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Making Dictionary Content Accessible for People with Visual Impairments

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Abstract: This article discusses the development and evaluation of EDictViz: a visually accessible dictionary website intended to meet the accessibility needs of people with visual impairments. It is argued that dictionary access is important not only because of the utilitarian role that dictionaries play in resolving language queries but also because of their potential to promote social inclusion. With reference to previous research, a summary is provided of the barriers to access typically faced by people with visual impairments when using dictionary websites. Following this, the way in which these problems have been addressed in the development and evaluation process of EDictViz thus far is discussed. An evaluation of a development version of EDictViz based on the Web Content Accessibility Guidelines is reported — it indicates that the latest prototype version of the tool is accessible. This suggests that the design decisions taken at the outset of the project were sound. Throughout this process the parallels between lexicography research, which is often concerned with providing efficient access to lexicographic data, and accessibility research in general are drawn. Plans for future experimental studies to evaluate EDictViz which directly involve people with visual impairments are set out. This development process demonstrates the potential for mutually beneficial collaboration between accessibility and lexicography researchers.

Keywords: ACCESSIBILITY, ADVERTISEMENTS, EDUCATION, LANGUAGE LEARNING, LANGUAGE TEACHING, LEXICOGRAPHY, LEXICOTAINMENT, ONLINE DICTIONARIES, WCAG, WEB DEVELOPMENT

Opsomming: Toeganklike woordeboekinhoud vir mense met visuele gestremdhede. Hierdie artikel bespreek die ontwikkeling en evaluering van EDictViz: 'n visueel toeganklike woordeboekwebwerf wat bedoel is om aan die toeganklikheidsbehoeftes van mense met gesiggestremdhede te voldoen. Daar word aangevoer dat woordeboektoegang belangrik is, nie net vanweë die utilitaristiese rol wat woordeboeke speel in die oplossing van taalnavrae nie, maar ook vanweë hul potensiaal om sosiale insluiting te bevorder. Met verwysing na vorige navorsing word 'n opsomming gegee van die hindernisse tot toegang wat mense met gesiggestremdhede tipies teëkom wanneer hulle woordeboekwebwerwe gebruik. Vervolgens word die manier bespreek waarop hierdie probleme tot dusver in die ontwikkelings- en evalueringsproses van EDictViz aangepak is. 'n Evaluering van 'n ontwikkelingsweergawe van EDictViz gebaseer op die Webinhoudtoeganklikheidsriglyne word aangebied — dit dui daarop dat die nuutste prototipeweergawe van die instrument toeganklik is. Die ontwerpbesluite wat aan die begin van die projek geneem is, is derhalwe sinvol. Gedurende hierdie

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proses word die parallelle getrek tussen leksikografiese navorsing, wat dikwels gemoeid is met die verskaffing van doeltreffende toegang tot leksikografiese data, en toeganklikheidsnavorsing in die algemeen. Planne word uiteengesit om EDictViz te evalueer aan die hand van toekomstige eksperimentele studies wat mense met gesiggestremdhede direk betrek. Hierdie ontwikkelingsproses demonstreer die potensiaal vir wedersyds voordelige samewerking tussen toeganklikheids- en leksikografiese navorsers.

Sleutelwoorde: TOEGANKLIKHEID, ADVERTENSIES, ONDERWYS, TAALAANLEER, TAALONDERRIG, LEKSIKOGRAFIE, LEKSIKOVERHOUDING, AANLYN WOORDEBOEKE, WCAG, WEBONTWIKKELING

1. Introduction

This article reports on the development and evaluation of EDictViz[1]: an online visually pared-down dictionary interface intended to be accessible for people with visual impairments. Firstly, the project is contextualised in a brief discussion of the problems involved in presenting lexicographic data in a visually accessible manner in traditional paper-based resources. These are juxtaposed with the affordances offered by online dictionaries. Then, in Section 2, the findings of recent research on the accessibility of online dictionaries for people with visual impairments are summarised. In Section 3, EDictViz is posited as a potential solution to the accessibility problems encountered in previous research. In Section 3.1, its development and evaluation thus far are described, while in Section 3.2, plans for future evaluation studies are outlined. The article concludes with a summary of some of the lessons learned from the project thus far and some of its wider implications for accessibility studies and lexicography.

Dictionaries are important. From a utilitarian perspective, they are used to search for the meanings of words and phrases, examples of their use in context, synonyms and antonyms, spellings, pronunciation, and etymological information, along with many other utilitarian functions. Beyond these utilitarian functions, they have a less obvious socio-political role, namely "giving tangible testimony to the status or identity of a language-speaking community" (Lew 2015a: 1). For example, dictionaries of lesser spoken languages attempt to mark out the boundaries of these languages by excluding loan words from more widely spoken neighbouring languages. Moreover, there is a generalised respect or reverence towards dictionaries in society. For example, the idea that the dictionary is the ultimate arbiter of wordhood is common if unjustified. Similarly, the ability to use a dictionary is sometimes perceived as a mark of an educated person. From this perspective, dictionary access can be seen as an important component in participation in society. In lexicography, there has been growing recognition of the importance of making lexicographic resources accessible in recent years. This is evidenced by recent congresses of the European Association for Lexicography (EURALEX). For example, the theme of the XIX congress (in Alexandroupolis, Greece, 2021) was *Lexicography for Inclusion* (Gavriilidou et al. 2021)

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while the XXI congress (in Cavtat, Croatia, 2024) was preceded by a workshop on *Lexicography and Accessibility* (Rees et al. 2024).

There is a vast literature on the affordances of online dictionaries relative to their paper counterparts. Lew (2015b) provides a summary of user research on the use of online dictionaries until 2015. A commonly cited advantage to online dictionaries is that they are not subject to the space constraints of paper resources. However, while the space constraints faced by online dictionary makers are less acute than those faced by the creators of paper-based resources, there is nonetheless a limit on the amount of information that can usefully be displayed on screen at any one time on a dictionary webpage (Lew 2011). The speed of access to the relevant entry and sense of a word provided by online dictionaries, compared with their paper counterparts, is a clearer advantage. For example, search functionality allows users to find the entry they need without having to flick through an alphabetical index. Features such as predictive text (Jackson 2018) and fuzzy matching for misspellings and partially remembered phrases can compensate for gaps in users' knowledge of a word or phrase's written form (Lew 2012), thereby making the look-up process more efficient. At the level of the entry for a particular word, the use of colour syntactic labels (e.g., noun, verb, adjective, adverb, preposition) permitted by online dictionaries has been shown to have benefits not only for look-up speed but also look-up accuracy and vocabulary retention (Dziemianko 2015).

The inclusion of multimedia elements permitted by the online format is also a key advantage (Rees 2025). In general, illustrations combined with verbal definitions have been shown to lead to greater vocabulary learning than illustrations or verbal definitions in isolation (Nesi 1998; Dziemianko 2022). The affordances of multimedia have been particularly valuable for sign language dictionaries (McKee and McKee 2013). For example, still images can be used to illustrate signs and search for them by handshape categories and the place of articulation. These are fundamental elements in the meaning of signs. Similarly, video allows the capture of the dynamic motion and changes in handshapes needed to interpret and articulate signs. The option to replay and watch in slow motion is obviously advantageous for those learning sign language.

All these affordances improve the user friendliness of dictionaries or their accessibility in the general sense of the word. The application of video and images in sign language dictionaries improves accessibility in the more specific sense for sign language users. More hypothetically, online dictionaries offer a potential accessibility advantage insomuch as their content can be manipulated by the dictionary user. For example, when designed with accessibility in mind, webpage elements such as font sizes, line spacing, and colour schemes can be changed at the click of a button or a change in browser settings so that the information they encode is easier to perceive. Another very important potential accessibility advantage offered by online dictionaries is their potential compatibility with assistive technologies. These include technologies such as refreshable braille displays (devices that render on-screen text as braille), magnifiers (tools which make text and images on webpages appear larger), and screen readers (synthe-

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sised speech tools which read the information displayed on screen). Although these possibilities exist for ensuring dictionary websites are accessible for people with visual impairments — and have been partially exploited in the case of *Mikaela_Lex*, a Greek school dictionary for students with visual impairments (Gavriilidou and Garoufos 2022) — previous research suggests that the creators of many dictionary websites have not yet exploited the full potential of these accessibility features (cf. Arias-Badia and Torner 2023; Rees 2023).

This lack of accessibility is particularly troubling when the number of people with visual impairments is considered along with the social exclusion this group often suffers. Globally, approximately 285 million people have some form of visual impairment (WHO EMRO 2012). This figure is likely to increase since there is a global trend of population aging while many of the conditions that cause low vision and blindness are age-related. Generally, many people with visual impairments suffer from social exclusion as evidenced by the high rates of un- and underemployment among this cohort (cf. National Federation of the Blind 2019). Several studies have attempted to address this problem, for example through an evaluation of the accessibility of library resources (McKenzie and Casey 1998) and educational software (Dini et al. 2007). The present project continues in this vein in the hope of making a small step forward in the inclusion of people with vision impairment and blindness in professional and educational contexts.

2. Previous research on the visual accessibility of dictionary websites

To my knowledge, there are two studies that address the accessibility of dictionary websites for people with visual impairments (Arias-Badia and Torner 2023; Rees 2023). They both employ the Web Content Accessibility Guidelines (WCAG) (World Wide Web Consortium (W3C) 2023), a series of guidelines aimed at improving access for people with disabilities to websites and other web applications. The guidelines were developed as part of the Web Accessibility Initiative, which is an initiative endorsed by the W3C — the international standards organization for the World Wide Web.

The current version of the WCAG (2.2) contains thirteen guidelines organised around four key principles that describe ideal characteristics of accessible websites: Perceivable (e.g., websites should contain information such as alternative text for images), Operable (e.g., their interfaces can be accessed with both keyboard and mouse), Understandable (e.g., the language used on a website should be programmatically specified to ensure that it can be pronounced correctly by screen reading software), and Robust (e.g., content should be compatible with assistive technologies such as screen readers). Each guideline has testable *success criteria* that are graded into three conformance levels ranging from A (the minimum standard), through AA (the de facto standard), to AAA (the ideal).

The two studies mentioned differ in scope and the way in which they employ

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the WCAG. Arias-Badia and Torner (2023) take a broad top-down approach, evaluating dictionary website accessibility both for people with intellectual disabilities and for people with visual impairments. Without referring to specific success criteria or conformance levels, they use the guidelines of perceivability and understandability to structure their evaluation of the influence that heading structure, use of images, and the typographic choices have on accessibility for these users. Rees (2023) adopts a narrower focus, examining the accessibility of dictionary websites for people with visual impairments. In line with common practice in web accessibility evaluations, they adopt a bottom-up approach working from dictionary websites to success criteria then to key principle. Furthermore, they evaluate the compliance of dictionary websites with success criteria related to all four key WCAG principles. The rationale is that although the Operable and Robust key principles are not directly related to visual perception, they are essential to rendering website content in a way that is perceivable and understandable for people with severe visual impairments. For example, since screen reader users often navigate by keyboard rather than mouse, websites must be operable in this way. Similarly, websites also need to be robust, insomuch as their content should be compatible with screen readers and braille displays.

Rees (2023) employs the two-stage methodology widely used in web accessibility evaluations. Firstly, automated evaluation tools are used to scan website source code for indications of unmet success criteria. Because of the high possibility of false positives and negatives, in line with common practice (Abascal et al. 2019), a combination of three tools is used: Achecker — Web Accessibility Checker (IDI 2022), MAUVE++ (Broccia et al. 2020), and WAVE — Web Accessibility Evaluation Tool (WebAIM 2021). In a manual inspection stage, an evaluator then browses through a sample of pages from a website checking their experience against a checklist of success criteria. In their evaluation, Rees (2023) compiled a list of 46 A and AA level success criteria that were potentially applicable to dictionary sites. These were considered in both the automated evaluation and manual inspection stages. In addition, a further three potentially relevant AAA success criteria of particular significance to lexicographic applications were also considered (see supplementary information). These include "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"; "3.1.4 Abbreviations: A mechanism for identifying the expanded form or meaning of abbreviations is available"; and "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". This two-stage methodology, the tools, and the checklist of potentially relevant success criteria are employed in the evaluations of prototype versions of EDictViz detailed in Section 3 below.

As shown in Table 1, the previous studies also differ partially in the dictionary websites they evaluate. All resources studied are monolingual. *Diccionario de la lengua española* and *Diccionario fácil* are Spanish resources while all other resources are English, although some offer localised versions[2] and links to

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bilingual resources. All resources except *Diccionario fácil*, which is the fruit of a project aiming to serve users with cognitive impairments, are mass market resources.

Table 1: Dictionary websites included in previous accessibility evaluations

Dictionary	Publisher	URL	Arias-Badia and Torner (2023)	Rees (2023)
Cambridge English Dictionary	Cambridge University Press	<https://dictionary.cambridge.org/dictionary/english/>	X	
Collins Dictionary	HarperCollins	<https://www.collinsdictionary.com/>		X
Diccionario de la lengua española	Real Academia Española	<https://dle.rae.es/>	X	X
Diccionario fácil	Plena Inclusión Madrid	<http://diccionariofacil.org/>	X	
Macmillan English Dictionary	Macmillan Education	<https://www.macmillandictionary.com/>	X	
Merriam-Webster.com Dictionary	Merriam-Webster	<https://www.merriamwebster.com/>	X	X
Oxford Learner's Dictionary	Oxford University Press	<https://www.oxfordlearnersdictionaries.com/>	X	

Despite their differences in scope, methodology, and the dictionaries they cover, the findings of both studies suggest that existing online dictionaries present significant accessibility challenges for users with visual impairments. These include problems with labelling, adaptable design, colour and contrast, and navigation for keyboard users, with each being discussed below.

Labelling

For users with low vision or without the sense of sight, information that is not encoded as text is imperceivable if it is not readable by a screen reader or braille display. This applies not only to the content of the page — such as the inclusion of alternative text to describe images or full-text labels for abbreviations — but also to the design of the page. Unless labelled with alternative text, a clickable arrow at the top of a page taking the user to an entry, the specific part of the dictionary page with the information about the search word, would for exam-

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ple be imperceivable to many users with visual impairments. Other interactive elements such as search boxes and menus also need to be appropriately labelled. Technologically, labelling can be achieved via on-screen text, which is readable to all users, alternative text to describe images that becomes visible when a user selects or moves the mouse over an image, or Accessible Rich Internet Applications labels (ARIA-labels). These are labels in the code of a webpage that provide information about the purpose and status of interactive elements on a webpage to users of assistive technologies.

Adaptable design

One of the principal potential advantages of online dictionaries over their paper counterparts is that, in theory, they offer the user the opportunity to change the layout of the page. This does not necessarily involve including an 'Enlarge Text' or 'Change Spacing' button. Instead, pages should be coded in such a way that the user can alter the size and spacing of text programmatically (e.g., using a browser plug-in or via browser settings). To comply with the relevant WCAG success criteria at an AA level, it should be possible to enlarge text by 200 percent without distorting the rest of the page. There are similar rules for spacing. For example, it should be possible to set line height to at least 1.5 times the font size, letter spacing to at least 0.12 times the font size, word spacing to at least 0.16 times the font size, and spacing following paragraphs to at least twice the font size. In practice, making these adaptations on dictionary websites often results in a distorted unusable site.

Colour and contrast

Traditionally, colour choices in paper-based dictionaries were limited to black print on white (or slightly off-white) paper. More recently, colour printing albeit with a limited palette, became economically viable. Devices such as colour signposts have made dictionary entries easier to navigate (Dziemianko 2015; Dziemianko 2016). However, as far as people with visual impairments are concerned, the huge range of colours possible on dictionary websites presents an accessibility challenge. To comply with the WCAG at an AA level, a contrast ratio of 4.5:1 between background and text is necessary. To put this into perspective: black text on a white background has a contrast ratio of 21:1. Several of the accessibility problems observed in Rees (2023) relate to insufficient contrast in dictionary entries. Elements such as labels indicating grammatical gender, as well as illustrative examples of word use in context were especially affected by low contrast issues. There is some debate about the adequacy of the WCAG2 contrast definition, particularly its applicability to dark backgrounds (Ulitin 2023). However, for practical effects, this is not relevant here since the contrast problems observed in the previous studies of dictionary accessibility relate to light back-

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grounds. More anecdotally, the figures provided in Rees (2023) suggest contrast problems that could also affect sighted users. The use of colour to encode usage warnings such as warnings about common grammatical errors (e.g., red = bad; green = good) is obviously problematic for people with colour-blindness.

Navigation for keyboard users

Many users of screen readers and other assistive technologies navigate websites using the keyboard not the mouse. Unfortunately, innovations in online dictionaries such as clickable signposts that scroll to the part of the entry of interest to the user and entries that unfold when clicked are not operable by keyboard (Rees 2023).

3. EDictViz: A potential solution

EDictViz is a website that uses a dictionary API to display dictionary data in a way that is accessible for people with visual impairments. For the purposes of prototyping, the *Merriam-Webster Advanced English Learner's Dictionary* (Merriam-Webster Dictionary API, n.d.) is employed, although any dictionary could hypothetically be used. The development of the resource follows the Agile software development methodology: an iterative process of collaborative development, evaluation and feedback, and further development in response to that feedback (Beck et al. 2001). Table 2 shows the milestones that mark each version and progress to date.

Table 2: EDictViz development plan

Version	Milestone	Achieved
0.1	Basic working prototype incorporating findings from previous research	Yes
0.2	Pass automated WCAG inspection	Yes
0.3	Pass manual WCAG inspection	Yes
0.4	Usability testing	Pending
0.5	User testing in language reception and production tasks	Pending

The next section deals with the development and evaluation using the WCAG criteria undertaken so far. Section 3.2 deals with plans for future development and evaluation. The WCAG are a good starting point for evaluating EDictViz and have the advantage of providing a broad overview of accessibility applicable

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to the enormously diverse group of possible low vision users (e.g., those with low visual perception, reduced visual acuity, colour blindness, tunnel vision, etc.). However, the pending evaluation with users will be essential for establishing the effectiveness of the tool and of paramount importance to its future development.

3.1 Previous evaluation

3.1.1 Version 0.1: Visual and technical simplicity

The goal for Version 0.1 of the tool was to make a simple website that used the API to display the basic parts of a dictionary entry (headword, word class, definition, and example) when a user looked up a word. The guiding principles throughout the development process have been visual and technical simplicity. This pared-down approach has its roots in a previous evaluation of those elements on dictionary websites that cause accessibility problems for people with visual impairments. As shown in Figure 1, Rees (2023) groups these problematic elements into four categories: advertising, lexicotainment, design, and core-lexicographic. They are discussed here in descending order of the percentage of accessibility problems they represented in Rees's study.

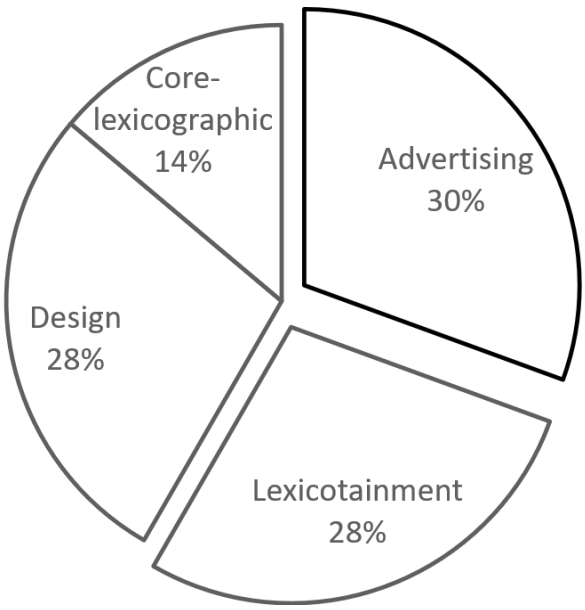

Figure 1: Sources of unmet success criteria on dictionary entry pages (data source: Rees (2023))

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Advertising relates to the inclusion of advertisements and other publicity material on dictionary websites. Since advertisements are often provided by third parties, the operator of the website has limited control over their content and form. For example, advertisements are frequently missing alternative text labels, meaning that they cannot be meaningfully described by screen readers. The inclusion of advertisements often interferes with structural elements such as headings and landmarks (hidden labels for page sections), which help screen-reader users navigate the page. Although the user may not be interested in the content of the advertisements, their presence alone is disruptive to the dictionary use experience. Images, moving or still at the side or top of a screen, can be distracting to sighted users. It is reasonable to assume that this effect is multiplied if the image is blurred or otherwise partially perceivable.

More generally, empirical studies have found the presence of advertisements to be disadvantageous to efficient dictionary use. Dziemianko (2019) found a detrimental impact on performance when dictionaries were used to complete language reception, production, and vocabulary learning tasks. Advertisements on dictionary websites have also been shown to increase the time taken to resolve language doubts (Dziemianko 2019; Dziemianko 2020).

Lexicotainment — including elements such as word games, word of the day features, mailing lists, social media, and blog posts — are a common feature of dictionary websites. They often involve user interaction (e.g., clicking or dragging words with a mouse or entering an email address). They can change the content of a screen without warning (e.g., an auto-updating list of popular searches) or simply add more visually complex elements to a webpage (e.g., unlabelled images or low contrast text from social media feeds). All of this entails significant accessibility barriers.

Design relates to the structure of site and page. This includes the logical use of headings that are helpful when navigating webpages for screen-reader users. It also includes the use of labels describing regions of the page (such as the header, footer, and main section) and navigation, or text inputs such as search. Keyboard operability is a further design consideration. This includes ensuring that all links and text inputs are accessible in a logical manner using the keyboard rather than the mouse. For example, ensuring that links can be operated using the Tab and Enter keys.

Core-lexicographic issues include those affecting microstructure. These include the colour and contrast of text and background in entries. For example, markers of grammatical gender, word class, and illustrative examples are often difficult to distinguish from the page background. The use of abbreviations in entries can also pose problems for people with visual impairments. If abbreviations must be used, the full form of the abbreviated text must be provided as alternative text. It should be possible to modify the size and spacing of the text of an entry without distorting the design of the webpage.

Since EDictViz is a non-commercial project with minimal running costs,[3] there is no need to include advertisements on the site. This means that 30% of the accessibility problems found in Rees (2023) can be avoided. The same logic jus-

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tifies the decision to exclude lexicotainment elements, which represent a further 28% of accessibility issues found in the same study. In commercial resources, these elements are often included to decrease a website's 'bounce rate' (i.e., the percentage of users who leave a site after viewing only one page). This is a key metric for advertisers and advertising agencies. In short, the lower the bounce rate, the more attractive a site is to advertisers. This means potentially greater advertising revenues for the publisher.

At first glance, the decision to exclude advertising and lexicotainment elements seems to run counter to universal accessibility, the argument being that users with visual impairments have as much right to experience advertisements as other users. However, given the proven detrimental effect of advertisements on the speed and retention of dictionary searches, it is possible to turn this argument on its head. Truly universal access would involve removing advertisements for all users. This counterargument may also apply to lexicotainment elements, since it seems one of the principal reasons for including these elements in commercial dictionaries is to increase attractiveness of a website to advertisers.

Excluding advertising and lexicotainment allows a focus on design and core-lexicographic elements. As far as design elements are concerned, this in practice means using a colour scheme with sufficient contrast; ensuring that regions of the page such as headers, footers, navigation menus, and the main section are properly labelled; ensuring that the search box is appropriately labelled; and ensuring the site can be navigated using a keyboard only. In terms of core-lexicographic elements, this involves ensuring sufficient contrast between background and text, ensuring that all information is encoded as text rather than images, ensuring that different parts of the entry are clearly labelled, and avoiding abbreviations for metalinguistic terms. The latter two points chime with the idea of "dictionary as prose" (Hanks 1987: 118), a key idea from the user-friendly turn in lexicography of the 1980s. In practice, this means the avoidance of metalanguage and the use of parenthesis, both of which are factors found to be particularly problematic in several dictionary use studies (cf. Nesi and Meara 1994; Nesi and Haill 2002).

3.1.2 Version 0.2: Passing automated WCAG evaluation

The yardstick for transition from Version 0.1 to Version 0.2 was having a site that passed automated WCAG evaluation. Passing automated WCAG inspection is understood here as having no genuine unmet success criteria indicated by the three automated evaluation tools used. Table 3 shows the unmet success criteria found for the lemma *test* with each of the three tools employed to evaluate Version 0.1 of EDictViz. The single unmet success criteria reported by Achecker is a false positive. The tool has interpreted the ARIA-label for the search form as an empty <Label> element in violation of Success Criterion 3.3.2, which is "Labels or instructions are provided when content requires user input". Issues requiring human verification refer to success criteria that cannot be evaluated by the rule-based evaluation tools (e.g., ascertaining whether alternative text accu-

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rately describes an image). In this evaluation, many of the issues highlighted as requiring further evaluation are repeated false positive results related to the same lines of webpage code. This suggests an incompatibility between the way the tools search for unmet success criteria and the way EDictViz is programmed. In any case, issues requiring human verification are covered by the manual inspection stage of evaluation discussed in Section 3.1.3 below.

Table 3: Results of automated evaluation

Evaluation tool	Unmet success criteria	Requiring human verification
Achecker	1	50
Mauve++	0	27
WAVE	0	0

Figure 2 from WAVE provides a visual summary of the accessibility of this version. WAVE detects no unmet success criteria ('Errors' and 'Contrast Errors'). There are no potential issues requiring human evaluation ('Alerts'). The label specifying the language of the page is noted as an accessibility feature. The 24 Structural Elements on the page are highlighted. These include the labelled header and footer sections, search box, navigation menus, main section, and hierarchically ordered headings, all of which are helpful to users navigating with screen readers. This is also true of the two ARIA-labels highlighted.

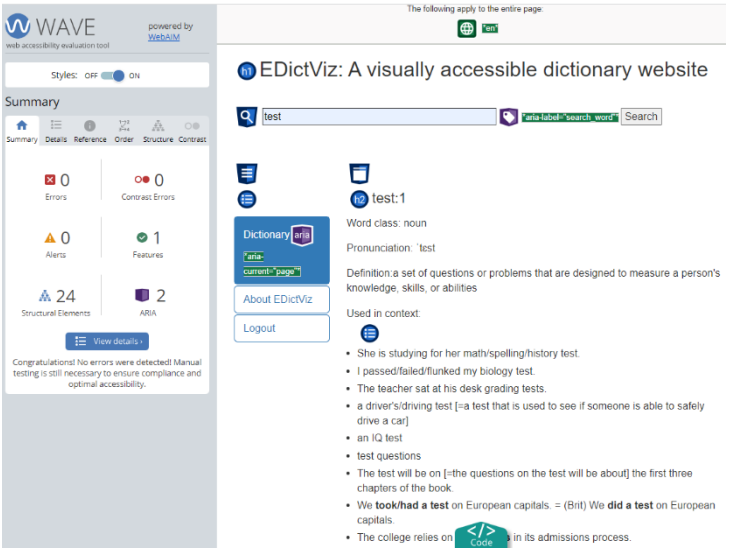

Figure 2: Visual summary of the accessibility of EDictViz Version 0.2

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3.1.3 Version 0.3: Passing manual inspection

The results of the manual inspection of Version 0.2 of EDictViz suggest the pared-down design philosophy offers accessibility advantages. Only 67% (33 of 49) of dictionary webpage success criteria applied to this version of EDictViz. Of these 33 applicable success criteria, only two are clearly unmet by EDictViz. These include Success Criterion 2.4.1, namely "Bypass Blocks: Provide a 'Skip to Content' link", and Success Criterion 2.4.5, which is "Multiple Ways: Offer several ways to find pages" (see supplementary information).

The 'Skip to Content' issue is remedied in Version 0.3 where a link is provided at the top of each page to allow the user to skip directly to the dictionary entry. The idea of allowing the user to skip to the content of interest to them has parallels with what was once considered a user-friendly innovation in learners' dictionaries (cf. Gouws 2014). Some learners' dictionaries provide maps or tables of contents for longer entries. In paper-based resources, these are numbered lists of the senses of a word included in the entry. The user can quickly skip to the relevant sense without having to read through the whole entry. In several commercial online dictionaries these entry maps are hyperlinked to the relevant sense. Unfortunately, this feature is often implemented in such a way that it cannot be perceived or operated by users with visual impairments (Rees 2023).

In Version 0.2 the only way to find a word in EDictViz is to search for it in the search box. This runs contrary to Success Criterion 2.4.5 "Multiple Ways: Offer several ways to find pages". To remedy this, an alphabetic index of headwords is included in Version 0.3. Here again there are parallels between this accessibility feature and lexicographic practice. Freedom from the constraints of the alphabetical index has been a major hope for many lexicography researchers in the digital age (De Schryver 2003). However, this somewhat maligned feature still has its uses. Due to limitations in the methods used to compile digital dictionaries (cf. Frankenberg-Garcia et al. 2021), users searching for derived or compound forms of a word are often left unsatisfied. For example, searching for the adjective *assumed* in the *Cambridge English Dictionary* takes the user to the page for the verb *assume.* However, the alphabetical index in the 'Browse' box at the bottom of the page contains the adjectival uses *assumed debt*, *assumed liabilities*, and *assumed name*, which may help the user resolve their query (Rees 2024).

3.2 Future development and evaluation

Using the WCAG to evaluate the accessibility of dictionary websites for people with visual impairments has several advantages. There are several types of visual impairments, many of which bring different accessibility needs. The WCAG approach allows an abstract evaluation over several visual impairments, concentrating on accessibility needs that are common to many of them. In this way, the approach addresses the needs of a greater range of users than would be feasible with research studies that directly involved users. Moreover, it is a widely employed methodology that is relatively cheap and straightforward to

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put into practice. Furthermore, it arguably offers an ecological validity advantage over tests carried out in closely controlled conditions.

Despite these clear advantages, the WCAG are not the perfect solution. As far as is practicable, there is an obvious need for end users with low vision to be directly involved in the development and evaluation of tools which aim to serve them. This may allow the investigation of other qualitative aspects of user experience not addressed by the WCAG evaluation. For example, it may provide further insight into user perceptions of the cognitive load involved in using the tool, the intuitiveness of its user interface, or other subjective measures of usability, such as the emotional impact of the tool. Future development and evaluation of EDictViz will therefore involve people with visual impairments more directly.

Two key aspects of the tool need further evaluation. Firstly, its usability for people with visual impairments needs to be investigated in comparison with other online dictionaries. Secondly, its effectiveness in typical tasks for which dictionaries are employed needs to be evaluated in comparison with other online dictionaries. Plans for studies with users to respond to these needs are set out in Sections 3.2.1 and 3.2.2, respectively.

A key challenge in carrying out dictionary use research is selecting vocabulary that users do not already know but could reasonably be expected to need in real life. Academic vocabulary lists provide a solution (Coxhead 2000; Rees 2021). Since many users of monolingual learners' dictionaries are university students or staff who use English for academic purposes, it is reasonable to assume that they will need to use the words on these lists. Furthermore, the words on these lists can be ordered by the frequency at which they are found in language corpora — large collections of machine-readable text. Following usage-based theories of language learning, learners are less likely to know words that appear at lower frequencies.

Recruiting low vision users of academic English represents a logistical challenge. Firstly, they are a relatively small, though nonetheless significant, subset of the population. Secondly, low vision users are a heterogeneous group (e.g. including those with low visual perception, those with reduced visual acuity, colour blindness, or tunnel vision). A key design assumption of EDictViz is that there is a limit to the specificity with which these user groups can be targeted. In practical terms, this means that it is not considered feasible to build individual dictionaries for those who need to adjust contrast, text size and spacing, those who require magnifiers, and those who require screen readers. EDictViz attempts to cater to all these groups. It is, however, considered feasible to recruit 10 to 12 users per study who represent this range of use cases for each of the studies outlined below.

3.2.1 Version 0.4: Usability testing

In this experimental study, low vision users will look up the meaning of two comparable sets of lower-frequency words from the New Academic Wordlist (Cox-

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head 2000). After doing this, they will complete the System Usability Scale (SUS) questionnaire (Brooke 1996). The SUS is used to calculate a score representing the usability of the tool. The decision to use the SUS, a proxy for usability, rather than a measure of accessibility is firstly based on the premise that usability and accessibility are mutual requirements (e.g., a tool cannot be usable if it is not accessible, nor can it be accessible if it is not usable). It is also based on the widespread use, ease of administration in challenging environments, and scalability of the SUS. The SUS is a de facto standard measure in usability testing. It is referenced in over 1,300 publications, including those related to the evaluation of lexicographic tools (Frankenberg-Garcia et al. 2019). It has proven quick, cheap to administer and, importantly in this context, reliable even with the expected small sample sizes given the difficulties associated with recruiting low vision users and the diversity of this group's needs. The SUS will allow the collection of subjective measures of the tool's usability that it was not possible to capture with previous WCAG-based evaluations.

In line with common practice, follow-up interviews will complement the SUS questionnaire and allow further insight into user experiences of EDictViz and opportunities for its improvement (e.g. how to make the interface more intuitive and enjoyable to use). It is important to clarify that the study has not been completed yet and that even if it had been, it would be beyond the scope of this article to report it in sufficient detail.

3.2.2 Version 0.5: Vocabulary knowledge testing

This experimental study is designed to compare low-vision users' productive and receptive vocabulary knowledge changes when using EDictViz with those made using a traditional online monolingual English learners' dictionary. This will go some way to elucidating the extent to which EDictViz mitigates barriers to successful dictionary use for people with visual impairments.

The study will use a counterbalanced design in which participants complete two tasks in two conditions: (1) using a standard online dictionary, and (2) using EDictViz. The counterbalanced design has ethical advantages since it ensures that no group is disadvantaged by missing out on any potential benefits of each condition. The first task is intended to measure receptive vocabulary gain from reading. In this task, participants look up the meaning of two comparable sets of lower-frequency words from the New Academic Wordlist (Coxhead 2000) in the two conditions. The second task is intended to measure vocabulary gain for writing. Participants complete two comparable sets of sentence frames (sentences with a missing word) with salient academic collocations — words that it has become conventional to use together (e.g., *powerful computer* but not *strong computer*) (Roberts et al. 2017). In both tasks participants self-rate their knowledge of the vocabulary items using a measure based on the Test of Academic Lexicon (TAL) (Scarcella and Zimmerman 1998). Once the tasks are completed, scores are calculated using acceptable responses to the sentence frames and TAL level

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in each condition. Scores are then compared for each condition.

Like the usability study outlined above, insight into user experiences of EDictViz and opportunities for improvement will be garnered from follow up interviews. The proposed study is in the design stage. If results were available, it would be beyond the scope of this article to provide the required context and discussion.

4. Discussion and conclusions

In this account of the development of EDictViz, it has been argued that dictionary access is important not only because of the functional role that dictionaries play as information tools, but also because of their potential as motors of social inclusion for marginalised groups such as persons with visual impairments. Unfortunately, paper-based dictionaries have historically proved difficult to access for people with visual impairments. Furthermore, it has been shown that while online dictionary websites, in theory, offer greater accessibility, they present significant accessibility challenges in practice, as demonstrated by previous research. EDictViz was posited as an attempt to remedy this. The project so far has not only developed an ostensibly more accessible online dictionary but also highlighted some of the communalities between access as understood in lexicography and accessibility studies. It could act as a model for the application of many of the guidelines from previous research on dictionary website accessibility. This has the potential to improve both access to dictionary websites and other online lexicographic resources for persons with visual impairments, as well as for people in general.

To understand the wider implications of the project, it is helpful to keep in mind Greco's (2018: 211) three shifts that mark the entrance and development of the construct of accessibility in various research fields. One key shift is from a reactive approach where access is 'bolted on' as an afterthought to existing products or services, to a proactive one where products and services are designed with access in mind from the start. Another is the shift from a maker-centred approach to access (in which the makers of a product or service make assumptions about users' accessibility needs) to one where users are active stakeholders in the design process. A further shift is the one from a particularist account of accessibility, in which access concerns concrete groups of people who were often persons with disabilities, to one where access concerns all users.

EDictViz clearly represents a proactive approach to access. It is designed from the ground up with accessibility in mind. Although many existing dictionary websites have accessibility features indicating that their designers are aware of the need to ensure accessibility, the effectiveness of these features is counteracted by overall inaccessible design.

Regarding the next shift, the position of EDictViz is less clear. Thus far, the development of EDictViz has exemplified a maker's account of access. Methodologically, the reliance on the WCAGs rather than direct testing with users entails possibly unfounded assumptions about the needs of persons with visual im-

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pairments. Moreover, as discussed above, it does not provide insight into user perceptions of the tool, such as how enjoyable or intuitive it is to use or even how useful it is. The planned development and evaluation of future versions of the tool will reveal whether the assumptions about the needs of persons with visual impairments are justified. It will also mark a user-centred shift in the tool's development. The SUS study will provide a subjective measure of usability, and the vocabulary knowledge study will provide a measure of the tool's effectiveness. The follow up interviews in both studies will allow the intended audience to give their own account of their lexicographic needs and to indicate the extent to which the tool meets them. More generally, it is hoped that these future studies will elucidate the extent to which, if at all, designing lexicographic resources for accessibility implies compromising the richness of lexicographic content. They may for example shed light on how or if visual indicators of word frequency can be made perceptible to screen reader users.

Although EDictViz embodies a particularist account of access, aimed as it is at persons with visual impairments, it also points the way to a universalist one. This is achieved not only by providing a model for making dictionaries more visually accessible to people in general, but also by implementing good practices from research about the most efficient ways to access lexicographic information. Thus far the project, with its WCAG-based evaluation, has only scratched the surface of the opportunities for mutually beneficial exchange between the fields of accessibility studies and lexicography. It is hoped that further development of the project, including the proposed studies with persons with visual impairments outlined above, will spark yet more progress towards the universal accessibility of lexicographic information.

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Endnotes

1. Development Version 0.3 of the tool is found at https://edictviz.com/. Access is available on request.
2. These versions contain elements such as introductory information and grammatical labels in the language of the user's region if that differs from the language of the dictionary. For example, a user from France using *Collins English Dictionary* would initially be presented with this information in French.
3. The first development version of EDictViz went live in June 2022. The initial development costs and hosting costs for a period of four years were financed by a small research grant from the BALEAP Funding Stream 2021 'Social Justice in EAP'.

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Supplementary Information

The supplementary information can be found at:
https://osf.io/75zum/?view_only=d6d20a8164fe4af0b4a96c3607871870