Google Translate search strategies used by learners of Spanish L3: A complex lexico-morpho-syntactic weave of trial and error

Estrategias de búsqueda en el traductor de Google usadas por estudiantes de español L3: una compleja trama léxico-morfo-sintáctica de prueba y error

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Abstract

This article presents a study on Google Translate search strategies among 16 Swedish senior high school students (age 17–18) engaging in writing tasks during their sixth year studying Spanish L3. The students wrote on laptops with Internet access and were allowed to use Google Translate to search for Spanish words. Analyses of approximately 43 hours of screen recordings covering the writing of 57 essays reveal a complex weave of Google Translate search strategies performed in Swedish, English, and Spanish. The strategies combine lexical and morphosyntactic searches, ranging from single words to longer sequences of words. The searches were frequently characterised by trial-and-error-based approaches that comprised numerous control translations of already known words. The observations also reveal search behaviors interpreted as lack of trust among the students in the search results and in their own language skills.

Keywords: Free online machine translation; Spanish as a foreign language; foreign language learning; foreign language writing; computer-assisted language learning

Resumen

Este artículo presenta un estudio sobre las estrategias de búsqueda en el traductor de Google empleadas por un grupo de 16 estudiantes suecos del bachillerato (17 a 18 años de edad) en ejercicios de redacción realizados durante su sexto año de estudios de español L3. Los estudiantes utilizaron ordenadores portátiles con acceso a internet y podían usar el traductor de Google para buscar palabras en español. El análisis de aproximadamente 43 horas de grabación de las pantallas durante la escritura de 57 ensayos reveló una compleja trama de estrategias de búsqueda en sueco, inglés y español. Las estrategias incluyeron búsquedas léxicas y morfosintácticas, desde palabras sueltas hasta secuencias más largas. Las búsquedas frecuentemente se caracterizaron por seguir métodos de prueba y error que incluían numerosas traducciones de control de palabras que los estudiantes ya conocían. Las observaciones evidenciaron también ciertos comportamientos en la búsqueda que pueden interpretarse como falta de confianza de los estudiantes en los resultados de su búsqueda así como en su propio conocimiento de la lengua.

Palabras clave: traducción automática; español como lengua extranjera; aprendizaje de lenguas extranjeras; escritura en lenguas extranjeras; enseñanza de lenguas asistida por computadora

1. Introduction

The frequent use of Google Translate (GT) and similar sites offering free online machine translation (FOMT) by foreign language learners is a well-known reality among language teachers. Ducar and Schocket (2018: 779) called GT "an inescapable reality in today's second language (L2) classroom", and studies have shown that language learners frequently resort to FOMT tools even when instructed not to (O'Neill, 2019; Fredholm, 2015a; Garcia and Pena, 2011; Niño, 2009; Williams, 2006; Luton, 2003). Machine translation use among L2 and L3 learners has been addressed in a small but growing number of studies. However, despite the omnipresence of easily available machine translation services such as GT, the search strategies employed by language learners when using GT during written text production have not been studied in detail so far, apart from a few studies that did not focus exclusively on GT search strategies. Fredholm (2015a) observed spontaneous use of online resources among upper secondary students writing in Spanish L3 and found that different machine translation sites were used for almost half the word count in each text. In a partially similar study, Knospe, Sullivan, Malmqvist, and Valfridsson (2019) observed the use of online sources among German L3 learners and described the use of GT by some of them. Although the studies above mentioned provide a general outline of FOMT use among young L3 writers, no study so far has described the complex interplay of different search strategies. This article delves further into FOMT use among Spanish L3 learners, exploring in detail their GT search strategies. It gives insights into the wide variety of GT search strategies used by a group of Swedish learners of Spanish L3. These insights are important for researchers in the language education and foreign language writing fields, and for practicing language teachers who face a competing source of information in their classrooms, in the form of a digital translation interface.

Hyland (2016: 40) stated that a literate person needs to have "control over a range of printed and electronic media", and con-

cluded that these have affected our ways of writing and accessing information, giving "writing teachers new challenges and opportunities for classroom practice" (ibid.). The use of FOMT together with an increase in computer-based writing instead of paper-and-pen-based approaches is such a challenge but, perhaps, also an opportunity for language teachers and students to access a wider range of approaches to tackle language-related issues in foreign language writing. GT is not the only resource of language learners to solve a linguistic conundrum; nevertheless, this study focuses on GT usage as this is one of the most easily available and most frequently used language resources (Aiken, 2019), and a topic of much concern to many language teachers. Anecdotes about faulty translations are common, but the accuracy of GT searches has increased drastically after the introduction of Google's Neural Machine Translation (GNMT) in 2016, which reduced the number of translation errors in as much as 55% to 85%, depending on the particular language pair (Le & Schuster, 2016; Wu et al., 2016). When GNMT was implemented, these effects concerned translations between eight different languages, including Spanish and English, but not Swedish.

Clarifying the strategies used by students for searching lexical and morphosyntactic information in schools with free access to Google Translate can help foreign language teachers to better understand the needs of their students and serve as valuable input for further studies on how language learners tackle problems in modern settings of foreign language writing.

2. Purpose and research questions

The purpose of this study is to give a detailed account of GT search strategies used by a group of Spanish L3 learners during essay writing, and discuss the implications of the observed strategies for foreign language teaching. The word *strategy* is used herein to denote all actions performed to search for lexical and morpho-

syntactic information needed to communicate a desired content in essays written in Spanish L3.

Explaining how students solve problems in a digital writing situation further deepens the insights from earlier studies such as those by Knospe et al. (2019) and Fredholm (2015a). No earlier study aimed to clarify in detail how L3 learners use GT affordances (cf. Gibson, 1986; Adolph & Kretch, 2015) during writing.[1] Thus, this study contributes to improve the understanding of foreign language writing researchers and teachers of the complex interplay of search strategies used by L3 learners.

The study addressed the following research questions:

- What GT search strategies do Spanish L3 learners use to search for lexical and morphosyntactic information during essay writing?
- What potential implications for foreign language teaching can be drawn from the GT search strategies observed?

The observed search strategies are described in §5 and their implications for foreign language teaching are discussed in §6.

3. Earlier studies on machine translation use in foreign language writing

Foreign language writing (FLW) is a vast research field that studies different aspects of L2 and L3 writing. After Flower and Hayes (1981) put forward a model for the writing process, several other models have been put forward to highlight the special characteristics of FLW processes (Nas & Van Esch, 2018). Studies on L2/L3

[1] There are, certainly, studies on the use of machine translation by professional translators and translator students within the computer-assisted translation research field, but the differences between translation professionals and intermediate, L3-level learners make the findings from those studies of little significance here.

lexical searches have mostly concerned dictionary use (see, for instance, Sue Atkins, 2015, for an overview). This article focuses on FOMT use strategies for lexical searches in FLW, a field of research scarcely investigated but highly relevant in current settings of digitalized foreign language learning where learners have easy access to online resources.

Earlier studies on FOMT use among foreign language learners have investigated different aspects of texts written with FOMT support. Studies such as Niño (2008), Garcia and Pena (2011), and Fredholm (2015b) point to benefits as well as drawbacks. (See Vold, 2018, and Errol Marinus O'Neill, 2012 for more comprehensive summaries of earlier research on FOMT use in FLW settings.) Likewise, there is little consensus regarding the question of whether FOMT use should be seen as plagiarism and cheating (Ducar & Schocket, 2018; Correa, 2014), but more recent papers on the subject seem more receptive of the presence of GT as a reality and tend to advocate for a judicious use of the technology, rather than a complete ban.

A few attempts (e.g., Fredholm, 2019) have been made to elucidate aspects of longitudinal outcomes of FOMT use. Within the field of translation studies, Alsalem (2019) showed that post-editing translations using GT may improve learning translation skills, but that this effect may be reduced if users over-rely on GT and do not work sufficiently with their texts, concluding that "students should avoid using technology to circumvent the requirements for proper training, which could ultimately lead to less learning" (p. 58). Similar hypotheses have been put forward by Larson-Guenette (2013), Garcia and Pena (2011), and Garcia (2010), but long-term learning outcomes have not been investigated yet.

Leaving aside the difficult question about learning outcomes, only a small number of studies have examined how students use FOMT and other online resources during L3 writing. Farzi (2016) addressed this question but did not give a detailed account of FOMT use strategies. Fredholm (2015a) observed L3 writing behaviors based on a variety of Internet-based information retrieval strate-

gies; apart from using Google searches for information, grammar help such as verb paradigms, retrieval of language-specific letters and punctuation marks, and picture searches to confirm the accuracy of translated words, the participants resorted extensively to the FOMT sites Google Translate and Lexikon24. Some 44.43% of the total number of words in each essay were machine-translated on average, with a wide variation range in individual essays from 6% to 100%. Even in the control group (use of online resources not allowed), most students resorted to FOMT through their mobile phones. The search strategies led to frequent switching between the text written, FOMT sites, and Google searches.

Similar actions were observed in the study conducted by Knospe et al. (2019) on the use of online sources by seven Swedish learners of German L3. The researchers found that attention was constantly split between writing and information retrieval. The students started using online resources early in the writing sessions and wrote without much planning beforehand. Broad variations were found among the participants, who mainly used their L1 to search for words, grammar, and other information. Knospe et al. (2019) grouped the writers into two main categories based on their writing behavior: a group called "controlling the sources" and another called "controlled by the sources" (p. 265). This is, to some extent, comparable to the study by Tate and Warschauer (2019) on the use of computers by American 8th graders while writing, in which five writer profiles were identified, ranging from the most to the least efficient computer users. They concluded that the ability to handle digital writing depends on the instructions that students receive on keyboard use and other aspects of computer use.

The "controlling the sources" group studied by Knospe et al. (2019) did not rely on FOMT and were able to search for words in their uninflected forms, detect aspects leading to difficulties in their search for words, and correct their search terms. "Controlled by the sources" writers relied more frequently on online sources and were less critical of the search results. Many searches were described as unnecessarily time-consuming. In both groups, the

researchers found students double-checking words or sentences, a strategy also observed by Clifford, Merschel, and Munné (2013). In the "controlled by the sources" group, stepwise changes in translations of complex phrases until a satisfactory result was achieved were also observed. Knospe et al. (2019: 277) concluded that writing while using online sources "is a complex process of hypothesis testing that frequently involves a high degree of learner attention and cognitive load". This may entail a cognitive load that writers struggling with a very reduced vocabulary are unable to sustain for extended writing sessions (Knospe et al., 2019).

The complex hypothesis-testing view of writing with online sources described by Knospe et al. (2019) can be seen in the light of the statement by Hyland (2016: 41) about the new "challenges and opportunities" that media access offers to classroom writing practices, as mentioned in the introduction to this article. Hyland (2016) further stated that the use of electronic media allows assembling text and images. In the current context of foreign language classrooms, we might further elaborate on this statement by adding that easy access to GT enables written products in foreign language writing to become assemblages of independently written text snippets and search results. Freely available online tools such as GT offer even inexperienced writers the possibility to produce texts or parts of texts far beyond their own capabilities. Whether these writers can evaluate the correctness or context adequateness of these translations is a separate matter.

According to Vold (2018), Enkin and Mejías-Bikandi (2016), and Correa (2014), FOMT can be used in foreign language classes as a way of raising language awareness with the guidance of a teacher. Learners should not be left to fend for themselves as best they can with the technology. Students may also need teachers to develop not only their language proficiency, but also their world knowledge, both essential for assessing the context appropriateness of FOMT search results. This is in line with views in Medvedev (2016: 188), who stresses the need for "more critical think-

ing on the part of the educator and the learner", especially when determining context adequacy and correctness of synonymous or polysemous lexemes and expressions, an area where he finds GT unreliable. The opinions found in recent literature on FOMT use in language learning settings may, thus, be summarised as a need for more critical thinking rather than letting the machine take control over what is being written.

4. Methods

4.1. *Participants and data collection*

The researcher collaborated with two Spanish teachers in a Swedish upper secondary school, observing their students (aged 17-18) as they engaged in essay writing during the schoolyear 2016-2017. In that schoolyear, the students started their sixth year of Spanish L3 studies, a level roughly corresponding to levels A2.2 to B1.1 in the *Common European Framework of Reference for Languages* (Council of Europe, 2001). This article presents data from 16 students who were allowed Internet access and encouraged to use Google Translate when they needed to look up words. The 16 students were randomly chosen from the two groups of the teacher, with only minor changes made before the study started to ensure an even distribution of Spanish grade levels among the participants.

The computers used by students in four essay-writing sessions during the schoolyear were screen-recorded with the software apowersoft.com. This enabled a detailed analysis of the writing and search behaviors of the students. A total of 43 hours, 8 minutes and 16 seconds were recorded, with individual recordings ranging from 27 minutes and 36 seconds to 57 minutes and 22 seconds, and a mean duration of 45 minutes and 24 seconds. The mean essay length was 191.59 words, ranging from 51 to 342 words. Table 1 summarizes the data used for this study.

Table 1. Data used in this study

Data type	Amount	Mean length	Shortest	Longest
Essays	57	191.59 words	51 words	342 words
Screen recordings	43 h. 8 min. 16 sec.	45 min. 24 sec.	27 min. 36 sec.	57 min. 22 sec.

4.2. *Analyses*

Screen recordings were watched closely and every action performed to make a GT search was noted, as well as those parts of each text that were the result of GT searches. Overall, 7137 actions related to GT searches — typing or deleting words, clicking, copying and pasting — were recorded. These actions produced 4112 instances of GT searches, 117 of which consisted of translating into Swedish or English parts of the Spanish instructions to the essay topics. These searches were not included in the analyses, as they are related to the passive vocabulary and written-comprehension capabilities of the students, rather than to their writing skills. Once these instances were removed, 3995 GT searches remained.

The observed GT search actions were given an initial, rough categorization based on the content of searches: translations of single words or word sequences; translations of new words previously not sought; double-checking of words already written; changes made within a series of searches, for instance, to spelling or morphosyntactic elements; languages that were used; and interactions with the GT interface. The initial categorization was further elaborated and stepwise refined during several subsequent analyses of the material, aimed at clarifying and simplifying the complexity of actions observed in the screen recordings. Through this process, subcategories with a common denominator were grouped together, for instance, the various types of morphosyntactic changes observed in the material. This process was driven by the data as no categories were established beforehand.

Attaining a clear, irrefutable categorization of the observed GT search strategies was an arduous and unobvious task as the

strategies were often intertwined. In fact, an initial attempt at categorizing the translated words in parts of speech or other morphosyntactic subdivisions was found to be of little practical value, as most search actions mixed lexical and morphosyntactic elements. The search strategy categorization described in §5 is an attempt to portray this complexity in an as uncomplicated way as possible.

4.3. *Ethical considerations*

Essay writing is a natural part of the curriculum, and the participants commonly use their laptops at school. The writing sessions were designed together with the teachers and incorporated as a regular element of Spanish lessons, ensuring as little disruption of the normal course content as possible, and avoiding unnecessary nervousness among the participants. All students in the groups observed were asked to write essays, but could freely choose to give their consent for the researcher to use part of their material; they were free to withdraw this consent at any time during the school year. They were informed that these essays would not affect their grading, and that screen recordings would be available only to the researcher. The teachers had access to essay texts and used them to provide formative feedback at the group level. The documents and recordings collected were blinded prior to analysis, and the students were informed that any text or screen recordings used as examples in publications would be anonymised. No sensitive topics or questions were addressed in the project.

5. Results

This section addresses the first research question — What search strategies do Spanish L3 learners use to search for words and phrases in Google Translate during essay writing? — by describing the GT search categories identified in screen recordings. The overall amount of GT use and the languages used in searches are

shown in §5.1 and §5.2, before turning to the search strategies in §5.3 to §5.7.

One or more examples are given for each search category. The examples are based on screenshots from the screen recordings, which have been modified for increased legibility.

Time marks (minutes ' and seconds '') indicate when a given action was performed during a specific writing session. English translations of Swedish and Spanish words are given 'between single quotation marks' and kept as close as possible to the original search strings. Additional clarifications are given [in brackets] as needed. Further comments on search actions and information on how the search results were used in the essays are given in tables in connection with the relevant searches.

Fictitious names are given to identify students in the result tables; names are followed by a number indicating which of the four essays the example comes from. For instance, *Anton*:1 refers to the first essay written by Anton.

5.1. *Use of Google Translate*

Earlier studies have investigated how many foreign language students resort to FOMT and how often they use it, and have reported a widespread use (O'Neill, 2019; Jolley & Maimone, 2015; White & Heidrich, 2013; Clifford et al., 2013). Fredholm (2015a) found that the mean percent number of machine-translated words out of the total word count was 44.43%. No other earlier study stating the magnitude of machine-translated text in FLW is available. This result is very close to the mean percent number of machine-translated words observed in our study: 43.69%. A 40–50% of machine-translated words may perhaps be expected among L3 writers at this proficiency level; however, this aspect deserves further investigation.

Fredholm (2015b) found no statistically significant correlation between the amount of FOMT use and grade levels. In contrast, a

significant correlation (Fisher exact test, $p = 0.001$) was found in our study, where students with lower grades used GT more extensively (Fredholm, 2019).

Studies such as those by Chandra and Yuyun (2018), Clifford et al. (2013), and O'Neill (2012) have found that FOMT searches conducted by foreign-language writers predominantly concern vocabulary, rather than grammar. Our observations revealed highly mixed search approaches among the participants, blurring the separation line between vocabulary and grammar searches, as shown in the sections below.

5.2. *Languages used in Google Translate searches*

The English language was used by 13 of the 16 students in our study; in contrast, Knospe et al. (2019) observed this in only one participant. The students translated mainly from Swedish to Spanish (64.25% of all searches), but English was also used, particularly when translations from Swedish did not yield clear results. More than one-fifth (22.15%) of the GT searches involved the use of the English language. Four students used almost exclusively English and three other students used predominantly English in their last essay. One student with L1 English level performed searches exclusively from English to Spanish. This student, however, performed relatively few searches that did not affect the degree of English use to any greater extent; when his results were removed from the data, the magnitude of GT searches involving English still reached 20.8% of the remaining searches. Language use is summarized in Figure 1.

On rare occasions, words were translated between Swedish and English (or vice versa), before the translated word was used to find a word in Spanish. Translations from Spanish to Swedish (and sometimes English) were common and mainly represented control translations of words that the students already knew (but were not sure of) and of words and phrases already translated to Spanish.

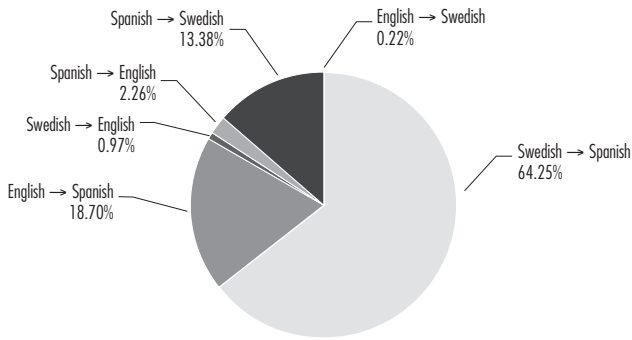


FIGURE 1. Languages used in Google Translate searches (% of total number of searches)

The use of three languages was seen in all the GT search strategies discussed in the following subsections.

As already mentioned, the Google Neural Machine Translation system was introduced in 2016, during the data collection period for this study. In theory, this could have improved the accuracy of translations between English and Spanish (but not Swedish); however, no such effect was clearly visible in our data.

5.3. *Google Translate search strategies observed in screen recordings*

The GT search strategies observed in screen recordings can be divided into four main categories:

- single-word translations (31% of all GT searches),
- translations of word sequences (58%),
- stepwise re-elaborations of words and sequences (45%), and
- control translations (11%).

The sum of the four categories exceeds 100% as several searches involved more than one strategy; for instance, many word-sequence searches also involved stepwise re-elaborations and/or

control translations. Although the translation of single words may be seen as a straightforward use of GT as a dictionary, re-elaborative searches and control translations were better characterized as iterative trial-and-error approaches to find the appropriate wording.

5.4. *Single-word translations*

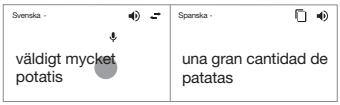
Almost one-third (31%) of the GT searches concerned single words. This strategy resembles the use of a printed dictionary, with the exception that GT also allows searching for inflected word forms (sometimes helping the students, but not in all cases as, for example, when translating polysemous words). GT can process translations of basic vocabulary fairly well, but mistakes may occur as frequently GT cannot determine context adequateness of a single word or expression (cf. Medvedev, 2016: 185). Single-word searches without additional re-elaboration were seen, for instance, when students produced lists or enumerations of (mainly) nouns, such as in the example in Table 2, where *Astrid* writes about what her family usually eats during a Swedish holiday.

TABLE 2. Google Translate used as a dictionary for single-word searches. Astrid: 2

TIME MARK	GT SEARCH	GT RESULT
Before the first search, she had written *Comemos* 'we eat'.		
13'47"		
	'egg[s]'	'eggs'
13'54"		
	'herring'	'herring'

(continued)

Table 2. Google Translate used as a dictionary for single-word searches. Astrid: 2

Time mark	GT search	GT result
13′58″		
	'fish'	'fish'
14′06″		
	'potato'	'potato'
	Goes to the Word document, writes *huevos, pescado y much.* Deletes *much.* Returns to GT.	
14′52″		
	'a huge lot of'	'very'
14′56″		
	'a huge lot of potato'	'a large quantity of potatoes'
15′04″		
	'a lot of potato'	'very potato'
	Returns to the text and adds *muy patatas* 'very potatoes' at 15′28″.	

Single-word searches were often an initial stage or a supplementary part of searches that led to longer sequences, built up step by step, as can be seen at the end of the search conducted by *Astrid*

(see Table 2). The initial translation of a single word may thus evolve into a search for longer sequences, which underlines the usually unstructured trial-and-error approach to GT searches and the stepwise construction of a text. In combination with direct translations of word sequences (see §5.5), this illustrates the extensive use of GT by students to string words together, and their apparent insecurity regarding basic vocabulary.

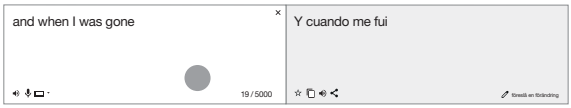
5.5. *Word-sequence translations*

Over one-half (58%) of the GT searches involved translating collocations, phrases, clauses, and complete sentences, herein called "word sequences" to simplify and avoid further subcategorization; it proved difficult to draw a clear distinction between phrases, complete clauses, and full sentences, as such searches (see §5.6) often began with a few words and then increased and were re-elaborated until a satisfactory result was attained. Word-sequence translations were generally executed intermittently during the writing process, whenever the students needed them to communicate the desired content.

On rare occasions, screen recordings revealed a linear writing process where idea generation and writing were performed almost exclusively sequence by sequence, directly in the GT search bar. This can be seen in the writing by *Amanda*, especially in her fourth essay (see Table 3). Adopting such an approach did not mean that the students were satisfied with the first outcome shown in the search result box (frequent changes were made to the search strings before accepting a search result) but, instead, that some students did not bother to write primarily in a Word document. The text document, in these cases, can perhaps be seen more as a canvas onto which the accepted search results were transcribed, and the GT search bar as a kind of scribbling paper to be discarded later on.

Table 3 shows two consecutive word-sequence searches that were accepted and inserted into the text without changes.

Table 3. Word-sequence translations accepted without further re-elaboration. Amanda: 4

Time mark	GT search	GT result
21'47"		'The wolf was a very bad wolf'
	Copies and pastes the translation into the text.	
22'12"		'And when I went away'
	Manually transcribes the translation in the text and continues the phrase with her own words.	

5.6. *Re-elaborations of single-word and word-sequence translations*

Every student resorted to trial-and-error-based search strategies, re-elaborating search strings by changing, adding, or deleting words until they were satisfied with a word or a longer sequence. Re-elaborations were observed in 45% of all GT searches, often combined with word-sequence translations or control translations. The intermediate steps were often contextually or syntactically incomplete in ways that rendered the translations more difficult and less accurate, depending, for instance, on missing subject pronouns or auxiliary verbs missing the main verbs. Re-elaboration was a strategy very frequently employed by many participants; only two students used it sparingly. Many re-elaborations led to search strategies also identified by Knospe et al. (2019), who described them as "long-lasting, complicated, and in many cases ineffective" (p. 271), which was also true for many of the re-elaborative searches observed in this study.

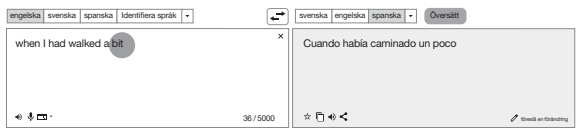
Re-elaborative strategies can be divided into sub-categories according to the changes made in the search string: stepwise re-elab-

orations, use of synonyms and circumlocutions, changes in spelling and punctuation, and morphosyntactic changes. Examples of these re-elaborative search strategies are given below.

5.6.1. Stepwise re-elaborations

Table 4 shows an example of a common strategy combining stepwise additions (or deletions) of words and rewriting of parts of the search string.

TABLE 4. Stepwise elaboration of a sequence. Amanda: 4

TIME MARK	GT SEARCH	GT RESULT
10′29″		'When I had walked'
10′32″		'When I had walked a little'
10′37″		'When I had walked a little in the forest'
	Copies and pastes entire phrase into text.	

Reformulations like the one shown above were also used by two students (*Bella* and *Anna*) who changed the order of words in the GT search box, from subject-verb to verb-subject — a strategy that produced no changes in the outcome.

5.6.2. Synonyms and circumlocutions

When the first attempt did not yield a satisfactory translation, many students used GT to try out circumlocutory expressions, synonyms, and words from the same semantic field. They used it mainly for nouns, adjectives, and verbs. Circumlocutions were mentioned by Knospe et al. (2019) as a way for (competent) writers to resolve issues. The screen recordings in our study further underscored the need for a good grasp of the target language for this strategy to be successful.

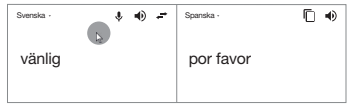
Table 5 shows an excerpt from the third essay written by *Beata*. She used synonyms as one of her main strategies. This is also an example of the frequent trial-and-error approaches. The excerpt also shows how GT, translating from Swedish via English to Spanish, mistakes the Swedish adjective *snäll* 'kind' for the English noun *(a) kind*.

TABLE 5. Trying out synonyms. Beata: 3

TIME MARK	GT SEARCH	GT RESULT
	She had searched *Santa Claus*, arrived at *Papá Noel* 'Father Christmas', and written *En navidad Papá Noel es muy* 'At christmas Santa Claus is very' in her text.	
12'22"		
	'kind' [adj.]	'kind' [noun]
12'32"		
	'sympathetic'	'sympathetic'

(continued)

Table 5. Trying out synonyms. Beata: 3

Time mark	GT search	GT result
12'37"		
	'nice'	'nice'
	Switches to the Word document, writes nothing, then goes back to GT.	
12'45"		
	'friendly'	'please'
12'49"		
	'kind' [adj.]	'kind' [noun]
12'53"		
	'nice'	'nice'
13'06"		
	'kind' [adj.]	'kind' [noun]
13'12"		
	'Santa Claus is kind'	'Santa Claus is a kind'
	Switches to the Word document. At 13'34" she adds *especie* to the text, switching back to GT twice to check the spelling.	

5.6.3. Changing spelling or punctuation

GT can sometimes translate misspelled words without asking the user to first choose the correct spelling (cf. Ducar & Schocket, 2018), something that occurred a few times in the screen recordings. On other occasions, students changed the spelling following a suggestion from GT (Table 6) or after having identified spelling mistakes by themselves.

TABLE 6. Changing spelling. Aurora: 4

TIME MARK	GT SEARCH	GT RESULT
23′24″		
	'terrified' [misspelt]	* 'försckräkt'
	Clicks on the GT suggestion for spelling correction.	
23′25″		
	'terrified'	
	Uses the result to continue with translation of a paragraph from English to Spanish.	

Changes of spelling also included trying out the use or omission of accents and other diacritics. When diacritics were omitted, misplaced, or incorrectly written, this resulted in translations that were incomprehensible, and the omission of English genitive apostrophes rendered translations with plural forms, creating somewhat confusing search results.

A few students tried adding punctuation (full stops, question or exclamation marks) to their searches, and this sometimes altered the translations, albeit in unclear and unsystematic ways that were probably difficult for the students to understand or evaluate. Giannetti (2016: 75) emphasized that "proper punctuation" is es-

sential for producing a good search result in GT, but the effects of adding punctuation were inconclusive in the material used in our study. This strategy can be seen in the final step of the writing process of *Aurora*, shown in Table 9.

5.6.4. Morphosyntactic changes

A strategy frequently used to find the correct translation consisted in making small morphosyntactic changes to word forms. The strategy was used in different ways for verbs, nouns, pronouns, adjectives, and even prepositions in a few cases where alternative forms are available in Swedish, such as *från* and *ifrån* (both meaning 'from'). The changes sometimes also involved a change of word class, for instance from noun to adjective. Morphosyntactic changes of nouns included re-elaborations from singular to plural or vice versa, changing noun definiteness, or changing the noun gender by using different articles. In the example shown in Table 7, *Beata* tried out different determinate articles, probably to ascertain the gender of the Spanish noun *Navidad* 'Christmas'.

TABLE 7. Trying out different genders. Beata: 3

TIME MARK	GT SEARCH	GT RESULT
23'53"	Spanska · el navidad	Svenska · jul
	*'the christmas' [incorrect masc. article]	'Christmas'
23'58"	Spanska · la navidad	Svenska · jul
	'the christmas' [correct fem. art.]	'Christmas'

Strategies like these often failed, as search strings in the determinate form sometimes yielded anarthrous translations, thus not guiding the students to the correct article or gender. In cases like these, a printed dictionary would solve the problem more easily, provided the student knows how to use it.

Spanish verbs are difficult to master due to their rich morphology, and it is not surprising that the students used GT to search for verb forms. These frequent trial-and-error approaches included adding or subtracting the sign of the Swedish infinitive *att* 'to', trying out different verb endings (either real or invented), and translating both diphthongised and monophthongised versions of verb stems (sometimes creating new forms that do not exist in standard Spanish). Table 8 shows an example of these complex search strategies. The excerpt is from the second essay of *Betty*, where she tried out different endings for the past tense of *aprender* 'to learn'. As the previous sentences in her essay were written in first person singular, she probably searched for "I learned".

TABLE 8. Trying out different verb endings. Betty: 2

TIME MARK	GT SEARCH	GT RESULT
9'10"	aprené 6 / 5000	jag aprené *'aprené'	'I *aprené'
9'17"	aprendéis aprendéis 7 / 5000	Lär dig hur *'aprendé'	'Learn how to' [imperative]
9'29"	aprendó 7 / 5000	du lär *'aprendó'	'you learn' [2nd p. sg.]

(continued)

Table 8. Trying out different verb endings. Betty: 2

Time mark	GT search	GT result
9'37"		
	'learned' [3rd p. sg. pret.]	'he learned'
	Adds *Aprende muchos* 'He / she learns many' to the text.	

In this case, GT did not help and, in the end, *Betty* failed to find the correct form and opted for the present tense, third person singular. A strategy like this undoubtedly requires a good basic knowledge of the Spanish verb system for the learner to be able to recognize the correct form. As found also by Fredholm (2015a), students sometimes not only did not recognize correct / incorrect verb forms, but also seemed to hesitate when confronted with search results that could not possibly constitute a verb. An example is when *Barbara*, in her fourth essay, searched for a Spanish translation of the Swedish verb form *bad* 'prayed' or 'asked [for]' (preterit tense of *be*) and GT showed a translation of the homograph *bad* '[a] bath', *natación*.

Finding and correctly understanding Spanish pronouns seemed to be challenging for many students, who mixed personal and possessive pronouns without recognizing their different forms or functions. Also, morphological changes were made to pronouns as a strategy to find the correct form. When enclitic object pronouns such as *lo* and *la* (= 'him', 'her', 'it') appeared in search results, they seemed to confound students, who tried back-translations of these words to ascertain their meaning, often with incorrect or incomplete results.

The informal second person plural pronouns *du* 'you' and *din / dina* 'your' caused many problems as they were frequently translated with the formal Spanish third person singular *usted* 'you' (sg.) and the polysemous *su / sus* 'your', 'his', 'her', 'their'.

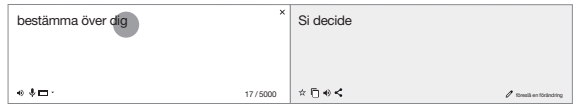
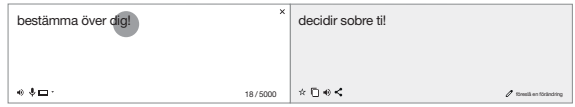
Ducar and Schocket (2018) discussed how context-driven levels of formality are rendered differently in GT searches from English to Spanish or French, stating that GT uses the informal second person singular in Spanish translations of the English *you*, but the formal second person plural in translations to French. In the 3995 GT searches analyzed in our study, GT did render the English *you* (both as subject and object) and *your*, as the Spanish informal *tú*, *te*, *tu* and *tus* in most cases, but exceptions were also found, especially concerning the possessive pronouns. When the Swedish *du* was used, the search results were highly inconsistent, repeatedly showing translations with alternating second person singular and third person singular verbal endings within a few seconds after each other. The excerpt shown in Table 9 gives a typical example of confusing pronoun search results when *Beata* looked for the correct translation of *dig* 'you' (2nd p. sg. dir. obj.). The final screen outcome shows how she added punctuation to change the translation.

TABLE 9. Changing pronouns. Beata: 1

TIME MARK	GT SEARCH	GT RESULT
30'47"	ingen ska bestämma över dig 27 / 5000	nadie debe decidir sobre ti föreslå en förändring
	'no-one must decide for you'	'no-one must decide about you'
	Writes *pienso que de nadie debe decidir sobre* in the text, looking four times at the search result.	
31'35"	dig 3 / 5000	usted föreslå en förändring
	'you' [2nd p. sg. obj.]	'you' [3rd p. sg. subj.]
31'39"	du 3 / 5000	usted föreslå en förändring
	'you' [2nd p. sg. subj.]	'you' [3rd p. sg. subj.]

(continued)

Table 9. Changing pronouns. Beata: 1

Time mark	GT search	GT result
31′43″		
	'you' [2nd p. sg. obj.]	'you' [3rd p. sg. subj.]
31′49″		
	'decide for you'	'If [3rd p. sg.] decide(s)'
31′53″		
	'decide for you!'	'[to] decide about you!'
	Adds *ti!* 'you!' to the text.	

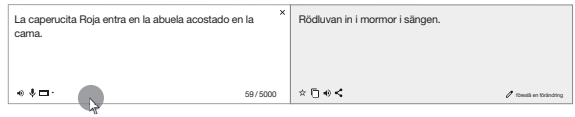
5.7. Control translations

Control translations used to double-check the accuracy of single words and word sequences accounted for 11% of all GT search actions. Students performed back-translations to Swedish and/or English as a means to control a GT search result, a strategy also observed by Knospe et al. (2019). A similar use was also found to be frequent in the study by Farzi (2016). Control translations were mainly performed in proximity to the initial search, sometimes resulting in a student repeatedly switching back and forth between translations, using two or three languages. Double-checking also occurred, but more rarely, with parts of texts previously written, as a part of text revision. As also observed by Fredholm (2015a), students were apparently aware of the occurrence of mistaken GT results and tried to avoid them as best as they could.

Control translations frequently concerned not only GT search results, but also Spanish words and sequences that the students had written with no help from GT. This might indicate insecurity on the part of the students regarding their own proficiency of the vocabulary, spelling, or grammar. A less pessimistic interpretation is that the strategy may reveal an interest and a will to ascertain the accuracy of word choice or grammatical form; nevertheless, it seems to be indicative of the lack of confidence of the students in their own command of the language.

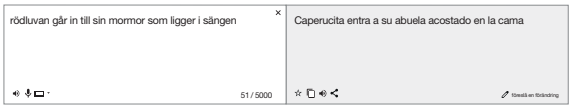
Table 10 shows an example of control translations and re-elaborations of a sequence.

TABLE 10. Control translations. Augusta: 4

TIME MARK	GT SEARCH	GT RESULT
32'55"		
	'goes in to [paternal] grandmother who is lying in the bed'	'[to] go to the grandmother lying in bed' [wrong agreement of perf. part. "acostado"]
	Deletes *y* 'and', adds *en la abuela acostado en la cama.* 'in the grandmother lying in bed', looking at GT three times. Copies the phrase and pastes it in the GT search box.	
33'43"		
	'Red riding hood enters in the grandmother lying in bed.' [wrong perf. part. agreement]	'Red Riding Hood in inside grandmother in the bed.'
	Copies *La caperucita Roja* from text, pastes in GT search box.	
34'03"		
	'Red riding hood enters'	'Red Riding Hood in'

(continued)

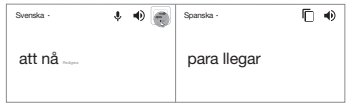
Table 10. Control translations. Augusta: 4

Time mark	GT search	GT result
34′30″		
	'red riding hood goes in to her [maternal] grandmother who lies in the bed'	'Red Riding Hood enters to her grandmother lying in the bed' [wrong perf. part. agreement]
	Changes *en la abuela* 'in the grandmother' to *a su abuela* 'to her grandmother' in the text.	
34′57″		
	'Red Riding Hood enters to her grandmother lying in the bed' [wrong perf. part. agreement]	'Riding Hood in [adv.] her [paternal] grandmother in the bed'
	Makes no further changes.	

In addition to control translations of words and sequences, students also used other functions provided by the GT interface to control their searches. The availability of these supplementary affordances depends on the language pairs used in the searches. The students used instant direction switches between languages, highlighting of translated words, and suggestions from GT. Three students executed control translations very swiftly and efficiently by clicking on the double arrow icon in the GT search interface, which affords the user the possibility to instantly change the direction of the translation. Sometimes, this was used simply to change the direction between separate searches. On other occasions, the function was used repeatedly during series of searches to double-check translations, sometimes involving three languages, and comprising different kinds of re-elaborations, again mixing several strategies at once. Medvedev (2016) talked of the language switching affordances as a way to check "what is lost in translation" (p. 188). The strategy,

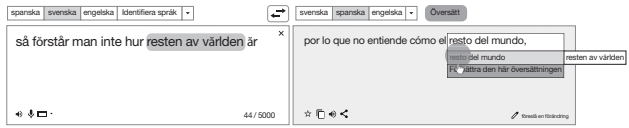
however, often led to new errors and confusions, such as those in Table 11, adding to the elements that were lost in translation, rather than clarifying them.

Table 11. Switching direction. Anita: 4

Time mark	GT search	GT result
6′33″		‘to reach’ ‘in order to get [to]’
6′34″		‘in order to get [to]’ ‘road direction’

Six pupils used the possibility to highlight translated words to see the corresponding words in the original search string, as can be seen in the examples in Table 12. This sometimes also enabled the pupils to consult alternative phrasings in pop-up lists.

Table 12. Highlighting words. Anna: 3

Time mark	GT search	GT result
28′52″		‘then you don’t understand what the rest of the world is like’ ‘why [3rd p. sg.] does not understand how the rest of the world’

(continued)

Table 12. Highlighting words. Anna: 3

Time mark	GT search	GT result
29'17"		
	'then you don't understand what the real world is like'	'why [3rd p. sg.] does not understand how the real world is'
	Copies the translated phrase into the text.	

Suggestions made by GT were used by 14 of the 16 students, some of them frequently. These suggestions appeared below the search bar as *Menade du:* 'Did you mean:' followed by a suggestion for an alternative spelling or phrasing. Suggestions also appeared directly in the search bar as words were written and could be clicked on to be inserted directly without writing the entire word. Common misspellings were automatically corrected by GT, indicated as *Visar översättning av:* 'Shows translation of:'. These functions sometimes helped students correct some mistakes, but suggestions were also accepted even when changing the meaning originally intended by the students, which raises questions about who really controls what is being written (cf. Knospe et al., 2019).

In addition to the GT affordances mentioned above, clarifying word definitions sometimes appeared onscreen below the search bar (after searches from English to Spanish), but were apparently not consulted by the students, judging from the position of the mouse cursor and the short time the students watched the screen before switching to the Word document.

6. Discussion

The previous section of this article showed highly varied GT search strategies, ranging from simple dictionary-like searches for single

words to complex, trilingual, stepwise morphosyntactic searches for short sequences, phrases, and entire sentences, using several of the functions of the GT interface.

Naturally, our findings from a group of 16 participants cannot be generalized to every foreign language learner, but the observations in this study, combined with the earlier findings of Knospe et al. (2019) and Fredholm (2015a), contribute to clarifying that the GT search strategies employed by foreign language learners may be highly varied and complex. Some of the behaviors observed are also consistent with those reported by Lantz-Andersson, Linderoth & Säljö (2009) when studying the use of autocorrecting exercises in mathematics; these findings further underline that trial-and-error approaches and the transfer of personal reasoning to the machine may be indicative of the interaction of students with digital resources and is not restricted to the use of GT. The affordances of the GT interface enable and invite the user to adopt stepwise, trial-and-error-based search and writing approaches, a fact that probably deserves greater consideration when discussing digital writing strategies in the current L2/L3 learning context (cf. Hyland, 2016).

The search strategies were, to a great extent, characterized by trial-and-error approaches, combined in various ways and ranging from changes of minor details such as spelling and punctuation, to more complex aspects concerning sentence structure and morphology. Overall, GT searches were regularly used to facilitate the writing of larger chunks of words, rather than to fill in single lacunae where pieces of vocabulary were missing, and the searches often encompassed both lexical and morphosyntactic aspects of the language (consistent with the view of grammar and vocabulary as two parts of the same lexicogrammatical continuum, Halliday, 2004: 24; cf. Sinclair, 2004). This complexity is worth emphasizing, as the almost effortless GT searches may seem deceptively simple for teachers and learners alike. Our study shows that one single series of GT searches may contain a large variety of linguistic information, some of it with a complexity level that the writer may not be

able to comprehend. Lexical information may be mixed with morphology and syntax to a point far beyond the grasp of a language learner, resulting in confusion and exasperation.[2]

What can this tell us about the possible implications for foreign language teaching? The frequent mixing of morphosyntactic and lexical searches seems to indicate a need among students to work with foreign language writing skills on a general level rather than with single words that may or may not be missing from their active vocabulary. Participants often did not search *either* for a word *or* for a grammatical form; instead, they used GT to search for words in inflected forms and in strands of syntactically complex contexts, to help them string their texts together. This complex weave of search strategies might stem primarily from an insufficient sentence-building proficiency, but it is also likely that the students simply perceived it as a more convenient way of writing, as opposed to thinking up the linguistic content of the texts by themselves. This approach does lead to morphosyntactic and lexical errors and inconsistencies, but so too does writing in a foreign language with a printed dictionary or without any help at all (cf. Fredholm, 2015b).

The key point is, then, not that errors are produced in GT searches and accepted by the students; GT is being continuously improved and the errors of today may be corrected tomorrow (albeit new errors can arise as the technology develops; cf. Ducar & Schocket, 2018; Aiken & Balan, 2011). A far more important insight, especially for foreign language teachers, is the lack of linguistic self-esteem that appeared in many of the screen recordings. In some studies, the use of FOMT by language learners is dismissed as a sign of laziness (cf. Garcia & Pena, 2011; Larson-Guenette, 2013). However, our screen recordings revealed significant efforts

[2] A case of exasperation was indeed seen in the first essay written by *Benedict*, where a series of inconsistent search results eventually made him write *AAAH jväla goggle* 'AAAH bloody goggle' in the search box (only to have it translated as *AAAH muy bueno* 'AAAH very good'!).

made by students to solve lexical and morphosyntactic issues, sometimes going to great lengths to revise searches before accepting a result. This speaks, it may be argued, less of laziness than of a lack of necessary linguistic resources, or a lack of trust in their own knowledge of the language. The most important finding of our study, from the perspective of foreign language teaching and learning, may well be that the participating students frequently did not trust their own knowledge of the Spanish language enough to refrain from searching for even very basic vocabulary in GT, or enough to critically question the results of GT searches that did not match their own language instincts.

Why did many of the students lack confidence in their own knowledge of the language? Is it a consequence of a desire to perform well in a writing task, leading to the double- or triple-checking of words, just to be on the safe side? Is it that the students really lack the ability to write better even after more than five years of Spanish studies? Or do we fail, as language teachers, to inculcate in them the sense of linguistic self-confidence needed to communicate without unnecessary hesitation? The answer may be a combination of all three hypotheses, and can, of course, vary from student to student.

That said, the fact that the students frequently mistrusted GT search results and tried to amend them by various re-elaborations of the search terms may indeed be interpreted as signs of language awareness. If correct, this view counters the observations above on the lack of language proficiency of the students. However, noticing that after a series of re-elaborations, students often accepted search results that were either incorrect or contextually inadequate, it is perhaps more reasonable to say that, for many, the main issue was insufficient proficiency in Spanish and/or insufficient trust in their own knowledge of the language. Strengthening the awareness of foreign language learners of — and trust in — their own knowledge thus appears as a key goal to achieve for foreign language teachers in the digitalized language classrooms of today.

Finally, if a rather more philosophical approach to the subject may be allowed, one might stop for a moment to ponder what the likely effects of free access to GT could be; not its effects on lexical variation, syntactic complexity, grammatical accuracy, text length, or other fairly easily measured aspects (and for which some answers already exist, e.g., O'Neill, 2012, 2016, and Fredholm, 2014, 2015b, 2019), but rather its likely effects on the psyche of the writer. What does knowing that there is continuous and easy access to — in theory — all the words on the World Wide Web do to an inexperienced writer in a foreign language? How does the possibility of checking everything you write or want to write, over and over again, with just a few clicks on a screen right there in front of our eyes, affect your writing behavior? If you are aware that you *can* look something up, and you feel a little insecure, then are you not tempted to do so, just in case? These questions are not answered here, but are worth exploring in further studies, where perspectives from language teaching, applied linguistics, and cognitive research fields, for instance within ecological psychology, could improve our understanding of the experiences of the machine-translating foreign language writer.

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