Patterns of reading assistance for software users with varying reading skills

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Current user interfaces present many different features that assist users in reading and comprehending texts in digital format. Although internal factors, such as visual impairment and dyslexia, can impose serious reading difficulties for technology users, we focus on the interface solutions designed to alleviate external factors, such as text complexity and low literacy. In this paper, we analyze popular software systems identifying five user interface design patterns developed to help users understand texts in situations involving text difficulty, unbalanced bilingualism, and low literacy. By providing this incipient pattern collection, we expect to enable interaction designers and accessibility researchers to achieve a better understanding of the topic and possibly propose improvements for the current solutions.

CCS Concepts: • **Human-centered computing** → **Accessibility design and evaluation methods**; **User interface design**.

Additional Key Words and Phrases: user interface, patterns, reading, accessibility

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1 INTRODUCTION

In the context of human-computer interaction (HCI) design, the purpose of accessibility is to provide equal access for all (or the majority of) computer users, with special consideration for people with disabilities and/or additional needs [6]. Concerning reading tasks, many factors might prevent users from visualizing and/or fully comprehending digital texts [16]. Situations involving internal factors, such as visual impairment, intellectual disabilities, or dyslexia, are among the most studied cases within the accessibility research community. In this paper, however, we focus on solutions designed to overcome difficulties imposed by external or environmental factors, such as text complexity and poor education.

This study stems from the observation, in current systems, of user interface patterns that assist users in fully comprehending written texts. For example, most e-book reader applications allow the user to perform dictionary lookup or automatic translation while reading a book. In particular, we believe this type of help can be useful in contexts of technical reading, unbalanced bilingualism, and low literacy (see Section 2.2). These patterns were discovered amid the development of a larger pattern language on the interaction design for multilingual users [5].

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After analyzing current websites and software applications, we identified five user interface design patterns that assist in reading. The main objective of this paper is to describe these five patterns in a clear and structured way. Since we did not find any other academic work or pattern library describing these specific patterns, we hope this collection can help the HCI and accessibility communities to further explore and study the topic. In the future, these patterns can be the starting point for a pattern language, and at least some of them might also be included in our language in the design for multilingualism.

This paper consists of six sections, including this introduction. Section 2 presents background on reading difficulty studies and some scenarios that illustrate our pattern collection. The patterns are presented in Section 3, and Section 4 summarizes the methods used in the discovery process. Discussing the relations between the patterns, the accessibility guidelines, and the proposed scenarios is the goal in Section 5. Finally, Section 6 presents final considerations and future work.

2 BACKGROUND AND SCENARIOS OF READING DIFFICULTY

Reading comprehension is a complex task that involves several variables [12]. Over the years, many aspects of literacy acquisition and reading difficulty have been addressed by researchers in the areas of cognitive psychology, linguistics, and education. The factors that may cause reading difficulty are generally categorized into internal (involving mostly physical, cognitive, and emotional conditions of the individual), and external factors (involving the social and environmental aspects of reading and literacy acquisition) [11, 15]. The solutions described by the patterns in this paper are more focused on helping the target users to overcome external factors, such as text difficulty and low literacy, even though we think they might also be helpful, in specific situations, to users with physical or psychological conditions that prevent reading comprehension. We recognize and equally value all research efforts that target individual factors (such as visual impairment, intellectual disabilities, dyslexia, etc.). However, such factors are considered beyond the scope of this particular work.

Regarding human-computer interaction, many studies have been conducted on the topic of reading assistance. A notable effort is the WWW Consortium (W3C) initiative Web Content Accessibility Guidelines (WCAG), which, among other recommendations, sets the standards for text accessibility on the Web [10, 17]. Other studies in the fields of applied and computational linguistics approach the identification and simplification of difficult texts [2, 8, 14]. Language diversity, multilingualism, and the design for under-represented populations are frequent topics among researchers of human-computer interaction for development (HCI4D) [7, 9]. Finally, some studies propose approaches and tools specifically targeted at low-literacy users [3, 19]. In the next two sections, we present in more detail the WCAG guidelines for text readability (Section 2.1) and propose three scenarios based on the previously mentioned related works (Section 2.2).

2.1 WCAG guidelines for text content readability

WCAG 2.1 is the current version of the W3C Web Content Accessibility Guidelines[1]. The recommendations in the document define how to make web content more accessible to people with disabilities, besides often improving the usability for general users. WCAG 2.1 is organized in so-called layers of guidance, including overall *principles*, general *guidelines*, and testable *success criteria* [10]. The four basic principles provide the foundation for Web accessibility and

[1] W3C is currently preparing an update of WCAG, namely WCAG version 3.0 (public working draft published in January 2021).

are named *perceivable*, *operable*, *understandable*, and *robust*. In this study, we are particularly interested in the readability guidelines, which fall under the third principle *understandable*.

Table 1. WCAG guideline 3.1 (Readable) and corresponding success criteria.

Success Criterion	Description	Level
3.1.1 Language of Page	The default human language of each Web page can be programmatically determined.	A
3.1.2 Language of Parts	The human language of each passage or phrase in the content can be programmatically determined (...).	AA
3.1.3 Unusual Words	A mechanism is available for identifying specific definitions of words or phrases used in an unusual or restricted way, including idioms and jargon.	AAA
3.1.4 Abbreviations	A mechanism for identifying the expanded form or meaning of abbreviations is available.	AAA
3.1.5 Reading Level	When text requires reading ability more advanced than the lower secondary education level after removal of proper names and titles, supplemental content, or a version that does not require reading ability more advanced than the lower secondary education level, is available.	AAA
3.1.6 Pronunciation	A mechanism is available for identifying specific pronunciation of words where meaning of the words, in context, is ambiguous without knowing the pronunciation.	AAA

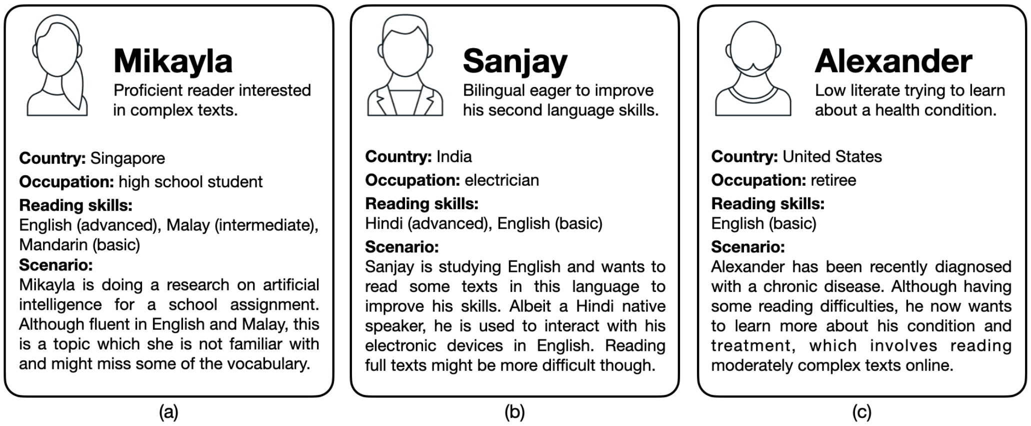
Guideline *3.1* defines criteria to make text content readable and understandable. Table 1 shows this guideline's list of success criteria as presented in WCAG version 2.1. The third column displays the conformance level for each criterion, roughly meaning the amount of effort necessary for content creators to abide by the requirement. Criteria *3.1.1* and *3.1.2* are crucial for user agents such as screen readers, which require knowledge of the text language to provide better pronunciation. Criteria *3.1.3*, *3.1.4*, *3.1.5*, and *3.1.6* define a series of mechanisms or features aimed at improving the readability and comprehensibility of text content. In Section 5, we discuss how these six criteria relate to the proposed patterns.

2.2 Scenarios of reading difficulty

The patterns described in this paper were discovered from current software systems and aim to improve text content's readability and comprehensibility in user interfaces. The target audience for the pattern collection is comprised of interaction designers and HCI specialists developing new user interfaces or innovative research on the topic. Even though improved readability is a welcome feature in most situations and can potentially benefit a wide range of technology users, in this section, we highlight three particular cases of reading difficulty in interaction design, each of them illustrated by a persona and corresponding scenario (see Fig. 1):

- **Text difficulty:** readers usually find it more difficult to comprehend texts that contain a high number of low-frequency words (i.e., high lexical complexity). This is the case of technical texts and texts written in cultured language. For instance, Jun Zhang and Bin Anual conducted a study with 37 Singaporean secondary school students, detecting that vocabulary difficulty affected their text comprehension performance [8]. The study occurred in the multicultural context of Singapore: all students used English as the main language at school, even though most of them had acquired it as a second language. To represent the population of this study, we propose the persona of Mikayla: a Singaporean student who might lack some of the vocabulary necessary to fully understand a complex technical text (see Fig. 1-a).

- **Unbalanced bilingualism:** asymmetrical or unbalanced bilingualism is a frequent form of bilingualism in which individuals present different proficiency levels in their two languages. This is a common case in developing countries, where people tend to use a colonial language in formal settings while speaking indigenous or minority languages at home. A study by Karusala et al. of 20 smartphone users from rural, suburban, and urban areas of India showed that many participants preferred to use English on their mobile phones even if they had only basic skills in that language [9]. Among the motivations for that preference was the aspiration for social mobility and the wish to improve their proficiency in English. The population of this study is represented by a persona called Sanjay: a native Hindi speaker willing to improve his English skills through the use of technology (see Fig. 1-b).
- **Low literacy:** individuals with difficulty in basic reading and writing tasks are said to be low-literate. A considerable amount of research on low literacy can be found in the literature, especially investigating its correlation with poor health outcomes. For example, Chaudry et al. conducted a study of 17 North American patients with Chronic Kidney Disease, all of which read below 9th grade[2] [3]. The authors highlight that 43% of the United States population were considered functionally illiterate at the time of the study[3] Using non-text-based prototypes, the researchers identified the best user interface widgets and forms of navigation for this public. To represent the population of this study, we propose a persona called Alexander: a low-literate retiree who has been recently diagnosed with a chronic disease and wants to learn more about his condition by reading texts online (see Fig. 1-c).



Mikayla
Proficient reader interested in complex texts.

Country: Singapore
Occupation: high school student
Reading skills:
English (advanced), Malay (intermediate), Mandarin (basic)
Scenario:
Mikayla is doing a research on artificial intelligence for a school assignment. Although fluent in English and Malay, this is a topic which she is not familiar with and might miss some of the vocabulary.

(a)

Sanjay
Bilingual eager to improve his second language skills.

Country: India
Occupation: electrician
Reading skills:
Hindi (advanced), English (basic)
Scenario:
Sanjay is studying English and wants to read some texts in this language to improve his skills. Albeit a Hindi native speaker, he is used to interact with his electronic devices in English. Reading full texts might be more difficult though.

(b)

Alexander
Low literate trying to learn about a health condition.

Country: United States
Occupation: retiree
Reading skills:
English (basic)
Scenario:
Alexander has been recently diagnosed with a chronic disease. Although having some reading difficulties, he now wants to learn more about his condition and treatment, which involves reading moderately complex texts online.

(c)

Fig. 1. Three personas and three scenarios illustrate situations of reading difficulty in which the patterns can be useful.

Based on the aforementioned related works, we propose the three loosely defined personas/scenarios depicted in Fig. 1 to illustrate typical cases in which the proposed patterns might be useful. Even though we think these scenarios are representative and can be useful to illustrate the patterns in this paper, we understand that they are not the only situations in which reading difficulty occurs in human-computer interaction.

[2] In the Chaudry et al. study, the literacy level of the participants was evaluated using the Rapid Estimate of Adult Literacy in Medicine (REALM) test [3].

[3] For updated information on literacy in the United States, refer to the U.S. Department of Education - National Center for Education Statistics website: https://nces.ed.gov/. More specifically, the *Highlights of PIAAC 2017 U.S. Results* report a summary of the most current results at the time [18].

3 THE PATTERNS

A total of five patterns for reading assistance have been identified, depicted in Fig. 2. SELECTION LOOKUP is a more general pattern that describes users selecting texts in a software interface and looking up additional information about the terms. DICTIONARY LOOKUP, TEXT SNIPPET TRANSLATION, EXPRESSION WEB SEARCH, and LISTENING ON DEMAND are particular types of SELECTION LOOKUP in which the user asks for a dictionary lookup, an automatic translation, a web search, or a read aloud (text-to-speech) of the selected text respectively.

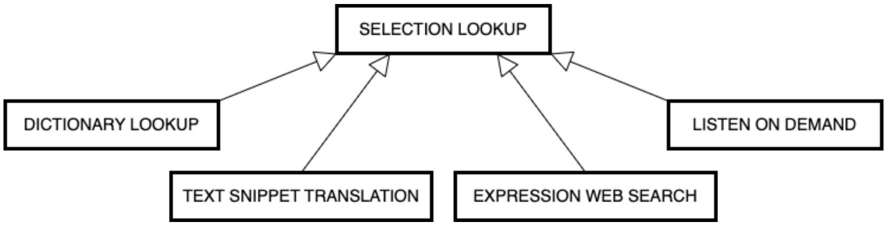


Fig. 2. Patterns of reading assistance.

3.1 Pattern: SELECTION LOOKUP

3.1.1 Context. A software interface presenting selectable text content on screen for users who may have difficulty understanding it.

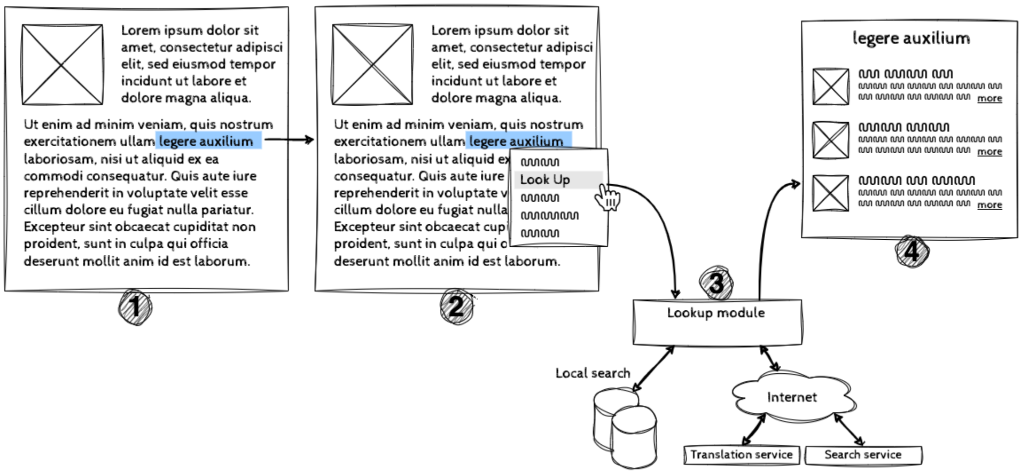
3.1.2 Problem. How can users obtain information on certain pieces of text which they lack knowledge or want to learn more about without disrupting their reading experience?

3.1.3 Forces.

- **Task efficiency:** the task of indicating the desired piece of text and obtaining information about it should be fast and easy not to disrupt the user's experience.
- **Different types of reading difficulty:** depending on the user's background and reading ability, certain types of additional information can be more relevant. For example, a dictionary lookup could be useful for someone reading a complex text (Mikayla), but could also be useless for a low-literate (Alexander), who might prefer a read aloud instead.
- **Different types of concepts:** depending on the characteristics of the text that the user selected, certain types of additional information can be more relevant to the user. For example, a single word is a good candidate for a dictionary lookup; a proper name produces better results if searched on Wikipedia; and a complex phrase/expression is better suited for translation or web search.
- **Privacy:** sending a snippet of confidential text to an external server is usually undesirable or even forbidden for some users.
- **Project budget and complexity:** the designer may not have budget for additional services or do not want to increase the complexity of the application.

3.1.4 Solution. **Allow the user to select a piece of text from the user interface and request more information about it.** The design must minimize the steps needed to select the text and look up additional information. Usually, performing a SELECTION LOOKUP is not the main intended task of the user but a secondary action aiming to clarify the meaning of a text on the screen. The system or application should give options for the user to reach the most appropriate search engines according to the context of the situation. Because this feature is useful in a wide range of software applications, it is sometimes implemented in the OS or user-agent level.

Different types of lookup can be offered to the user: DICTIONARY LOOKUP, TEXT SNIPPET TRANSLATION, EXPRESSION WEB SEARCH, and LISTENING ON DEMAND are the most common and are discussed in more detail in the subsequent sections. Other types include thesaurus lookup, encyclopedia search, e-commerce search, artificial intelligence (AI) powered search, etc. For some of these types, the search results are directly obtained from a data source (e.g., dictionary and web search). Other types will require some sort of information processing to produce the final result (e.g., translation, text-to-speech, and AI-powered search). The basic steps to perform a SELECTION LOOKUP are (summarized in Fig. 3):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1
Look Up
2
legere auxilium
more
more
more
4
3
Lookup module
Local search
Internet
Translation service
Search service

Fig. 3. A diagram for the SELECTION LOOKUP pattern.

1. **Text selection:** different hardware and software platforms can offer different types of text selection. Text selection with a mouse or keyboard is familiar to most (if not all) desktop/laptop users. A long press over a word is sufficient for selection in some touchscreen-based systems. For Wikipedia articles, a simple mouse hover on a hyperlink is enough for a summary of the corresponding article to be displayed.
2. **Lookup activation:** in the moment of the lookup activation, the system should offer the user all types of searches available. Different contexts require different information for text comprehension. Besides individual options for the main types of searches, the system may also offer a generic lookup feature in which a set of recommended search results are automatically generated and displayed to the user.
3. **Search execution:** according to the control activated by the user, the system will perform the correspondent search and information processing. Most searches are performed on the Web, therefore requiring an internet connection. Nevertheless, many systems support the previous download of dictionaries and voices, allowing DICTIONARY LOOKUP and LISTENING ON DEMAND to be performed faster and without the need of an active connection.
4. **Results presentation:** depending on the chosen lookup, results may be displayed in a panel or dialog inside the application itself or in a separate website/application. Typically, dictionary definitions are displayed in small panels/dialogues inside the application. On the contrary, web searches will trigger the opening of a

web browser tab to display the query results. Presenting the results in internal widgets is preferred whenever possible because it helps to keep the user's attention on the primary task. It is common that applications display summarized results and then offer the option for the user to visualize a more complete version of the definition. The speech resulting from LISTENING ON DEMAND is a special type of result that is presented in the form of sound instead of visually, although in some cases basic audio controls may appear on the screen for the user to control the reading.

3.1.5 Consequences. Upon applying this pattern:
Benefits:

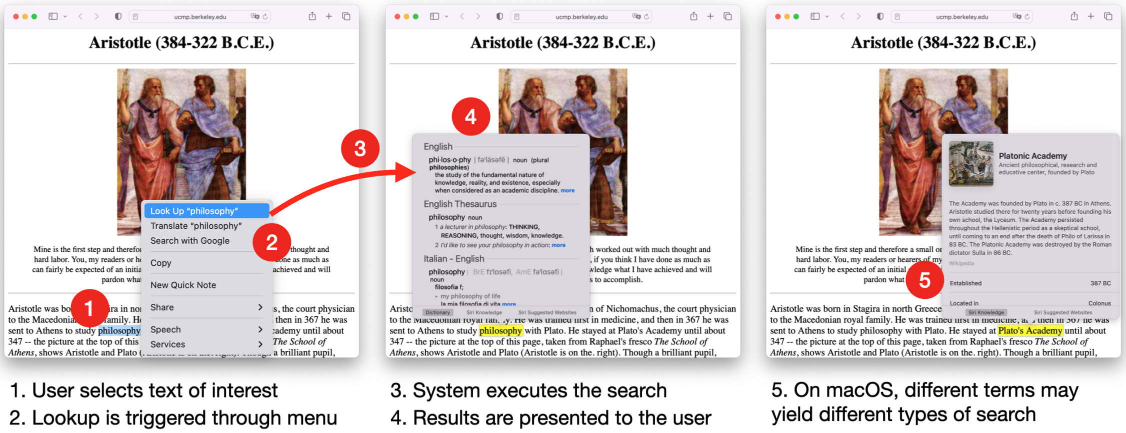
- By quickly selecting texts and triggering lookups within the application, users can have reading assistance while keeping their **task efficiency**.
- Offering different types of searches increases the possibility that users with **different types of reading difficulty** will achieve a better comprehension of **different types of concepts**.
- If this pattern is implemented by the operating system or by the web browser, design teams do not need to implement it from scratch, reducing chances of impacting the **project budget and complexity**.

Liabilities:

- Because most of this pattern solution is still based on text, users with **specific types of reading difficulty**, such as low literacy, might not be fully benefited. In these cases, LISTENING ON DEMAND could be more appropriate.
- Due to business decisions, some applications may not rely totally on the operating system implementation. The company responsible for the OS usually chooses search engines that are of their economic interest (e.g., macOS showing results from iTunes and App Store), which might not be acceptable for some applications. If a company implements this pattern from scratch, this will inevitably impact the **project budget and complexity**, even though there are some libraries and services that can be reused.

3.1.6 Relationships with other patterns. Patterns **DICTIONARY LOOKUP**, **TEXT SNIPPET TRANSLATION**, and **EXPRESSION WEB SEARCH** can be considered specializations of this pattern. Further reading assistance can be provided by **LISTENING ON DEMAND** in cases the user prefers to listen to a speech of the written text.

3.1.7 Known uses. Fig. 4-1 shows a simple web page on the Safari web browser for macOS Monterey with a piece of text selected (in this case, *"philosophy"*). In Fig. 4-2 it is possible to see the result of a mouse right-click on the selected text: a context menu is displayed with the three topmost options being *Look Up…*, *Translate…* (TEXT SNIPPET TRANSLATION), and *Search with Google* (EXPRESSION WEB SEARCH). The *Look Up* option in macOS (Fig. 4-3) is a special type of lookup in which the system tries to anticipate the most appropriate search engines and presents to the user a list of results. Different types of terms might yield searches in different engines and, consequently, different results. Fig. 4-4 shows the results for the word "philosophy": because it is a generic word of the English language, the system automatically chose *dictionary* definitions, *thesaurus*, and *translations* to be displayed on the foreground. Fig. 4-5, in turn, shows a lookup for the more specific term *"Plato's Academy"*, generating results from Wikipedia instead of dictionary definitions and thesaurus. The macOS implementation presented here only illustrates the pattern, which is intended to be a more generic description of the select-and-lookup operation. Simpler implementations based on DICTIONARY LOOKUP, TEXT SNIPPET TRANSLATION, and EXPRESSION WEB SEARCH are considered specialized versions of this pattern and can be observed in web browsers, web applications, and mobile applications.



English

phi·los·o·phy | fəˈläsəfē | noun (plural philosophies)
the study of the fundamental nature of knowledge, reality, and existence, especially when considered as an academic discipline. more

English Thesaurus

philosophy noun
1 *a lecturer in philosophy*: THINKING, REASONING, thought, wisdom, knowledge.
2 *I'd like to see your philosophy in action*: more

Italian - English

philosophy | BrE frˈlɒsəfi, AmE fəˈlɑsəfi | noun
filosofia f;
‣ my philosophy of life
la mia filosofia di vita more

Dictionary Siri Knowledge Siri Suggested Websites

Platonic Academy
Ancient philosophical, research and educative center, founded by Plato

The Academy was founded by Plato in c. 387 BC in Athens. Aristotle studied there for twenty years before founding his own school, the Lyceum. The Academy persisted throughout the Hellenistic period as a skeptical school, until coming to an end after the death of Philo of Larissa in 83 BC. The Platonic Academy was destroyed by the Roman dictator Sulla in 86 BC.
Wikipedia

Established	387 BC
Located in	Colonus

Siri Knowledge Siri Suggested Websites

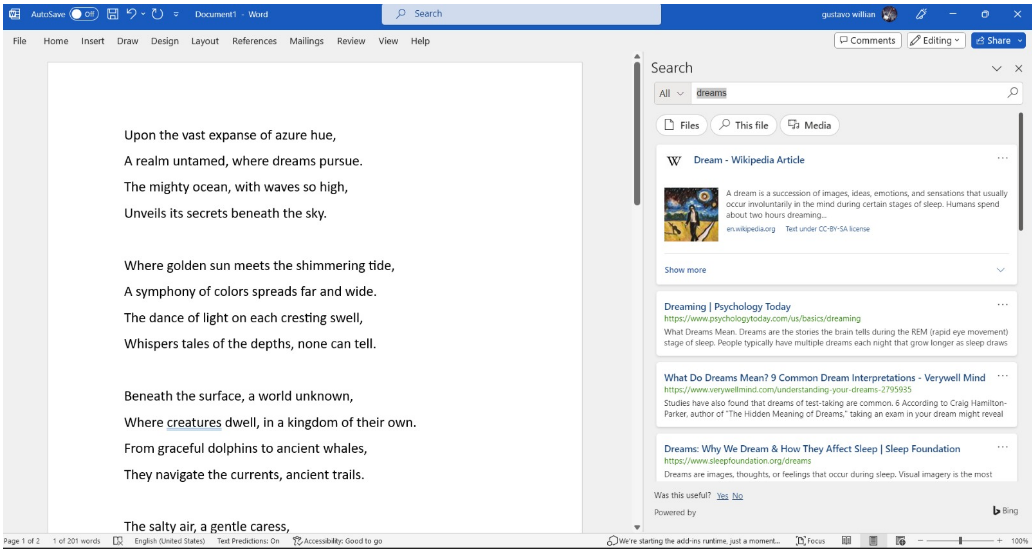
Aristotle was born in Stagira in north Greece ... to the Macedonian royal family. He was trained first in medicine, and then in 367 he was sent to Athens to study philosophy with Plato. He stayed at Plato's Academy until about 347 -- the picture at the top of this page, taken from Raphael's fresco *The School of Athens*, shows Aristotle and Plato (Aristotle is on the. right). Though a brilliant pupil,

1. User selects text of interest
2. Lookup is triggered through menu

3. System executes the search
4. Results are presented to the user

5. On macOS, different terms may yield different types of search

Fig. 4. The macOS Monterey implementation of the SELECTION LOOKUP pattern.



Upon the vast expanse of azure hue,
A realm untamed, where dreams pursue.
The mighty ocean, with waves so high,
Unveils its secrets beneath the sky.

Where golden sun meets the shimmering tide,
A symphony of colors spreads far and wide.
The dance of light on each cresting swell,
Whispers tales of the depths, none can tell.

Beneath the surface, a world unknown,
Where creatures dwell, in a kingdom of their own.
From graceful dolphins to ancient whales,
They navigate the currents, ancient trails.

The salty air, a gentle caress,

Search

All dreams

Dream - Wikipedia Article

A dream is a succession of images, ideas, emotions, and sensations that usually occur involuntarily in the mind during certain stages of sleep. Humans spend about two hours dreaming...
en.wikipedia.org Text under CC-BY-SA license

Dreaming | Psychology Today
https://www.psychologytoday.com/us/basics/dreaming
What Dreams Mean. Dreams are the stories the brain tells during the REM (rapid eye movement) stage of sleep. People typically have multiple dreams each night that grow longer as sleep draws

What Do Dreams Mean? 9 Common Dream Interpretations - Verywell Mind
https://www.verywellmind.com/understanding-your-dreams-2795935
Studies have also found that dreams of test-taking are common. 6 According to Craig Hamilton-Parker, author of "The Hidden Meaning of Dreams," taking an exam in your dream might reveal

Dreams: Why We Dream & How They Affect Sleep | Sleep Foundation
https://www.sleepfoundation.org/dreams
Dreams are images, thoughts, or feelings that occur during sleep. Visual imagery is the most

Was this useful? Yes No

Powered by Bing

Fig. 5. Lookup mechanism seen in Microsoft Word 365 for Windows 11.

As shown by the example, **macOS** implements this pattern at the OS level, meaning that all applications can opt to include the *Look Up…* menu item in their context menus. Some applications, however, opt to remove it, which is the case with the Mozilla Firefox web browser. **Firefox** presents a very specific implementation based on add-ons, which means that, for users to have access to features such as SELECTION LOOKUP, they need to install certain software extensions. In some applications for Windows 11 designed by Microsoft, such as the **Microsoft 365** tools and the **Edge** web browser, there is a lookup feature similar to the one found in macOS (see Fig. 5). Nonetheless, we could not identify whether the feature is available to all applications or only to the Microsoft suite. All web and mobile applications analyzed for this study (Wikipedia and e-book readers) presented some sort of implementation for this pattern (see the other pattern descriptions for more details).

3.2 Pattern: DICTIONARY LOOKUP

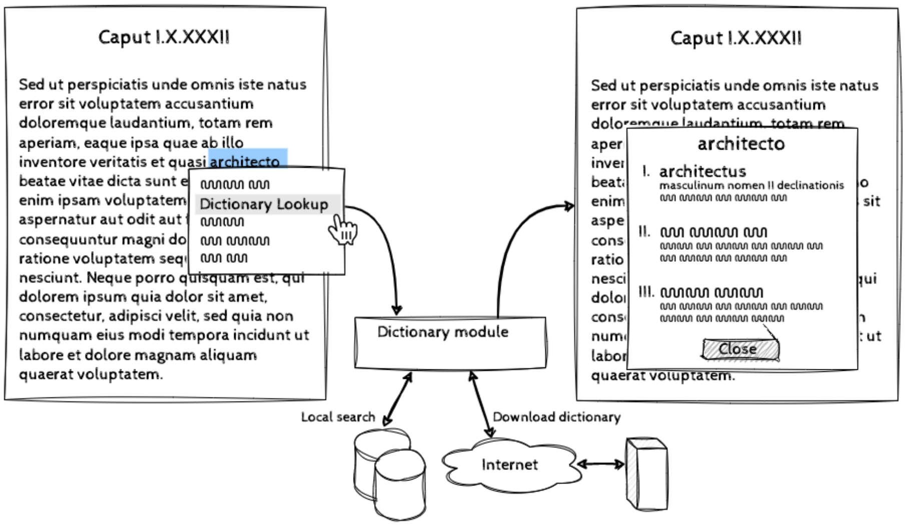
3.2.1 Context. A software interface presenting selectable text content which might contain vocabulary considered complex for some users.

3.2.2 Problem. How to improve readability when the text contains words/terms which the user is not familiarized with?

3.2.3 Forces.

- **Text difficulty**: the user wants or needs to read a text that is written in a cultured language.
- **Second language acquisition:** users in the process of learning a second language may favor dictionary lookup over translation.
- **System complexity:** implementing the infrastructure for downloading and managing installed dictionaries can increase the system's complexity and hardware requirements.

3.2.4 Solution. **Offer to the user a way to look up a dictionary definition for the selected word/term.** The definition should be readily available; for example, it can be opened from a context menu, displayed after a double click, or displayed after a long press. The lookup can be provided by a web service (online dictionary) or can be provided locally upon previous download of the corresponding language dictionary (offline). Fig. 6 shows a diagram for the DICTIONARY LOOKUP pattern.


Caput I.X.XXXII
Sed ut perspiciatis unde omnis iste natus
error sit voluptatem accusantium
doloremque laudantium, totam rem
aperiam, eaque ipsa quae ab illo
inventore veritatis et quasi architecto
beatae vitae dicta sunt e
enim ipsam voluptatem
aspernatur aut odit aut
consequuntur magni do
ratione voluptatem seq
nesciunt. Neque porro quisquam est, qui
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consectetur, adipisci velit, sed quia non
numquam eius modi tempora incidunt ut
labore et dolore magnam aliquam
quaerat voluptatem.
Dictionary Lookup
Dictionary module
Local search
Download dictionary
Internet
Caput I.X.XXXII
architecto
I. architectus
masculinum nomen II declinationis
II.
III.
Close

Fig. 6. A diagram for the DICTIONARY LOOKUP pattern.

3.2.5 Consequences. Upon applying this pattern:
Benefits:

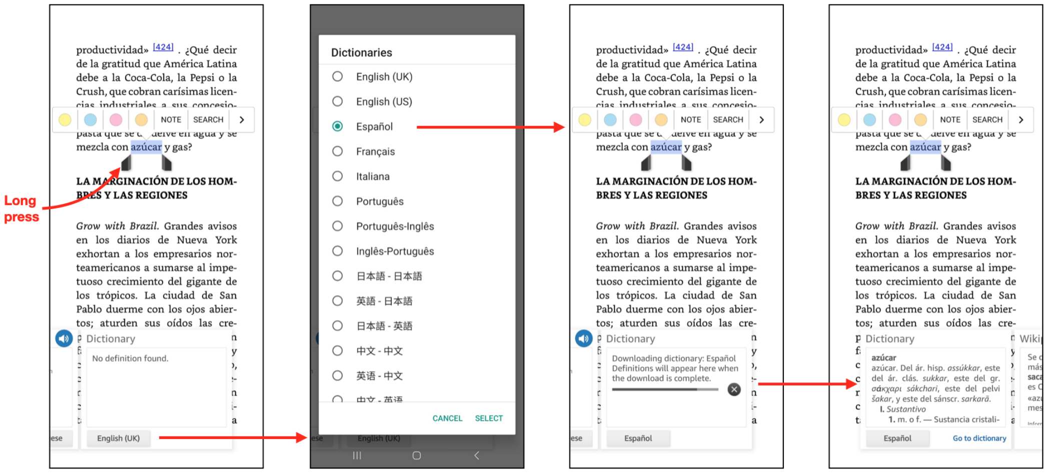
- Users can have a better understanding of **difficult texts** that are written in a cultured language or that contain technical terms.

- Users in the process of **learning a second language** can take more advantage from reading a word definition (in the same language) than being presented with automatically translated text. A dictionary definition can also be more comprehensive than a translation, as it describes many possible meanings of the term.

Liabilities:

- In case **text difficulty** is caused by terms absent from the dictionary (e.g., slang), this solution would be less effective. Users could try TEXT SNIPPET TRANSLATION and EXPRESSION WEB SEARCH instead.
- In the case of low literate users, even the dictionary definitions might be a **difficult reading**. In these cases, users can try LISTENING ON DEMAND.
- The dictionary lookup may require an Internet connection (online lookup) or the previous download of the dictionary (offline lookup), which can be costly in terms of time, network load, storage space, maintenance, and overall **system complexity**.

3.2.6 Relationships with other patterns. This pattern is a specialization of **SELECTION LOOKUP**. In case the user is not satisfied with the provided definition, they can try a **TEXT SNIPPET TRANSLATION** or a **EXPRESSION WEB SEARCH**. To be certain of the word pronunciation, the user can rely on a **LISTENING ON DEMAND**.



productividad» [424] . ¿Qué decir de la gratitud que América Latina debe a la Coca-Cola, la Pepsi o la Crush, que cobran carísimas licencias industriales a sus concesio- … pasta que se … delve en agua y se mezcla con azúcar y gas?

LA MARGINACIÓN DE LOS HOMBRES Y LAS REGIONES

Grow with Brazil. Grandes avisos en los diarios de Nueva York exhortan a los empresarios norteamericanos a sumarse al impetuoso crecimiento del gigante de los trópicos. La ciudad de San Pablo duerme con los ojos abiertos; aturden sus oídos las cre-

No definition found.

Downloading dictionary: Español Definitions will appear here when the download is complete.

azúcar
azúcar. Del ár. hisp. *assúkkar*, este del ár. clás. *sukkar*, este del gr. *σάκχαρι sákchari*, este del pelvi *šakar*, y este del sánscr. *sarkarā*.
I. *Sustantivo*
1. m. o f. — Sustancia cristali-

1. No definition found for English (UK)

2. Dictionary language selection

3. Start downloading after selection of Español (Spanish dictionary)

4. Displays the word definition in Spanish

Fig. 7. The DICTIONARY LOOKUP pattern as seen on the Android app for Amazon Kindle: definition for a Spanish word looked up in the dictionary.

3.2.7 Known uses. This pattern can be found in e-book applications such as **Google Play Books** and **Amazon Kindle**. Fig. 7 shows an example of the DICTIONARY LOOKUP pattern as implemented by the Amazon Kindle app for Android. It can also be found as a basic feature of the **macOS Monterey** operating system.

In the web version of Play Books, the dictionary definition is displayed as a popup as soon as a word is double-clicked (apparently, many languages are supported). In the Android version of the same app, the definition is displayed in an overlay panel appearing from the bottom of the screen when the user long presses on some word (this feature only works for English words). The web version of Amazon Kindle works similarly to its Google counterpart, with additional controls to change the dictionary language (current options are *English (UK)*, *English (US)*, and *Español*), and to see a full definition of the term (by default, only the main definition is displayed). The Amazon Kindle app for Android works similarly to the web version of the same app, with two main differences: it requires the download of the dictionary at the first usage; and it offers 34 language/dialect options, against the already mentioned three options in the web version.

MacOS Monterey offers a search service that is present as the top menu item in all context menus within the operational system (for any application). Clicking this menu item opens a popup dialog in which the main panel displays a dictionary definition for the term. This same dialog displays many other panels depending on which search engines the term has been found, for instance: *Wikipedia*, *Knowledge from Siri*, *Suggested Websites by Siri*, and *iTunes Store*.

3.3 Pattern: TEXT SNIPPET TRANSLATION

3.3.1 Context. A software interface presenting selectable text content which is written in one or more languages other than the user's first language.

3.3.2 Problem. How to improve the user's understanding of a text written in a language in which the user is not fluent?

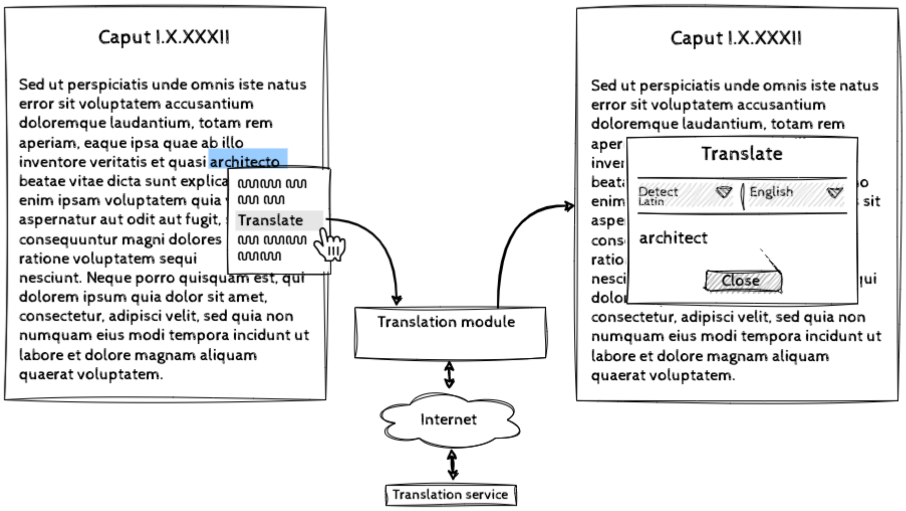
3.3.3 Forces.

- **In-app support:** the user does not want to resort to a separate translation tool.
- **Asymmetrical bilingualism:** the user may be fluent in their first language, but much less proficient in one or more of their second languages. Even so, the user feels capable of comprehending the general idea of the text.
- **Quality of the provided translation:** users require the translation to be of good quality in order to improve their understanding of the text.
- **Cost of translation web service:** the company may not have the budget for additional costs with a web-based translation service.
- **Convenience:** users may feel the system is more or less convenient depending on the way the languages are detected/chosen for the translation. In general, fewer steps to perform an action lead to more convenience.

3.3.4 Solution. **Offer to the user a way to obtain a machine translation for the selected piece of text.** The translation should be readily available, for example through a context menu, and is usually an automatic machine translation provided by a web service. Some applications offer the possibility of downloading a certain language for future offline use (e.g., Google Translate mobile app), in which case the translation can be performed locally. Ideally, the application should guess the source and target languages from the content, context, and user profile, accelerating the user interaction. In any case, the user should be able to change the source/target to the desired languages. Fig. 8 shows a diagram for the TEXT SNIPPET TRANSLATION pattern.

3.3.5 Consequences. Upon applying this pattern:
Benefits:

- Providing an automatic translation service with **in-app support** allows users to better understand texts without relying on a separate translation website or tool.
- **Asymmetric bilingual** users do not need to translate the whole document or web page to consume the content. With this pattern, they can translate only specific parts of the text while still having the opportunity to read the remaining text in its original form.


Caput I.X.XXXII
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Internet
Translation service
Caput I.X.XXXII
Translate
Detect Latin
English
architect
Close

Fig. 8. A diagram for the TEXT SNIPPET TRANSLATION pattern.

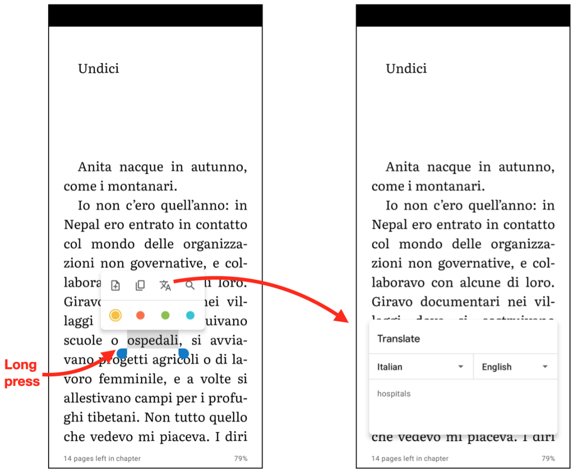
- The general **quality of machine translation** has improved over the last years, generating satisfactory results in most situations.
- Automatically detecting the source/target languages reduces the number of steps that the user has to perform to obtain the translation, hence improving the user's productivity and system's **convenience**.

Liabilities:

- In specific situations (e.g., texts with lots of slang or technical terms), the **quality of machine translation** may not be accurate, providing results that are useless or even misleading. The user may try selecting a bigger snippet of text or even prefer a DICTIONARY LOOKUP or EXPRESSION WEB SEARCH in these situations.
- The **costs of a translation web service** may not fit into the project budget.

3.3.6 Relationships with other patterns. This pattern can be considered a special type of **SELECTION LOOKUP**. It usually appears alongside **DICTIONARY LOOKUP** and **EXPRESSION WEB SEARCH**, allowing users to decide which lookup is more suited for each situation.

3.3.7 Known uses. Fig. 9 shows an example of the TEXT SNIPPET TRANSLATION pattern as seen in the Google Play Books app for Android. In both versions of this application (web and mobile), the translation option is presented as an item in a context menu. The menu item is represented by a translation icon (without text). The expression to be translated is the snippet of text selected by the user, and, although not stated, it is presumable that the translation is provided by the Google Translate service. In the **Amazon Kindle** Android app, a translation is shown as soon as an expression is selected with a long press (Kindle actually displays three panels containing a dictionary definition, a Wikipedia definition, and a translation for the selected word/expression). The same feature was absent from the Kindle Cloud Reader (web). Google Chrome presents a similar functionality, but it will translate the whole web page/document instead of only the selected piece of text. The macOS Monterey offers a translation service that can be included in the



Undici

Anita nacque in autunno, come i montanari.

Io non c'ero quell'anno: in Nepal ero entrato in contatto col mondo delle organizzazioni non governative, e collabora li loro. Girav nei villaggi uivano scuole o ospedali, si avviavano progetti agricoli o di lavoro femminile, e a volte si allestivano campi per i profughi tibetani. Non tutto quello che vedevo mi piaceva. I diri

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Undici

Anita nacque in autunno, come i montanari.

Io non c'ero quell'anno: in Nepal ero entrato in contatto col mondo delle organizzazioni non governative, e collaboravo con alcune di loro. Giravo documentari nei vil-

Translate

Italian English

hospitals

che vedevo mi piaceva. I diri

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Fig. 9. The TEXT SNIPPET TRANSLATION pattern as seen on the Android app for Google Play Books (February 2023): Italian word of a book translated into English.

context menu of applications: this service is activated for any selectable text and can be observed in applications such as Safari and Text Editor.

3.4 Pattern: EXPRESSION WEB SEARCH

3.4.1 Context. A software interface presenting selectable text content which includes complex concepts. These terms can be references to people, products, organizations, historical events, etc., and are usually absent from dictionaries. The device (desktop/laptop/mobile) has one or more installed web browsers.

3.4.2 Problem. How to help users to achieve a deeper knowledge of a certain term and a better comprehension of the full text when translation and dictionary definitions are either not applicable or not enough?

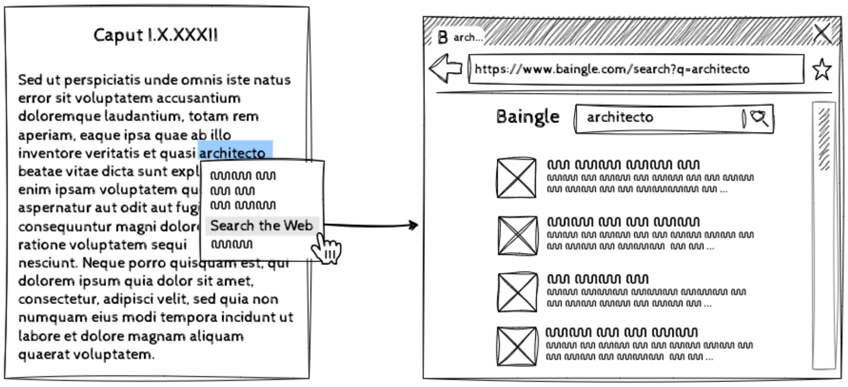
3.4.3 Forces.

- **Text difficulty:** the user wants or needs to comprehend a text which contains technical terms.
- **Needed context:** some terms can have many different meanings depending on the context in that they are used. Sometimes context is not well captured by other solutions such as translation or dictionary definition.
- **Task efficiency:** users want to perform the search keeping their efficiency and without deviating too much from their primary task.

3.4.4 Solution. **Offer to the user a way to perform a web search for the selected word/term.** By looking at the term depicted in many different contexts, possibly also through images, the user can decide on which is the best conceptualization of the term. Fig. 10 shows a diagram for the MULTILINGUAL OUTPUT pattern.

3.4.5 Consequences. Upon applying this pattern:
Benefits:

- Users can produce a deeper understanding of **difficult texts** that contain complex and/or technical terms.


Caput I.X.XXXII
Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt expl enim ipsam voluptatem qu aspernatur aut odit aut fug consequuntur magni dolor ratione voluptatem sequi nesciunt. Neque porro quisquam est, qui dolorem ipsum quia dolor sit amet, consectetur, adipisci velit, sed quia non numquam eius modi tempora incidunt ut labore et dolore magnam aliquam quaerat voluptatem.
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Baingle
architecto

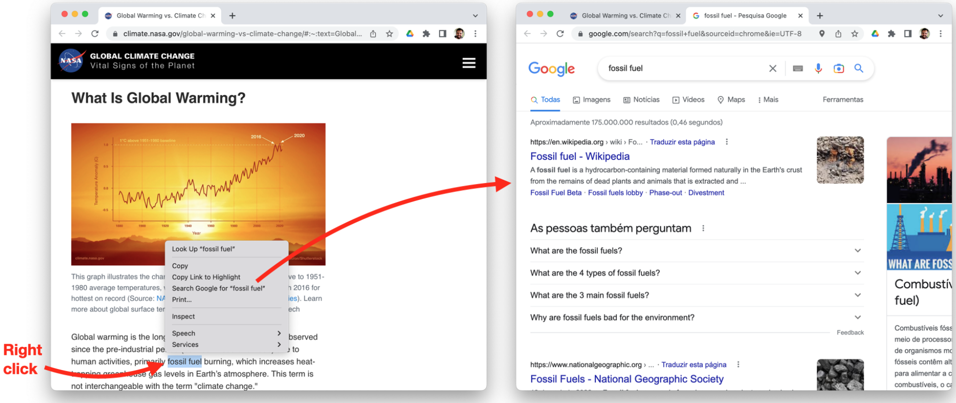
Fig. 10. A diagram for the EXPRESSION WEB SEARCH pattern.

- The possibility of selecting the words surrounding the desired term can produce the **needed context** for a more precise search.
- Working as a shortcut, this pattern allows users to perform a search without having to open a search engine and type the desired term, hence keeping **task efficiency**.

Liabilities:

- In most cases, choosing to perform a web search will take the user to a different application or website in which the results are displayed. A possible adverse effect is an increase in distraction, potentially reducing **task efficiency**. Solutions that try to anticipate the user's need (such as the macOS implementation of SELECTION LOOKUP) can reduce this risk by displaying in-app lookup results considered more relevant.

3.4.6 Relationships with other patterns. This pattern is a specialization of **SELECTION LOOKUP**.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Search Google for "fossil fuel"
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Mais
Ferramentas
Feedback

What Is Global Warming?

This graph illustrates the char ve to 1951-1980 average temperatures, \ 2016 for hottest on record (Source: NA ies). Learn more about global surface ter ech

Global warming is the long bserved since the pre-industrial pe e to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. This term is not interchangeable with the term "climate change."

Aproximadamente 175.000.000 resultados (0,46 segundos)

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A **fossil fuel** is a hydrocarbon-containing material formed naturally in the Earth's crust from the remains of dead plants and animals that is extracted and ...

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As pessoas também perguntam

What are the fossil fuels?

What are the 4 types of fossil fuels?

What are the 3 main fossil fuels?

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Fossil Fuels - National Geographic Society

WHAT ARE FOSS

Combustív fuel)

Combustíveis fóss meio de processo de organismos mo fósseis contêm alt para alimentar a c combustíveis, o ca

Fig. 11. The EXPRESSION WEB SEARCH pattern as seen on the Google Chrome web browser for macOS: the term is selected and searched for deeper comprehension.

3.4.7 Known uses. This pattern can be found in context menus of e-book applications (**Google Play Books**, **Amazon Kindle**, **Readera**), web browsers (**Chrome**, **Firefox**, **Safari**), and as basic features of operating systems (**macOS Monterey**). Fig. 11 shows an example of the EXPRESSION WEB SEARCH pattern as implemented by the Google Chrome web browser.

3.5 Pattern: LISTENING ON DEMAND

3.5.1 Context. A software interface is presenting text content for a non-blind user. The device has working sound speakers and computer audio is not muted. The user is able to hear produced sound and is in a silent environment.

3.5.2 Problem. How to help users understand a text in a language they comprehend when listening but are unable to read?

3.5.3 Forces.

- **Better comprehension of spoken language**, rather than written language, might be the case for users that are not fluent in that specific tongue.
- **Multitasking:** listening does not require visual contact with the screen, allowing users to perform other tasks while still consuming text content.
- **Interest in learning pronunciation** is common among users willing to learn a second language.
- **Correct and pleasing speech** is important to keep the user's attention.
- **Time and cost of the project** are constant concerns of the development team when new features are involved.

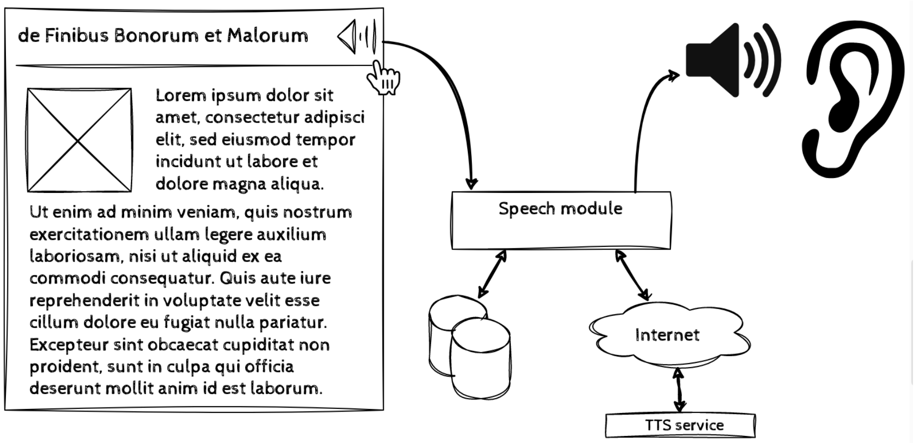

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Fig. 12. A diagram for the LISTENING ON DEMAND pattern.

3.5.4 Solution. **Offer to the user the possibility of listening to a spoken version of the text instead of reading it.** Two options are available for producing an audible version of the text: providing an audio counterpart for the text (recorded by a human); or automatically generating speech from text, also known as text-to-speech (TTS) software. It is the user who actively chooses which part of the text and at which time the content is going to be listened to. In cases where full articles of books can be listened to, the recording is usually produced by a human. When the user is allowed to freely select the text to be heard, the audio is usually produced by the software. Some systems allow the download of voice files, performing the TTS conversion locally without the need for an Internet connection. Fig. 12 shows a diagram for the LISTENING ON DEMAND pattern.

3.5.5 Consequences. Upon applying this pattern:
Benefits:

- Users with **better comprehension of spoken language** can achieve a better comprehension of a piece of text by listening to it.
- The possibility of listening to a book or a full article enables users to perform other activities (**multitasking**) while still consuming the content.
- Users **interested in learning pronunciation** can listen to selected pieces of text, improving their knowledge of a second language.

Liabilities:

- Automatic text-to-speech conversion does not always produce enjoyable results, especially when the text includes too much slang, neologisms, or foreign expressions. Producing a **correct and pleasing speech** is a challenging task for developers.
- Producing audible content read by humans can be a laborious task, potentially increasing the **time and cost of the project**.

3.5.6 Relationships with other patterns. This solution differs from a **SCREEN READER** in the sense that the user is not visually impaired and is still able to navigate through the graphical interface of the system/application. It is only a piece of the displayed text content that is selected for listening upon request of the user.

3.5.7 Known uses. This pattern can be found in some articles of **Wikipedia**, which have audible counterparts. E-book readers such as **Google Play Books** also offer some books with audible content. The **macOS Monterey** operating system offers a text-to-speech service present in all context menus that produces the corresponding audio for the selected text. Microsoft applications for Windows 11, such as **Microsoft 365** and **Edge**, also offer a text-to-speech service for reading text content aloud. Fig. 13 and Fig. 14 show examples of the LISTENING ON DEMAND pattern on the Wikipedia website and on macOS Monterey respectively.

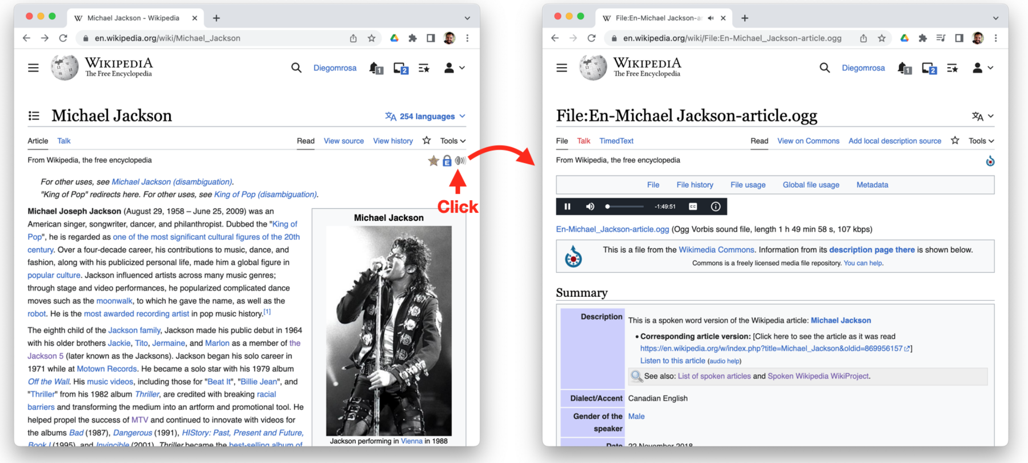
4 METHODOLOGY

This section briefly describes the methodology involved in the patterns discovery process. As a guideline for the procedure, we adopted a simplified version of the development framework for HCI patterns described in a previous work [4]. Fig. 15 summarizes the methodology with the selected phases, which we describe in more detail below.

The planning of the discovery process consisted of a domain study and a review of patterns background. During the domain study, we tried to comprehend typical user interface solutions for reading assistance by reviewing the literature and exploring current software systems.

During the exploratory research, we identified that some of the patterns were implemented in different levels of the software stack (OS, user agent, application). Besides that, some of the patterns were implemented in multiple of these levels. Table 2 shows the final set of operating systems, web browsers, and applications that were analyzed for pattern discovery.

The systems' interfaces were then scrutinized in search of recurrent solutions. Patterns identification and writing followed best practices from the HCI [4] and patterns [13, 20] communities. After a first round of identification and



Michael Jackson

From Wikipedia, the free encyclopedia

For other uses, see Michael Jackson (disambiguation).
"King of Pop" redirects here. For other uses, see King of Pop (disambiguation).

Michael Joseph Jackson (August 29, 1958 – June 25, 2009) was an American singer, songwriter, dancer, and philanthropist. Dubbed the "King of Pop", he is regarded as one of the most significant cultural figures of the 20th century. Over a four-decade career, his contributions to music, dance, and fashion, along with his publicized personal life, made him a global figure in popular culture. Jackson influenced artists across many music genres; through stage and video performances, he popularized complicated dance moves such as the moonwalk, to which he gave the name, as well as the robot. He is the most awarded recording artist in pop music history.[1]

The eighth child of the Jackson family, Jackson made his public debut in 1964 with his older brothers Jackie, Tito, Jermaine, and Marlon as a member of the Jackson 5 (later known as the Jacksons). Jackson began his solo career in 1971 while at Motown Records. He became a solo star with his 1979 album *Off the Wall*. His music videos, including those for "Beat It", "Billie Jean", and "Thriller" from his 1982 album *Thriller*, are credited with breaking racial barriers and transforming the medium into an artform and promotional tool. He helped propel the success of MTV and continued to innovate with videos for the albums *Bad* (1987), *Dangerous* (1991), *HIStory: Past, Present and Future, Book I* (1995), and *Invincible* (2001). *Thriller* became the best-selling album of

Michael Jackson

Jackson performing in Vienna in 1988

File:En-Michael Jackson-article.ogg

From Wikipedia, the free encyclopedia

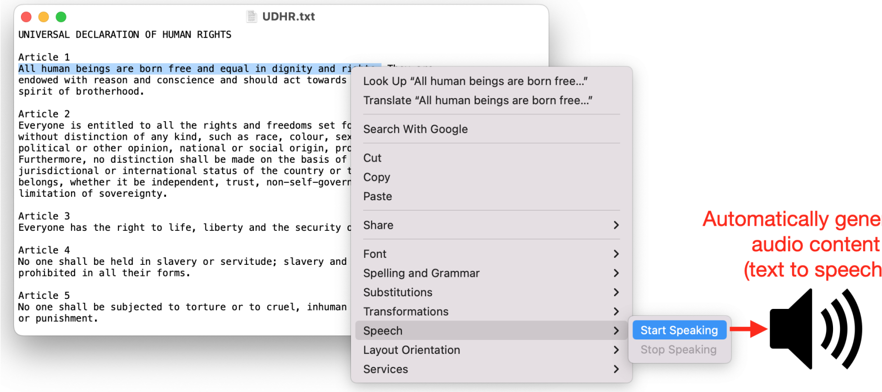
En-Michael_Jackson-article.ogg (Ogg Vorbis sound file, length 1 h 49 min 58 s, 107 kbps)

This is a file from the Wikimedia Commons. Information from its **description page there** is shown below.
Commons is a freely licensed media file repository. You can help.

Summary

Description	This is a spoken word version of the Wikipedia article: **Michael Jackson** • **Corresponding article version:** [Click here to see the article as it was read https://en.wikipedia.org/w/index.php?title=Michael_Jackson&oldid=869956157] Listen to this article (audio help) See also: List of spoken articles and Spoken Wikipedia WikiProject.
Dialect/Accent	Canadian English
Gender of the speaker	Male
Date	22 November 2018

Fig. 13. The LISTENING ON DEMAND pattern as seen on the Wikipedia website (February 2023): the article contains a spoken word version that can be listened to by the user on demand.



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UNIVERSAL DECLARATION OF HUMAN RIGHTS

Article 1
All human beings are born free and equal in dignity and ri
endowed with reason and conscience and should act towards
spirit of brotherhood.

Article 2
Everyone is entitled to all the rights and freedoms set fo
without distinction of any kind, such as race, colour, sex
political or other opinion, national or social origin, pro
Furthermore, no distinction shall be made on the basis of
jurisdictional or international status of the country or t
belongs, whether it be independent, trust, non-self-govern
limitation of sovereignty.

Article 3
Everyone has the right to life, liberty and the security o

Article 4
No one shall be held in slavery or servitude; slavery and
prohibited in all their forms.

Article 5
No one shall be subjected to torture or to cruel, inhuman
or punishment.
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Fig. 14. The LISTENING ON DEMAND pattern as seen on the macOS Monterey operating system (Text Editor application): the text-to-speech service is evoked for the selected text.

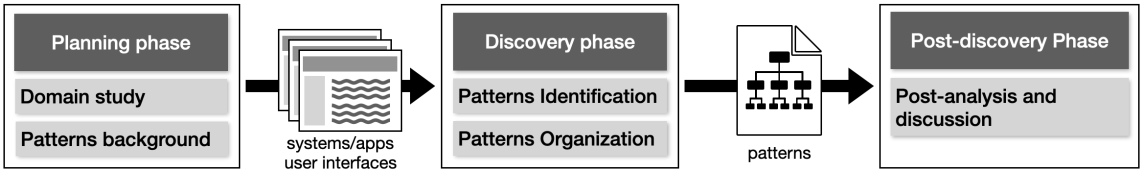

Fig. 15. Phases of the patterns development.

writing, the patterns were organized and the relations between them were elicited in the form of an incipient pattern language. Images of the interfaces have been taken whenever needed in order to serve as evidence and illustration of the patterns.

Table 2. List of analyzed systems for the patterns discovery.

Category	Name / Version	Domain / Description
Operating System	macOS Monterey v12.6.5	Desktop/laptop OS
Operating System	Windows 11	Desktop/laptop OS
Operating System	Android 13	Mobile OS
Web browser	Google Chrome for Mac v.112.0.5615.137	Desktop/laptop browser
Web browser	Firefox for Mac v112.0.2	Desktop/laptop browser
Web browser	Safari for Mac v16.4.1	Desktop/laptop browser
Web browser	Google Chrome for Android (18 Apr 2023)	Mobile browser
Web app	Wikipedia (30 Apr 2023)	Collaborative encyclopedia
Web app	Kindle Cloud Reader (30 Apr 2023)	E-book reader
Web app	Play Books (30 Apr 2023)	E-book reader
Mobile app	Wikipedia for Android (13 Apr 2023)	Collaborative encyclopedia
Mobile app	Play Books for Android (17 Apr 2023)	E-book reader
Mobile app	Amazon Kindle for Android (14 Apr 2023)	E-book reader
Mobile app	Readera for Android (9 Mar 2023)	E-book reader

Implementation details were included in the solution description for each pattern. In particular, the proposed patterns can be classified according to the software level in which they are implemented. These were the levels of implementation considered for the analysis:

- **OS level:** the pattern is implemented by the operating system, making it potentially available to any installed application.
- **User-agent level:** the pattern is implemented by the user agent, such as a web browser for example. This makes the pattern available for all systems accessed through the user agent. In the context of this research, patterns implemented by web browsers become usable with all web applications.
- **Application level:** the pattern is directly provided by the application without relying on OS or user-agent implementation.

A final step in the process consisted of analyzing the proposed patterns and establishing connections between them and scenarios of reading difficulty. The discovered patterns were also compared with the WCAG guidelines for readability. Section 5 shows a discussion of the patterns and their impact on these two aspects of human-computer interaction design.

5 DISCUSSION

The proposed patterns, identified from current desktop/laptop, web, and mobile systems, can be further analyzed from different perspectives. Firstly, we discuss the tendency of these patterns to migrate from the application level to the user-agent level and then to the OS level. Next, we discuss the relations existing between the patterns and the WCAG

2.1 guidelines for readability presented in Section 2.1. Finally, we analyze how the personas and scenarios presented in Section 2.2 are affected by the proposed patterns.

5.1 Implementation level

The version 12 of the macOS operating system (macOS Monterey) implements all of the five patterns. Apple's desktop and laptop OS offers software developers the possibility of including items in the edit menu for SELECTION LOOKUP, TEXT SNIPPET TRANSLATION, EXPRESSION WEB SEARCH, and LISTENING ON DEMAND. Pattern DICTIONARY LOOKUP is available through SELECTION LOOKUP. Different applications can use these features as is, suppress them and offer alternative implementations, or simply suppress them at all. Apple's applications for macOS, for example, will include all items in their menus. Activating *Search with Google* in these applications will launch the Safari browser with the corresponding Google search. In turn, Google Chrome includes items for SELECTION LOOKUP and LISTENING ON DEMAND, which execute the OS implementation of both functionalities, but rewrites EXPRESSION WEB SEARCH to open the search results in Chrome itself. Firefox suppresses all of these items, offering similar features by means of software add-ons. The Microsoft Edge web browser for Windows 11 implements similar functionalities. In summary, all of the described patterns are currently implemented either at the OS level or at the user-agent level (web browser).

Some particular applications can totally rewrite the standard menu implementations to adapt to their contexts. That is the case for e-book reader applications, which tend to offer custom menus that facilitate access to frequent actions such as DICTIONARY LOOKUP and TEXT SNIPPET TRANSLATION. Besides that, the standardization observed in macOS is not present in the Android operating system; therefore, Android mobile apps offer their own implementation of the patterns.

The implementation of reading assistance patterns at the OS level presents at least two advantages over user-agent-/application-level implementations. Primarily, it guarantees uniformity among many apps within the operating system, potentially improving productivity as users get used to it. Secondly, it simplifies the development of applications for that operating system because software developers do not need to consider the implementation of these patterns in their roadmap. It is important to note, however, a possible drawback: if the feature is not configurable by the user, all lookups (dictionary definitions, text translations, web searches, etc.) end up being controlled by a single company.

5.2 Patterns and the WCAG guidelines

The proposed patterns also present clear relations to the readability guidelines of WCAG 2.1. Implementations of LISTENING ON DEMAND that make use of automatic text-to-speech generation will depend on the correct implementation of guidelines *3.1.1* and *3.1.2* (*the human language of text content can be programmatically determined*). This same pattern is also closely related to guideline *3.1.6* (*a mechanism is available for identifying specific pronunciation of words*): at the same time, it depends on the correct implementation of this pattern and also serves as a possible mechanism for users to listen to differences in pronunciation.

Patterns DICTIONARY LOOKUP and EXPRESSION WEB SEARCH (or other implementations of SELECTION LOOKUP) can offer the required mechanisms to deal, at least partially, with unusual words (guideline *3.1.3*) and abbreviations (guideline *3.1.4*). These two patterns, together with TEXT SNIPPET TRANSLATION in the case of bilingual users, can assist in situations of *low reading level* (guideline *3.1.5*), in the sense that they provide supplemental content about the text. These patterns, however, do not provide simplified versions of the text as also stated by guideline *3.1.5*.

The fact that the patterns are currently implemented by operating systems and user agents and that they meet some of the readability guidelines of WCAG 2.1 raises the question of which is the best level to implement such readability requirements. WCAG establishes recommendations for web applications, but W3C also publishes a set of guidelines for the development of accessible user agents called User Agent Accessibility Guidelines (UAAG), currently at version 2.0[4]. From all patterns presented in this paper, UAAG 2.0 only addresses pattern LISTENING ON DEMAND (through its guideline *1.6 - provide synthesized speech configuration*); notwithstanding, UAAG could be expanded to include other guidelines for readability improvement. Considering recent advances of tools for automated text simplification (ATS) [1], for example, one might consider a user agent implementation to address WCAG guideline *3.1.5*. Besides the many experimental methods and tools reported by Al-Thanyyan and Azmi [1], it is already possible to find commercial implementations of ATS. Snap&Read[5], for instance, offers a Chrome extension that, among other things, simplifies the vocabulary of web text content.

5.3 Patterns and reading difficulty scenarios

As a final discussion, we return to the personas described in Section 2.2. Mikayla (Fig. 1-a), the Singaporean student, presents a good level of reading; nonetheless understanding a technical text is still difficult for her. In this case, pattern DICTIONARY LOOKUP can provide dictionary definitions for English complex words, while EXPRESSION WEB SEARCH can give her insights on technical terms not present in dictionaries.

Sanjay, the Indian worker, prefers using his smartphone in English, rather than in Hindi, his native language. His main objective is to improve his skills in a second language. Performing a DICTIONARY LOOKUP is a good way to learn new word definitions without resorting to automatic translations. When a complete sentence is difficult to understand, then TEXT SNIPPET TRANSLATION may be useful, converting the text to his mother tongue. He may use EXPRESSION WEB SEARCH to acquire deeper knowledge on specific terms. Finally, he can use LISTENING ON DEMAND to verify the pronunciation of words or whole phrases.

Our last persona, Alexander, is a low-literate retiree. He can try DICTIONARY LOOKUP and EXPRESSION WEB SEARCH to comprehend texts about his disease and corresponding treatment. In some situations, however, he may depend on LISTENING ON DEMAND to convert text into speech, which he can understand better.

6 CONCLUSION

E-book readers, web applications, web browsers, and operating systems are being improved by the adoption of different features aimed at helping users to read and comprehend text in digital form. In this paper, we presented five pattern descriptions identified from current systems: SELECTION LOOKUP, DICTIONARY LOOKUP, TEXT SNIPPET TRANSLATION, EXPRESSION WEB SEARCH, and LISTENING ON DEMAND. These patterns can help User Experience designers, HCI specialists, and Accessibility experts to better comprehend these solutions, map the design space, and identify improvement opportunities. The presented patterns can also be the seed for a broader pattern language related to the field. The possible impact of AI-powered search engines (such as ChatGPT) on these patterns is another topic for future work.

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