.g. *un profesor*, *el profesor*, *unos profesores*, *los profesores*; and *una profesora*, *la profesora*, *unas profesoras*, *las profesoras*). These forms denote grammatical gender, noun-adjective concordance, number, and so on. This practice is particularly relevant for Spanish verbs and verbal expressions that can have up to 60 different forms. Nine of these forms have been stored in the database. The verb *amar* (to love) and the verbal expression *no saber ni jota* (to have absolutely no idea) will illustrate this. For the verb, the following forms are stored: *amar*, *amo*, *amé*, *amaba*, *amaré*, *amaría*, *ame*, *amado*, *amando*; and for the expression: *no saber ni jota*, *no sé ni jota*, *no supe ni jota*, *no sabía ni jota*, *no sabré ni jota*, *no sepa ni jota*, *no sabría ni jota*, *no sabido ni jota*, *no sabiendo ni jota*. This way of storing facilitates the search process and retrieval of data. In this respect, four search methods are foreseen:

1. “=lemma” (the same search string)
2. “=lemma” (part of the search string)
3. “*lemma” (derived form of the search string, i.e. an inflected form of the search string)
4. fuzzy searches.

To illustrate the implications of the chosen search methods, we can take a Spanish native speaker who is writing an English text and types *no habían sabido ni jota* in order to get assistance. The system will then connect this sequence to *no sabido ni jota* (see above) and retrieve the relevant data. It is, therefore, expected that *Write Assistant* in the nearby future will be able to serve the writer with the lexicographical data that he or she needs when typing similar Spanish expressions.

The lemmatization of a large number of multi-word expressions and the provision of precise meaning descriptions also benefit *Write Assistant*'s consultation window in two important ways. The first advantage is that around 80% of these multi-word lemmas have either one or two meanings. Hence, users do not need to scroll down and they can easily and quickly get what they need. The second advantage is that our lexicographical decision makes it easier to treat common single words, e.g. adjectives. One of the meanings of *dead*, for instance, refers to a financial product that is no longer productive. This meaning is only found when the adjective *dead* collocates with *money*, *assets*, *capital* and similar words. Existing English dictionaries tend to include expressions such as *dead money* in examples, thus assuming that users will make correct deductions. We have opted for a different solution and decided to make these expressions more explicit by including them as lemmas. They have typically only one meaning and are, thus, ideal candidates for *Write Assistant*'s windows.

At this stage we still have to deal with three important challenges. The first one is to examine how the future alert window can be integrated into the lexicographical presentation. The data types required for this integration as well as the consequences for the database are still, to a large extent, an incognito. The second challenge is to prepare *Write Assistant* to identify the above-mentioned expressions and treat them as the single-word lemmas are treated now. In this respect, we can already see light at the end of the tunnel. The third challenge concerns words with too many senses. Especially some very common words like the verb *get* and the noun *set* require a large number of pages for a full description. The Spanish verb *picar*, for instance, has 56 different senses in our database. The lexicographical data addressed to each sense amount to around 25 lines, i.e. almost one page. Hence, a full description of *picar* would require more than 40 pages if it was printed. In the following section, we will discuss how to deal with this big amount of data in *Write Assistant*'s consultation window.

5 Reflections on the consultation window

As we saw in the previous section, some of the cards in the database Valladolid-UVa contain a large amount of data that would require 10, 20, 30, or even more pages if they were printed on A4 paper. Thus, the challenge is to elegantly present all these data in the consultation window and, at the same time, avoid a too long and user-unfriendly access route. The challenge is huge and we have to look for inspiration. In 2001, when Apple was preparing the iPod project, Steve Jobs insisted that the new device should allow its users to get what they wanted in only three clicks:

“Once the project was launched, Jobs immersed himself in it daily. His main demand was “Simplify!” He would go over each screen of the user interface and apply a rigid test: If he wanted a song or a function, he should be able to get there in three clicks. And the clicks should be intuitive. If he couldn’t figure out how to navigate to something, or if it took more than three clicks, he would be brutal.” (Isaacson 2011: 388–389)

The following proposal is inspired by these ideas. It continues the reflections by Tarp (2019) and is a result of a healthy exchange of ideas with experts from other fields. But it is not necessarily what is going to happen. For the time being, it is only a proposal that has to be dressed in professional design and tested by real users. Apple is famous for its disruptive design and a high degree of user-friendliness. We do not claim to be Apple nor Steve Jobs. But we modestly think that we can learn something from the above quotation. Hence, we translate it into the following five guidelines for the design of the consultation window:

1. All navigation should be intuitive. No special skills should be required. Users should be able to navigate immediately without any instructions. Few users read instructions and many become impatient if it does not work for them at once.
2. The users should be able to find what they need in as few clicks as possible. We agree that three clicks should be the ultimate objective. But we doubt that it can be reached in all cases. The big amount of data addressed to some of the words in the database makes it difficult. Hence, we accept a fourth click.
3. Scrolling down should be reduced to a minimum. Many users take what they find at first glance without exploring the whole text. A reduced number of clicks cannot compensate for a bigger need to scroll down. A writing assistant is not an iPod. Users looking for instantaneous writing aid will behave differently from users looking for their favourite songs.
4. Data overload should be avoided. Any data, symbol, line, or button that is included in the consultation window should be justified. If they cannot be justified, they should not be there.
5. Metatexts should be easily understandable. Specialized terminology which many target users may not understand should be avoided. Everything should be written in a plain, user-oriented language.

The first victim of these guidelines is the lemma. Wiegand (1983) referred to it as the “lemma sign”. His argument was that the canonical form placed at the head of the traditional dictionary article represents the whole inflectional paradigm of the word in question. The lemma has its own history that still has to be written. When the Greek scribes in the fifth century B.C. introduced glosses in the manuscript copies, they did not need any lemma. The connection between the gloss and the word it was addressed to was clear. It was only when the Alexandrian librarians started compiling the glosses into glossaries that the lemma became necessary. However, as Tarp/Gouws (2019) have shown, the tradition of inserting glosses into books continued up to our time. Sometimes the glosses were shown in small boxes with a headword that could be interpreted as a sort of lemma. Other times they were presented in the form of footnotes with only a number or a letter to establish the connection. Now the circle is closed. As can be seen in Figures 4 and 5, innovative technologies once more allow the glosses (lexicographical data) to be placed directly in the context where they are required. There is no longer any need for a sign that represents the whole inflectional paradigm because the modern glosses connect directly to a grammatical word. Besides, the lemma takes up space that could be used for other data; cf. Guideline 4.

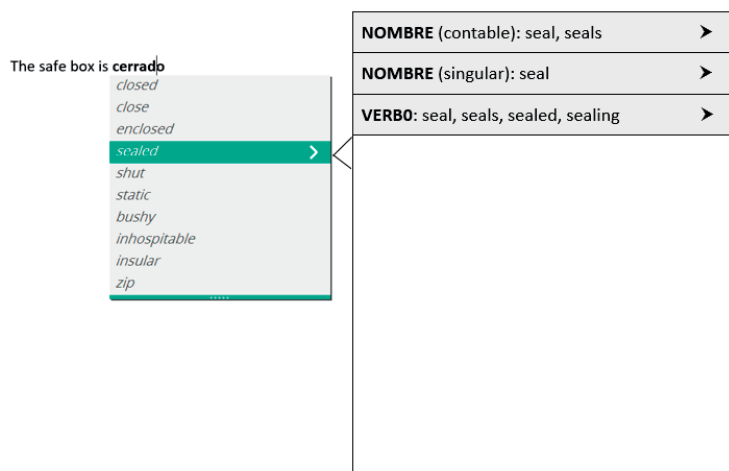


Figure 7: Pre-default page in case of grammatical homonymy

When the user clicks on a word in the suggestion window, we envisage two different default windows to be displayed. The first one can be seen in Figure 7. This window contains part of speech and inflection. It serves as a stepping stone to further data and will only pop up when there is a need to distinguish between different options in case of grammatical homonymy; cf. Tarp (2009: 301–303). The frequency of this type of homonymy depends on the specific language. In our database, it affects roughly 20

percent of the English entries. The phenomenon is inconvenient as it adds an extra click to the consultation process. But it cannot be avoided until the language model, by means of natural language processing (NLP), has been trained to recognize the respective word classes with almost 100 percent certainty.

The word classes in the pre-default window are aimed at guiding the users to the basic default window (see Figure 8). We are aware that many people today, even university students, do not have a good grasp of the respective word classes. To some extent, their inclusion in the pre-default window therefore violates Guideline 5. But there is no alternative way of naming them. The inflectional forms are added to help more users to click on the right option.

Figure 8 shows the basic default window. Apart from the word class, it only contains two data categories, namely the inflectional paradigm and the definitions of the various senses. Nothing else. There are two main reasons for this decision.

1. Many users, especially L2 learners at the beginner's level, will have little or no previous knowledge of many of the words with which they are continuously confronted in the suggestion window. We thus assume that meaning and, next to that, inflection will be the two types of information which they will most frequently require.
2. The second reason is structural. All other relevant data classes are not related directly to the lemma but to one of its senses. This could be equivalents, cultural and pragmatic notes, synonyms and antonyms, syntactic properties, collocations, compounds, and example sentences. In conventional dictionary articles, many of these data are often placed at the bottom of the article giving rise to a complex microstructure. The digital technology does not only permit a more logical presentation. It also allows us to handle large amounts of data in a more elegant and user-friendly way.

Now, the verb *seal* has nine senses in our database. If all the definitions were provided in their full length, it would be necessary to scroll down to see all of them. They are therefore cut down to only one line, or to the first semicolon. This allows for all nine senses to be displayed immediately. The idea is to give the user a preliminary idea of the meaning of each sense. If it looks good, a simple click takes the user to the next page where an expanded definition can be found (see Figure 8). This simple technique reduces considerably the need to scroll down at this stage of the consultation process, in most cases down to less than one percent of all consultations. (The percentage depends on the size of the window which varies from device to device.) In addition, the digital environment makes it possible to register which senses are most often expanded. This implies that their order, after some time, can be rearranged according to frequency.

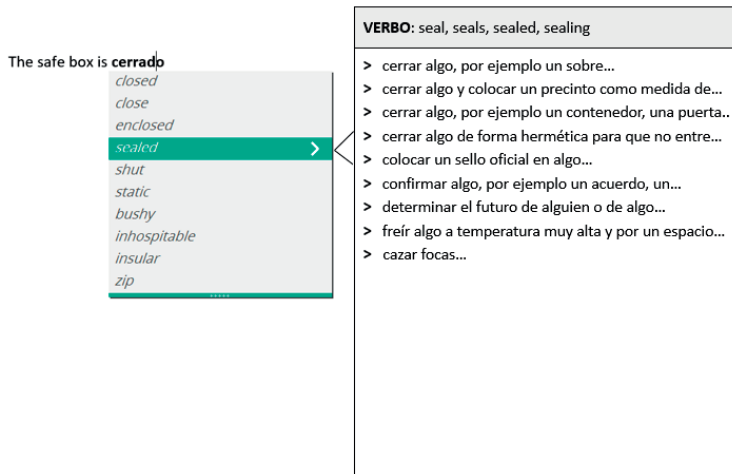


Figure 8: Basic default window

The proposal in Figure 8 poses a special challenge to lexicographical databases. If short one-line definitions are not foreseen in the database, many sentences will be cut abruptly before the first semicolon (semicolons are used to separate the different segments of the definition as shown above in Examples 1 and 2). Although this solution could be recommended as interim, it is nevertheless disturbing. It means that the user may find it difficult to deduce the preliminary meaning from the abridged definitions. Alternatively, the definitions could be extended and cut after the first semicolon (see Figure 9). This option raises the need for scrolling down and the final (interim) solution will therefore have to be negotiated by user tests. As to a more lasting solution, future lexicographers should consider the inclusion of both short (one-line) and longer definitions into their databases if these are aimed at sustaining writing assistants with characteristics similar to the one discussed here.

The second page in the consultation window (see Figure 10) consists of the expanded definition as well as a number of metatexts. The latter will be written in Spanish but are here translated into English for the benefit of the reader. The highly specialized terminology is provisional. A more user-friendly wording and presentation will be tested once the proposal has been translated into a professional design. The respective metatexts will only appear when there are additional lexicographical data to be visualized. The idea is that a simple click on one of them will provide access to these data.

How should these data be presented? There are basically two ways. They could either appear directly under the activated metatext. Or they could be placed on a separate page. Both solutions have advantages and disadvantages. The challenge is to handle an amount of data that varies considerably from sense to sense, from metatext to metatext. If the first option is chosen, it will probably work in many cases. But

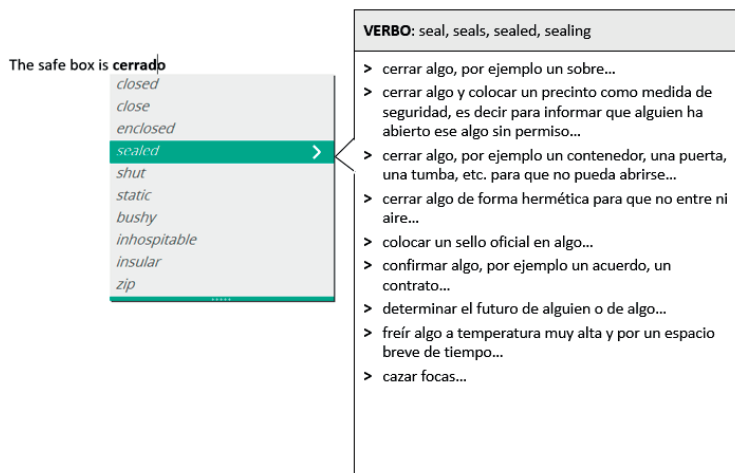


Figure 9: Basic default window (alternative option)

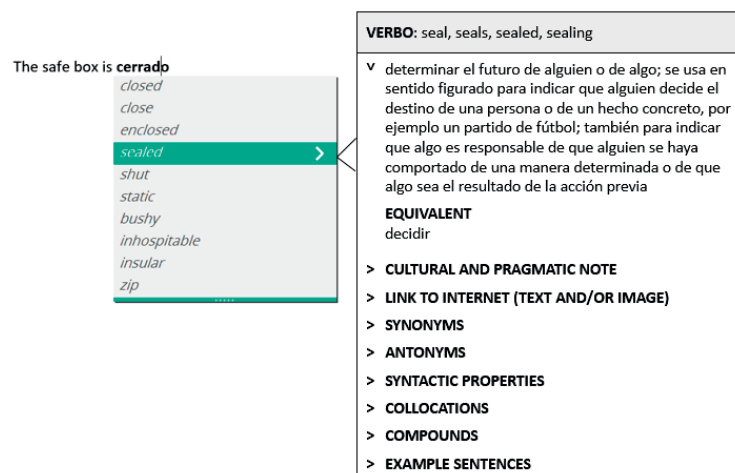


Figure 10: Second page: Expanded definition with metatexts

when there is a large amount of data to be displayed, it would be necessary to scroll down to access all of it. By contrast, scrolling down will hardly ever be required if the second option is chosen and the data is presented on a separate page. However, this solution implies that the amount of data displayed sometimes may appear almost too small.

So, which solution should we choose? At the end of the day, it will be decided by future user tests. But we are inclined to opt for the first solution (see Figure 11). We consider scrolling down to be a minor problem at this stage of the consultation

process. Users who have clicked through to this page are expected to be more motivated and exploring. Those who were in a hurry and just needed information about meaning or inflection have already been satisfied and have left the consultation window. Besides, the solution shown in Figure 11 allows for several metatexts to be unfolded simultaneously.

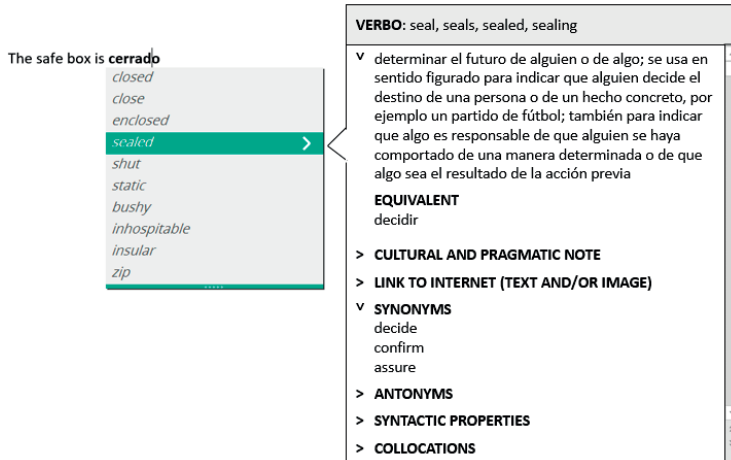


Figure 11: Third page: Expanded metatext

Above, we hypothesized that the most demanded lexicographical data are meaning and inflection. If this is so, the proposal suggests that most users can get what they want in only one click (inflection) or two clicks (meaning). The users who need more detailed data can access them with a further click. (In case of grammatical homonymy, an additional click is required.) At the same time, scrolling down has been reduced to a minimum, especially in the first phases of the consultation process.

To sum up: The proposed design of the relatively small consultation window will allow the users to access the relatively big amount of data contained in the Valladolid-Uva database with a maximum of 3–4 clicks:

1. Click on a word in the suggestion window (or in the already written text)
2. (Click on a word class in the pre-default page in the consultation window)
3. Click on a definition in the default page in the consultation window
4. Click on a metatext in the second page in the consultation window

6 User testing

The proposal presented in the previous section will have to be tested by the end-users in order to make the necessary modifications and adjustments. How should such a test be conducted? What methods will be the most appropriate?

There is already a large number of publications that treat this question and discuss the results of already conducted user studies. Welker (2006) listed 220 research projects. Since then, the number of papers has not ceased to grow. Apart from a healthy academic curiosity, there seems to be a deeper reason for this. The massification of dictionaries, especially since the XIX century, has created a growing distance between the lexicographers and their users. The interest in user research can be interpreted as an attempt to remedy this alienation and loss of personal contact. Lew (2016) and Wolfer et al. (2018), for instance, have documented that the consultation of dictionaries improves their users' performance when writing in L2 or L1, respectively. Most lexicographers have probably known this intuitively but the hard evidence may stimulate some of them in their daily work. By contrast, Dziemianko (2019) has proved that advertisements reduce the usefulness of online dictionaries. This is hardly surprising. But it seriously challenges this option as an alternative revenue model if the objective is to produce high-quality dictionaries.

Nonetheless, although a few general observations may be relevant for any type of reference tool, conventional user research also has some clear limitations that make it less appropriate for a high-tech project like *Write Assistant*. Most user studies have been conducted within the old paradigm of printed or digital stand-alone dictionaries. It is well known that each lexicographical product has its distinctive characteristics. It is therefore difficult to transfer research methods from one technological paradigm to another and generalize research output from one type of product to another. In this respect, Tarp writes:

“Current lexicographical user research does not make a dent in the universe. It is generally conducted into already published dictionaries or so-called prototypes with no prospect of being produced due to financial constraints. Its results are most often published months or even years after the research has been conducted. The real needs of users as they express themselves *before* dictionaries are consulted are largely ignored. It is therefore of little relevance for the design of a completely new tool aspiring to prove its *raison d'être* in the era of the Fourth Industrial Revolution.” (Tarp 2019: 244–245)

The new technological paradigm and the integrated information tools that are under construction both require and make allowance for new ways of conducting user research. It is now possible to cut the distance between lexicographers and users. The solution chosen in the *Write Assistant* project is the use of test-driven development (TDD). This method is generally used by providers of software to test their products. It relies on iterative processes where a very short development cycle is repeated until a satisfactory solution has been reached. It goes more or less like this: A requirement is

turned into a test case that is run together with all test cases to see if the new one fails. A programming code is written and further test cases are run. The programming code is rewritten (refactored) in order to simplify it without affecting its functionality. The cycle is repeated with the introduction of a new test case, and so on.

The testing of a tool like *Write Assistant* that has been conceived to compete on the international market must be done on an industrial scale. It starts internally at the company. When the very first results are satisfactory, it is little by little taken out of the house and conducted by professional testers among future users in various countries. Until now, it has been done in Spain, Germany, France, Italy, Denmark, and Egypt. The test subjects are introduced to *Write Assistant* and given a task that has to be solved with assistance from the tool and without consulting any other information tool. While they are working with the task, the test subjects are observed by Ordbogen's testers who subsequently interview them to collect their opinions as well as their positive and negative criticism. All this is synthesized and translated into a programming code that is ready for testing the next day or even before.

When using test-driven development, the role of conservatism must be taken into consideration. The method should be applied gingerly if the software has even a touch of something well-known to its users. A historical parallel will illustrate this. When Apple introduced the mouse in its Macintosh computer, many customers were already used to navigate with cursor arrow keys. Instead of asking them what they preferred, it was decided to eliminate the cursor arrow keys on the Macintosh keyboard to compel "old-fashioned users to adapt to point-and-click navigation" with the mouse "even if they didn't want to" (Isaacson 2011:138). Steve Jobs, the genius behind Apple's successes, was convinced that "customers don't know what they want until we have shown them". (Isaacson 2011: 143)

Today, we have a similar situation with the elimination of the lemma in the consultation window. Although the test subjects have never before worked with anything like *Write Assistant*, they have undoubtedly consulted dictionary articles that may influence their initial opinion. The elimination of the lemma should therefore be presented as a *fait accompli*. After a short while, a new test should be conducted to see whether the proposed solution works and the users have adapted (most of them are young people).

The use of test-driven development has several advantages. The product does not have to be fully developed when launched. User tests can continue. Experiences can be synthesized and translated into modifications and adjustments that can be tested and implemented immediately, even a long time after its official launching. This also implies that it can be launched as free software. Later when it has become more sophisticated, a special premium version with new and improved functionalities can be offered for subscription (an important source of revenue in a new business model). Simultaneously, another less sophisticated version can remain free of charge as a means to promote the former. A writing assistant like *Grammarly*, for instance, is already available in both a free and a premium version.

Test-driven development cannot provide answers to all questions. It can contribute to an optimal tool in terms of user-friendliness. It can determine whether the users of the tool feel comfortable and find it useful. But it cannot objectively determine whether the users' performance improves. Neither can it say anything about the effect on their L2-writing skills and proficiency level. Tarp (2020) has listed other urgent research questions such as the implications that the continuous externalization of knowledge and skills has for L2 learning and language didactics in general. To answer these and similar questions, other research methods, like the ones applied by Lew (2016) and Wolfer et al. (2018), will be required.

7 Perspectives

Our interest in the Write Assistant project is not so much piqued by its current version (which is being constantly improved). In spite of all its qualities, we are fully aware of several shortcomings and challenges. Especially the handling of the lexicographical aspects is still not satisfactory. Our interest is mainly aroused by its future potential. It is likely to turn into a powerful integrated information tool that provides qualified assistance to its users when learning and writing in a second language. As such, it may lay the technological basis for a new business model that creates revenue and finances lexicographical projects, including traditional online dictionaries. We therefore aspire to influence it and leave a stronger lexicographical footprint.

Our engagement in the project takes various forms. We do not only contribute with a lexicographical database that adapts to its requirements and introduces new compilation principles and techniques; cf. Fuertes-Olivera et al. (2018). We also participate directly in the design of the two windows where the lexicographical data are presented. This design will probably be decisive for its final acceptance by the users. It will not only be negotiated between lexicographers and other specialists that may have different approaches. The interaction with the users will be crucial. In this respect, it is important to understand that we are on the threshold of a completely new relationship between lexicographers and users.

During the past decades, it has become customary to talk about dictionary culture and the need for users to have reference skills. This is fully understandable. Conventional dictionaries are tools with complex macro and, particularly, microstructures. It is not easy to find what one needs without training. This is about to change dramatically. The new technologies make allowance for a completely different approach. The burden has now shifted from users to producers. It is the latter's job to design products that their customers can use almost intuitively. This is a general requirement for modern "human-centered design"; cf. Norman (2013: 8). If the producers are not able to do so they may lose customers and perhaps even their business. Lexicographers engaged in the production of digital information tools should therefore stop talking

about reference skills and blaming their users for bad usage. Instead, they should take more responsibility for the design of their products and promote a culture of intuitive usage.

In the previous section, we observed that the massification of dictionaries created a distance between lexicographers and users. The latter little by little turned into the “well-known unknown” (Wiegand 1977: 59). This allowed some lexicographers to develop bad habits and introduce a highly specialized metalanguage in their works. The alienation prevented them from seeing the consequences of this practice. Now, the distance to the users has been shortened. Lexicographers are placed in a situation similar to the Greek scribes who assisted their readers directly in the context where problems occurred. But different from the scribes’ customers (who belonged to the intellectual elite), today’s clients are ordinary people who do not always understand the applied terminology.

Our participation in the Write Assistant project has been and is a learning process. We have become aware that part of the (correct) terminology used in the Valladolid-UVa database to describe grammatical phenomena (e.g. valency) is too specialized for most users of the software. An intellectualist attitude to the users has no prospect of success. We therefore have to change the approach and introduce a sort of lexicographical storytelling to please our customers. Unfortunately, this has retrospective consequences for the design of the database but we see no other alternative if the objective is to make a premium product. The demand for a simplified metalanguage may challenge all types of digital lexicographical products that appeal to a broad spectrum of users. It is just but one small example of the seismic changes that we can expect within our discipline in the framework of the Fourth Industrial Revolution. Among the many slogans used today, open-mindedness is surely one of the most important.

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Dictionary of the English Language. Ed. by Johnson, S. London: J. & P. Knapton, 1755.

Lexico. <https://www.lexico.com/en/about>

WordReference. <https://www.wordreference.com/>

8.3 Writing assistants

AWA (Academic Writing Assistant). <https://awa.schrijfhelp.be/>

ColloCaid. <http://www.collocaid.uk/>

Ginger. <https://www.gingersoftware.com/>

Grammarly. <https://www.grammarly.com/>

HARenEs (Herramienta de Ayuda a la Redacción en Español). <http://harenes.taln.upf.edu/CakeHARenEs/check>

ProWritingAid. <https://prowritingaid.com/>

WhiteSmoke. <https://www.whitesmoke.com/>

Write Assistant. <https://writeassistant.com/en/>

Writefull. <https://writefullapp.com/>