

Reengineering an Online Historical Dictionary for Readers of Specific Texts

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Abstract

This paper presents an example of how a digital historical dictionary can be reengineered for new uses and new audiences, without changing the underlying data and editing processes. We start from the premise that a large proportion of users of historical dictionaries will be using them to read specific old texts as part of their studies or research in fields that use the texts as source material (literature, history, religion, etc.). *Ordbog over det norrøne prosasprog / A Dictionary of Old Norse Prose* (ONP) has a vast archive of digitized texts, together with detailed referencing sufficient, in theory, to generate a glossary for each page and line of the texts. For the feature demonstrated here we reverse the normal dynamic dictionary-generation process. Instead of generating dictionary entries, the application searches for citations on an edition page and generates a running glossary to the edition, displaying it alongside the edition text. In this paper we present the new public interface to the dictionary (currently at onp.ku.dk) and the contextual glossaries that are generated from the dictionary's data. These have been developed using adaptive web technologies for use on a range of devices, including tablets and phones.

Keywords: Old Norse; lexicography; reading aids

1. Background

Comprehensive historical dictionaries such as *Ordbog over det norrøne prosasprog / A Dictionary of Old Norse Prose* (ONP) are major long-term research projects whose output includes tools which assist researchers in understanding the language and literature under investigation. Modern historical dictionaries use a range of digital methods to help compile and publish dictionaries, but very few lexicographic decisions are automated, with experts making all decisions about word categorization and semantics, for example. This is partly because the researchers who use such dictionaries expect extremely high levels of accuracy.

Many, if not most, users of dictionaries of written languages use them primarily to understand texts which they may be reading as objects of study or research in literature, history, history of religion and so on. A great deal of effort has been made in recent years towards making these dictionaries digital and therefore easy to search as a reference tool.

Anyone used to using such dictionaries will know that when they consult the dictionary in order to understand a specific text, they will not only find the word and the appropriate sense, but also, in a good proportion of cases, the specific passage they are reading cited in the dictionary. This is due to the fact that such dictionaries are remarkably comprehensive in their excerption of the corpora upon which they are based, with a strong tendency to cite passages that may be difficult or of interest for other reasons.

Post-1900 historical dictionaries also tend to be very detailed in their references, citing not only edition pages but also line numbers. This dense excerption and detailed referencing, when combined with digital texts, means that the lexicographic material can potentially be combined in complex ways with the original corpus. The present paper demonstrates that dictionaries can exploit the detailed and accurate referencing in digital historical dictionaries to turn the dictionary around, making a lexical glossary to the texts themselves.

1.1 History of ONP

The dictionary which later became known as ONP was established in 1939. Originally, the objective of the project was to supplement the renowned Old Norse dictionary, Johan Fritzner's *Ordbog over det gamle norske Sprog* ('Dictionary of the Old Norwegian language'; 1883-96), as many new scholarly text editions had been published in the early 20th century, which had not been excerpted for lexicographic purposes. However, it soon became clear that a new comprehensive lexical description of Old Norse was warranted, and so work began on an entirely new and extensive scholarly dictionary. The primary focus of this new lexicographic work was to be the vocabulary of prose texts, as a thorough overview of the vocabulary of the poetic language had then recently appeared with the publication of the revised *Lexicon Poeticum* (Jónsson, 1931). The project has from its inception been funded by the Arnamagnæan Commission and hosted by the University of Copenhagen.

The scope of the new dictionary was further defined by the time period for the textual source material. The dictionary was to account for the vocabulary of Icelandic and Norwegian medieval texts, from about 1150 to 1370 (for Norway) and from 1150 to 1540 (for Iceland). All the source texts are found in manuscripts of various qualities, many of which have been edited and published in scholarly editions. The dictionary was not to be limited to material from text editions, but could also cite medieval manuscripts.

In the early days of ONP, the staff were mostly concerned with collecting and organizing citations through extensive excerpting of all known Old Norse prose genres. Text citations were copied onto slips, which then were filed in alphabetical order by lemma. The citation archive was intended to contain examples illustrating the range in meaning of every word. A few key works were comprehensively excerpted, i.e. every single word

was written down in context on a slip and filed in the citation archive. With the increasing availability of text editions and ongoing excerption work, the citation archive continued to grow.

The ultimate aim of the excerption work was to build a foundation for a print publication. The initial plan was to publish a twelve-volume dictionary over a period of 25 years, with the first volume to appear in the mid-sixties (Widding, 1964: 21). This plan was not realized for various reasons, and the publication of the dictionary was delayed until 1989 when a volume of indices (ONP Registre) finally appeared. The print publication continued over the next 15 years with three additional volumes of dictionary entries (ONP 1-3, covering the alphabet from *a-* to *em-*). The rate of publication indicated that it would take around 45-50 years to publish the remaining nine volumes, so it was decided in 2005 to put the print publication on hold in order to explore alternative means of publishing the dictionary material. As technological advances were starting to fundamentally change the lexicographical world, a new publication plan was conceived, according to which ONP was to be published on a digital platform and made available online.

In 2010, the first version of ONP Online was published on the web, containing both entries from the printed volumes as well as all the citation slips from *h-* through the rest of the alphabet (for an overview see Johannsson, 2019). The shift from print publication to a digital publication entailed some changes in the editorial process. The traditional alphabetical approach was abandoned in favour of focusing on specific word types. The remaining headwords were divided into twelve different groups based on part of speech and morphological complexity. These groups were: simplex (uncompounded) nouns (with fewer than ten citations), simplex nouns (with ten or more citations), compound nouns, verbs, simplex adjectives, compound adjectives, simplex adverbs, compound adverbs, pronouns, numerals, conjunctions and prepositions. The editing work continued according to new editing procedures with edited entries published directly online.

In the digital ONP there is a distinction between semantic and structural editing. Nouns, adverbs and adjectives are being edited both structurally and semantically, whereas verbs and prepositions have been organized according to structure. The different types of entries are compared and discussed in some detail in Johannsson and Battista (2014: 173-174). Today the dictionary consists of approximately 65,000 headwords and over 800,000 citations. Around 30,000 headwords have been edited in some form: semantically, structurally or both, with 500,000 citations within the entries' semantic / grammatical trees. There are around 60,000 senses identified, of which 16,000 are defined in both English and Danish (mainly words starting A-E). A further 15,000 are only in Danish and 1,000 in English.

In addition to the dictionary itself, the digital resources include an index of approximately 5,000 manuscripts and other documents, and a bibliography with around

5,000 items. Every citation in the dictionary is linked to the manuscript which it originally comes from, providing a link between every word, its semantics, and the material record from which it derives. Every citation also has a reference to the page and line of the edition or manuscript from which it is excerpted, with over 17 citations recorded on average for each page of an edition.

The total corpus of Old Norse prose is difficult to quantify, but based on samples of excerpted texts the authors estimate it to be around 10 million words, including lexical variants but excluding texts which are otherwise substantially the same as other included texts. This means that for most texts the dictionary will have excerpted, and thus eventually will have defined, 5-10% of words in the entire text. ONP will thus by its completion have semantically categorized and defined a significant proportion of the entire corpus of Old Norse.

1.2 The data model and software used to generate the dictionary

ONP's data is managed through an Oracle database and edited via a desktop application which will eventually be replaced by the web applications described here. The data structures were largely developed in the 1980s (before TEI/XML was available as a possible digital standard for a historical dictionary), and can be represented by the schema in Figure 1. Each dictionary entry (article) consists of a headword with the semantic tree built through two linked tables, effectively allowing the semantic tree to be up to six levels deep when internal references are used in the tables.

Each citation is linked to the semantic tree with a corresponding scanned citation slip held on the filesystem in about two thirds of cases. The citation is linked to an edition or manuscript page (with page and line numbers) and through the indexes of the bibliography, texts and manuscripts it is identified as belonging to a particular edition and manuscript. The dating of the manuscript is used to sort the citations within each part of the semantic tree.

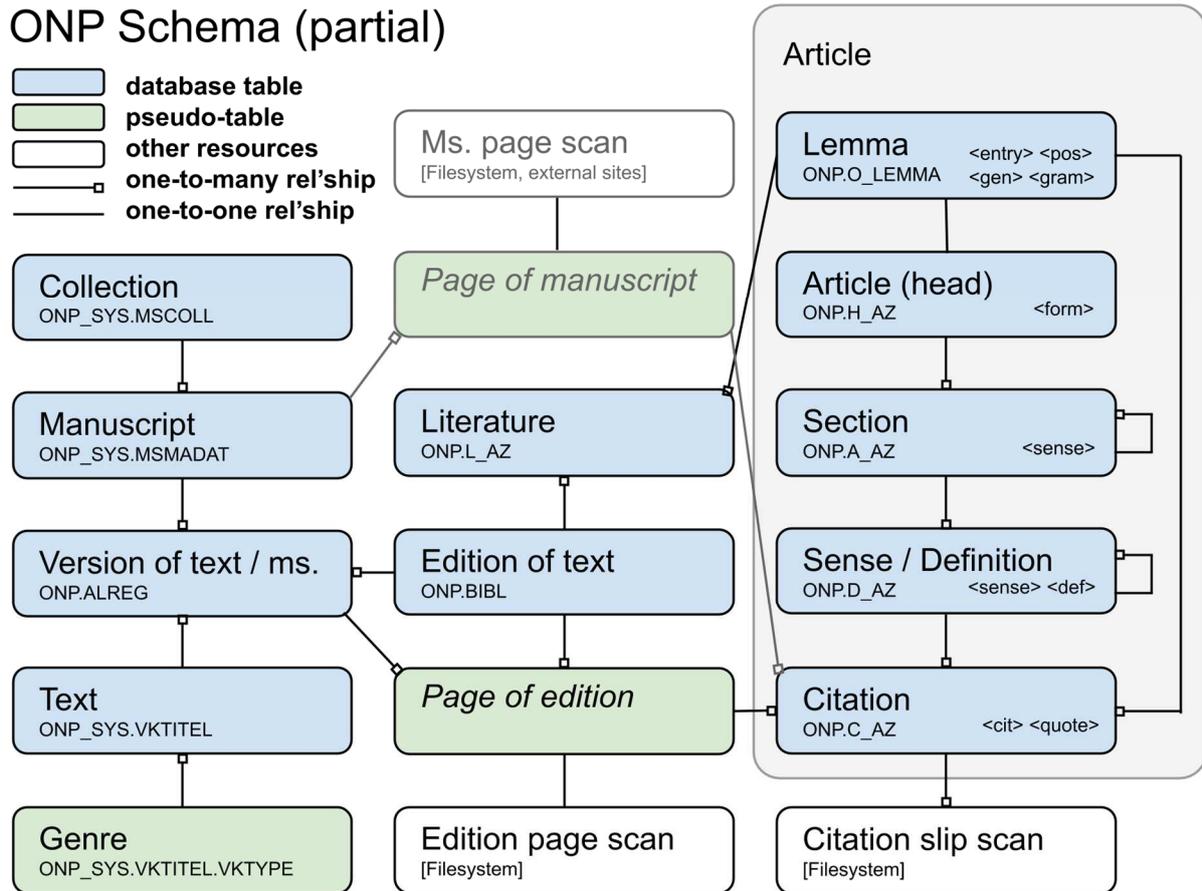


Figure 1: Simplified schema of ONP's database.

1.3 Comparisons with other digital historical dictionaries

Although ONP's methodology and data structure developed independently, it can be compared with other historical dictionary projects of its era and later. For example, the Middle English Dictionary (MED) covers a similar period to ONP (1100-1500) with comparable challenges, including a very a large number of potential manuscripts for each text and highly variable orthography. It also started in the interwar period (1925) and is larger but comparable in scope to ONP (3,000,000 citations¹ compared with ONP's 800,000).

MED was digitized from 1997 and has subsequently been updated. The framework of the online dictionary is similar to ONP and reflects a comparable underlying data model, with entries structured semantically and each citation including linked

¹ <https://quod.lib.umich.edu/m/middle-english-dictionary/about>. Accessed 22 May 2019.

information about its source — both the printed edition and the original main manuscript from which it derives.

The University of Michigan Library, which publishes MED, also supplies a searchable digital corpus in parallel, but users can neither access the corpus from the dictionary, nor access the dictionary from the corpus, although the references between the two are detailed enough to potentially allow this.

The Dictionary of Old English (DOE) is a more modern dictionary which started in the 1970s. It is now based on a fully-digitized corpus, with both the dictionary and corpus available online by subscription. At around 3,000,000 words² the corpus is smaller than both MED and ONP. Separate subscriptions are provided for the dictionary and corpus, and it is perhaps for this reason that the user cannot navigate digitally between the dictionary and corpus, despite their close connections in both referencing and digital methodology.

Similar historical dictionaries in Scandinavia are not as developed digitally. Some are incomplete, such as the Gammeldansk Ordbog (Dictionary of Old Danish), which includes a searchable headword list and access to scanned citation slips. Others belong to the print era and have not been digitized beyond OCR of the content and indexing of the headwords.

The concept demonstrated in this paper is perhaps most closely implemented in the Anglo-Norman Dictionary (AND). The digital AND was undertaken in a similar era to ONP's digital development and has a similar detail of referencing, although manuscript identification is not comprehensive. AND provides, in addition to citation source information for each citation in each entry, links to the citation's textual context in the corresponding corpus. It also generates a full alphabetical glossary for each text, with each citation linking to the corresponding headword. AND's web release, now over a decade ago, was well-received.³

Unlike ONP, which mostly relies on printed editions and provides scanned pages of them, the Anglo-Norman Dictionary has a full digital corpus. It does not, however, provide a parallel glossary to the corpus text itself, nor does it link the citations in the text's citation listing to the semantic tree of the dictionary entry, only to the complete entry.

² <https://tapor.library.utoronto.ca/doecorpus/wordcount.html> - Accessed 18 May 2019.

³ “One reviewer, after remarking that “the online AND permits an ease, speed and depth of consultation that a printed dictionary could never rival”, concluded that it “represents the future of lexicography, in a freely available form that surpasses in every respect the commercial electronic versions of other dictionaries in the field” [D. Burrows in *Medium Aevum* Vol 26 (2007)].” <http://www.anglo-norman.net/dissemin/data/page2.htm> - Accessed 18 May 2019.

1.4 End-users and the digital historical dictionary

The major, comprehensive historical dictionaries that have been produced over the last century have researchers as their primary end-users. The dictionaries give a detailed semantic analysis of all words and, perhaps most usefully, a fairly complete concordance of the word's occurrence across all texts and genres in their corpora. These dictionaries do not normally aim to be comprehensive in their coverage of high-frequency words, but tend to be fairly comprehensive in citations of lower-frequency words, and include citations as evidence for every identifiable sense.

Many editions of the texts in the corpora which these dictionaries cover provide their own glossaries in alphabetical order, and some editions (for example, editions of Middle English poetry for students) have marginal word glosses. The end-users of editions of older texts are frequently students of language and literature, or those working in related fields — such as history, comparative literature or history of religion — which use the texts as their sources. For many individual editions and in some editing traditions, accompanying glossaries are not provided. There are often students or junior researchers who wish to understand these texts but who have a less advanced understanding of the language than the researchers who are the primary audience for historical dictionaries. In these cases the readers can understand much of the text but must make recourse to a dictionary.

Probably the most common type of dictionary used in these cases are abridged versions based on nineteenth-century historical dictionaries (e.g. for Old Norse: Zoëga, 1926; Heggstad, 2008; for Old English: Hall, 1960). These dictionaries normally remove almost all citations and are often not comprehensive, usually focusing on the (then) higher status texts. They are additionally limited by the original historical dictionary upon which they are based (Zoëga is based on Cleasby & Vigfusson (1957), Heggstad on Fritzner (1886-96) and Hall on Bosworth & Toller (1898)), which tend to be less comprehensive than their modern equivalents. Readers of such texts can also use online dictionaries, including digitized versions of the shorter or longer dictionaries, and others like the Oxford English Dictionary, which include information about earlier forms of the language.

For the first two examples above (MED and DOE), the digital resources appear to have sufficient linked information to be able to generate, for example, a glossary of a particular text, either in alphabetic order, or in the order which the words appear in the text. AND, as mentioned above, implements this capability, in alphabetical order. ONP also implements this capability, providing both alphabetical and text-order glossaries for each text in the corpus. Figure 2 shows the glossary for the saga of St. Agatha, sorted according to the order in which the citations appear in the text. Clicking on a citation will show the full citation detail, including definition and citation slip, in the same format as shown in Figure 4.

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ONP: Dictionary of Old Norse Prose

Home Words Manuscripts Works Bibliography Citations look up word

Agðu saga: Agat¹

Ms.: Holm perg 2 fol (c1425-1445) 82vb-84ra

Bibl.: Unger 1877¹ 1-6

Pages: 1 2 3 4 5 6

Alphabetical Text order

Filter 81 citations...

sikileyjarjarl <i>sb. m.</i> — 1 ¹	
jarl <i>sb. m.</i> — 1 ¹	Qvincianus Sikileyjar jarl
þyrja <i>vb.</i> — 1 ¹	Her þyrjar upp sögu heilagrar Agathe meyjar
tígnn <i>adj.</i> — 1 ⁴	hann leitadi margra rada, at hann metti fa hennar ok hugdiz mundu tígnaz af því, at hann teingdiz vit tígna menn, þar er hann var sialfr lagr at burdum
lággr <i>adj.</i> — 1 ⁴	hann var sialfr laggr at burdum
saurlífr <i>adj.</i> — 1 ⁵	
taumr <i>sb. m.</i> — 1 ⁶	þa leysti hann tauma fegirni sinnar til aura hennar
gírdarauga <i>sb. n.</i> — 1 ⁶	iarll leit gírdar- augum a þessa ena göfðu mey
djǫflablót <i>sb. n.</i> — 1 ⁷	hann ... eggjadz svo a dísfa blót af illku sinni, at hann marti eigi Kristz nafn heyra
eindómi <i>sb. n.</i> — 1 ⁸	Slikum endimun eggjadz iarll þa, er hann let guds mey taka ok selldi hana
óráðvandr <i>adj.</i> — 1 ¹⁰	
telja <i>vb.</i> — 1 ¹¹	
ógja <i>vb.</i> — 1 ¹²	

Figure 2: Glossary to a text in ONP (<https://onp.ku.dk/r24>).

For incomplete dictionaries such as DOE, AND and ONP, such a glossary will only include the words that have been edited and / or excerpted for the dictionary. Many users of the dictionary would be simply using it to trying to read an old text. It would therefore be useful to have a glossary to the texts they are using, even where the dictionary is incomplete. In many cases for these older and highly inflected languages, having the linked headword and word class information can potentially help a reader understand a text, even when a word is not defined.

There are potential issues in reproducing a large proportion of a copyrighted work in the form of collected citations from a particular work. A glossary could nevertheless be provided without including the full citations, for example, which would not raise any copyright issues. For editions that are out of copyright, appropriately licensed, or open access, the whole text can potentially be provided alongside the glossary.

From a technical point of view, producing such a glossary requires turning the dictionary inside out, so to speak — starting with the innermost detail of the dictionary entry and finding references to the same text throughout the entire dictionary in order to assemble a glossary of a particular text. This includes traversing the semantic tree backwards. This is potentially technologically complicated and slow for XML and NoSQL-type systems. Some data management technologies, however, are very efficient at this kind of operation, especially SQL-based RDBMS systems, and can work seamlessly with the existing and (in some cases) evolving lexicographic data.

The real utility in the technique presented here is in providing glossaries to texts that do not appear in user-friendly or student editions. These digital historical dictionaries are highly comprehensive with regard to their corpora, meaning that they can provide

a very useful service to users who wish to understand more obscure texts, or ones that have not been of particular interest in the past but nevertheless may be of increasing interest.

2. Method

2.1 The web application

Two web applications have been built in the last year for ONP, with different aims: one as an integrated web publishing and editing application, the other as a fast and archivable public interface to the dictionary. Both interfaces include a version of the feature described here, but the focus here will be on the public interface. They both retain the dictionary's Oracle RDBMS back-end and build an interface using PHP to interact with the database and generate HTML and/or JSON output. User interaction is coded in JavaScript and both applications use Bootstrap as the HTML framework.

A fundamental difference between the original print output of the dictionary (via TeX) and earlier versions of the web output (as largely static HTML) is that these earlier versions generated the output procedurally (as Windows applications written in Delphi), with the data tables queried separately. No table joins were used in the database queries in the earlier applications, possibly to reduce load on the database server. These applications treated the Oracle server as essentially a 'NoSQL' system. The new applications, however, make extensive use of the possibilities in SQL of joining multiple tables in complex queries. With modern hardware and software these operations are very quick, despite joining data from several tables containing hundreds of thousands of rows. This means that entries can be built from queries starting with the headword and linking the semantic tree and citation, or pages can be generated from locating information in the citation table itself, such as references to particular texts, and then linking the semantic trees and headwords back to the citations.

As the dictionary is constantly being updated, with individual entries now published as soon as they are reviewed and corrected, the web interfaces retrieve data directly from the evolving database. This means that as new entries are finalized they are available instantly in all parts of the application that use them, including the text reader described here. Corrections can therefore also be made instantly to the online dictionary.

The new web applications are written with Adaptive Web Design principles. The pages are designed to show all useful information laid out in one layer on larger devices, with smaller devices reflowing elements into a vertical scrolling page and making more use of tabs and pop-ups to access details about the entries and indexes. They also include print-friendly output.

2.2 Linking back from the editions

Through the web interface the user can navigate to the reader view either through the indices (by text, manuscript or bibliographic item – if the edition is available publicly), or through the entry and citation, to see other citations in the vicinity of the same text. Opening the reader view runs a query in which the database searches the citation table for citations that occur on the same page of the edition and links the corresponding headwords and definitions, if available. At this stage the semantic tree is traversed upwards one level, which is sufficient to give the full sense of the word in the vast majority of cases. The resulting information is formatted for the reader.

Figure 3 shows a sample view from the reader feature of the web application. Most of the unused space in the browser window is removed so that the page and gloss can fill the window. In order to effectively use the glossary as an aid to reading the text, it is helpful to have the relevant information available without requiring further interaction.

The server load on both the web and database servers to generate this output is negligible. For the entire operation of querying the database server and formatting the output as HTML, the web server takes around 0.3 real seconds. Subsequent views, which take advantage of the database server’s query optimizer cache, take around 0.1 second. This means that, despite joining six tables, one of which contains 800,000 rows, the application server can generate 3-10 page views per second. This is much more than the anticipated real-world load on the application, even when search engine robots are taken into consideration.

The screenshot displays the ONP Reader interface. At the top, there are navigation links: Home, Words, Manuscripts, Works, Bibliography, Citations, and a search box labeled 'look up word'. Below this, the page title is 'ONP Reader' and the text is identified as 'EgM(2001) (Egils saga Skalla-Grimssonar) in Bjarni Einarsson 2001 [EA A 19]' on page 52 of 50. The main content area is split into two columns. The left column shows a text passage from 'Egils saga Skalla-Grimssonar' with line numbers 15 to 42. The right column contains a glossary of Old Norse terms found in the text, such as 'steint', 'ofán', 'lorum', 'vndraz', 'liðsemð', 'flutningsmaðr', 'hugang', 'stendr', 'vanar', 'katr', 'raðu', 'sannindum', and 'hugang'. Each term is followed by its grammatical information and a brief definition in English.

Figure 3: The ONP reader (<https://onp.ku.dk/r11194-52>).

The scanned page of the edition or manuscript is shown in over 99% of cases. Where the edition is out of copyright, open access, or rights held by the Arnamagnæan Commission (as in the example in Figure 3), the scanned image of the page is shown together with buttons to browse through the work. Where the scans of the edition are covered by agreement with the Danish Copyright Agency (Copydan), no browsing buttons are supplied, as browsing access to the scanned editions is not covered by ONP's agreement with Copydan. In some cases the citations are linked to the original manuscript page, in which case the manuscript image is shown. In other cases a digital text is available.

On the right hand side of the reader view is the glossary generated from ONP's database. Each excerpted word is shown with:

- Line number (grey). Sometimes words within a particular line will appear in a different order because the database does not have information about ordering within an edition line.
- Word form in the text (underlined) where this information is in the database (around 75% of citations).
- Parallels from the source or related texts in Old Norse or other languages (italics), if available (around 5% of citations).
- Headword (bold) with word class information (italics), plus citation count (in brackets), which, when compared with other words, approximates the headword's frequency in the corpus (these are available for all citations in the corpus).
- Semantic tree node (for 69% of excerpted words), including the syntax of the word in the particular sense for the excerpted word (square brackets); the main definition in Danish (40% of words), English (19%), both (or neither); and if applicable the phrasal use of the word. If there is a higher-level definition then that is also shown, separated by an arrow.

The minimum information available for an excerpted word is the corresponding headword, its word class and citation count. Even this basic information can be useful to a reader who is less familiar in the language, as it allows the reader to look up a word with an unusual orthography in another dictionary, and helps them to understand the grammar of the sentence in which the word occurs. The majority of glossed words, however, include much more information than this.

Clicking or tapping on a gloss (citation) brings up a popup with the full citation and scanned slip if available, plus more detailed information about the manuscript (including linked images of the manuscript pages), as shown in Figure 4.

Much of the dictionary’s definitions are at this stage only in Danish. This text appears in a different colour. Clicking / tapping such text will automatically translate it via the Google Translate API. In most cases this is fairly accurate, but still not ideal. Eventually all definitions will be in both Danish and English.

The fact that most editions appear as scanned images produces a small challenge in laying out the page in an adaptive way, because the edition text cannot be reflowed as the screen narrows. However, as the references to the corpus are by page and line of the editions, it is helpful to retain the edition layout in any case, where reflowing might cause confusion.

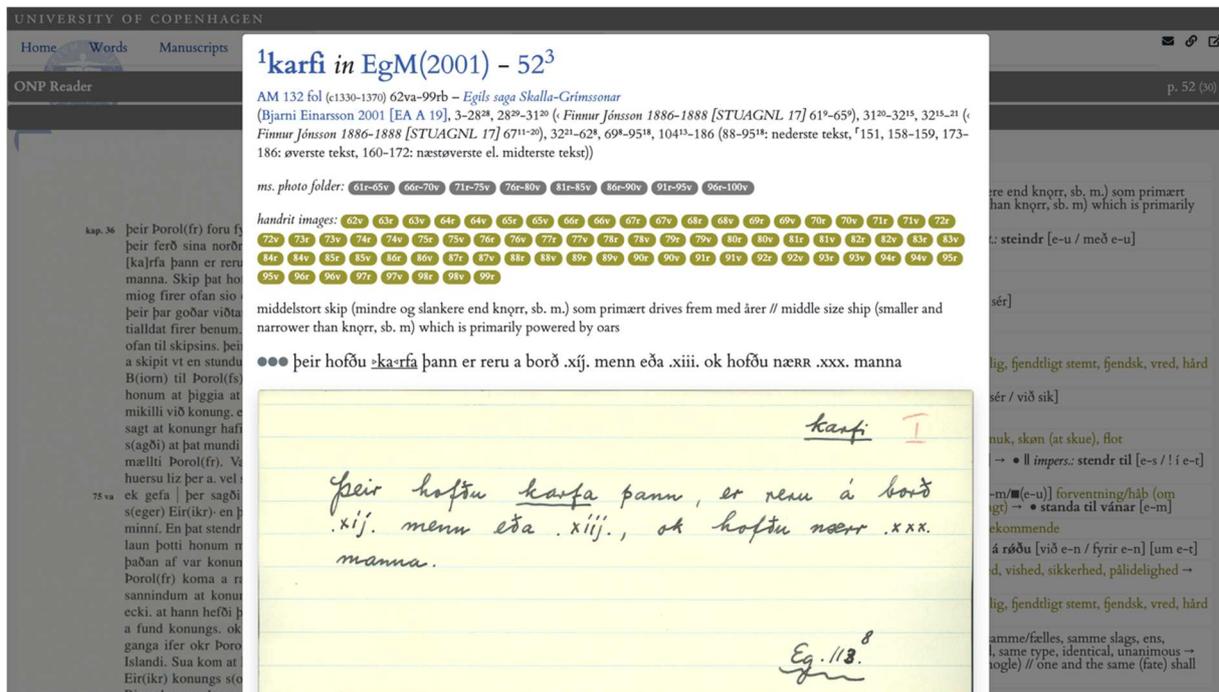


Figure 4: Additional information on a glossed word.

As the scanned images cannot be altered, the gloss is instead modified to fit. Citations are spread out vertically on most devices so that they can best approximate the position on the corresponding page. The text size also scales on different device sizes so that the full glossary in most cases can be viewed as a whole alongside the edition page, with the glosses more or less in line with the word in the corresponding text. On the narrowest devices the text and gloss appear as separate tabs which the user can easily switch between.

Eventually the output will be made print-friendly, so that hard copies of the gloss can be printed, again, where copyright and licensing permits.

3. Discussion

The ONP Reader application demonstrates that using standard web application technologies a complex historical dictionary can be repurposed with a focus on the

individual texts in the corpus it covers. This broadens the utility of the dictionary to assist users who are primarily interested in the texts rather than the language itself, as well as those learning the language.

The utility of the system has been tested informally by giving beta access to members of the Arnamagnæan Collection's Old Norse reading group. Members of the group used a range of devices (various smartphones and laptop computers) to access the Reader, as well as direct hard copy print-outs from the web pages, and feedback was very positive. We anticipate further real-world feedback and have provided a user-feedback form for all pages.

The feature demonstrated here can also be integrated with other developments at ONP, including the incorporation of fully digitized corpora (see Wills, Jóhannsson & Battista, 2018). Using the TEI/XML texts published through the Menota project, ONP can potentially provide glosses to more simplified forms of the original texts, for example, if a normalized text is embedded in the digital edition.

This output of the dictionary as glosses to texts is more than just a means to make access to the dictionary easier. Research into second language acquisition suggests that glosses assist in language acquisition and text comprehension. There is long-standing evidence which demonstrates that glossed texts improve text comprehension and aid in vocabulary acquisition (Lomicka, 1998). This applies to comparable cases with digital glosses and 'authentic' texts (Abraham, 2007). Although the teaching and learning methods in acquiring written-only languages are different from those used with the acquisition of living languages, it is likely that tools such as the one presented here may also assist learners of languages such as Old Norse.

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