A study of the users of an online sign language dictionary

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Abstract

In this paper I report on a mixed method user study of the Online Dictionary of New Zealand Sign Language (ODNZSL). While sign language dictionaries make comparatively full use of the potential offered by the digital format, they have not previously been the focus of much user research and to date there have been no published studies of the usability of electronic dictionary features such as video material, bidirectional search methods and hyperlinked information. This study focuses on broad questions: who the users of the ODNZSL are, their motivation for consulting the dictionary, aspects of their dictionary consultation behaviour and problems that they currently experience.

The study draws on two data sets: firstly, I analysed log data from the ODNZSL website using Google Analytics; and secondly, I carried out a think-aloud protocol and follow-up interview with representatives of potential user groups identified through a pre-compilation user survey. After a brief description of the structure and format of the ODNZSL, results from these two investigations will be discussed along with implications for optimising the ODNZSL's usefulness for its diverse users, and for online dictionaries in general.

Keywords: sign languages; electronic dictionaries; users; log files; think aloud

1. Introduction

Sign language dictionaries are amongst the dictionaries of lesser-resourced languages (Prinsloo, 2012) that arguably stand to benefit the most from the digital revolution. There are two main purposes for creating dictionaries for sign languages: firstly, to document the language and support its preservation and recognition; and secondly, as an aid to people wishing to learn the language (Schermer, 2006; Woll, Sutton-Spence & Elton, 2001). Digital technologies support these purposes, both for the dictionary maker and the user.

In the case of sign languages, some of the capacities of digital dictionary-making are not yet applicable: for example, since there is no accepted sign language orthography there are no large corpora of written texts to draw on. Although video corpora of sign languages are becoming more widespread (see Konrad, 2012 for a survey of current sign language corpora), these are still small compared to spoken and written corpora, partly because of technical limitations but also because in many ways, sign languages are 'young' languages that have until recently been used only in limited domains and that have high levels of polysemy and variation (McKee & McKee, 2013). Structural issues in sign formation also affect lemmatisation, with a large set of productive

morphemes and semi-lexicalised sign forms, but relatively few established lexemes (Johnston & Schembri, 1999, estimate that these number in the thousands rather than the much higher rates of established lexemes found in spoken languages). This means that most (online) sign language dictionaries have a comparatively modest content of around 2,000–5,000 headwords (Zwitserlood, 2010). In other respects, digital technology has significantly facilitated sign language lexicography. In particular, sign language dictionaries can now store video data to represent signs much more effectively than previous static images. The electronic format thus allows for greater visibility and accessibility of sign languages to both the language community and the wider public, raising awareness that may lead to increased recognition of the linguistic and cultural rights of their communities (Schermer, 2006; McKee & McKee, 2013).

An increase in the production of sign language dictionaries in the past decades has been accompanied by these dictionaries becoming the object of research. Within the growing body of articles on sign language lexicography, there has been some focus on the user; however, this has mostly been limited to surveys of potential users prior to the compilation of a sign language dictionary (e.g. Moskovitz, 1994; McKee & Pivac Alexander, 2008) and reviews of existing dictionaries (e.g. Zwitserlood, 2010; Schmaling, 2012). It is generally assumed that sign language dictionaries – especially the first dictionary for any particular sign language – are multifunctional and will serve a wide range of users; indeed, the forewords to many dictionaries mention the sign-language-using deaf community, (hearing) language learners including parents of deaf children, and language professionals such as sign language interpreters. As a result, sign language dictionaries have nearly always been bilingual, and often unidirectional, allowing only for searches by a written word to locate a sign.

There are now a few examples of thematic dictionaries and smaller dictionaries for specific user groups (Schermer, 2006). For most general sign language dictionaries, however, better use might be made of limited resources by using the digital medium to provide customisation of dictionary content for different users and different functions. One example of this is the bidirectional access provided by some of the recent online sign language dictionaries, which allows users to identify a sign by its phonological features to look up spoken or written language equivalents, as well as the more usual word-to-sign search direction (Zwitserlood 2010; Kristoffersen & Troelsgård, 2013). While performing such a search at the moment requires considerable analytical skills from users unfamiliar with sign phonology, there is potential for modern technologies, such as motion recognition, to provide much more accessible user interfaces in the near future. In the same way as Lew & de Schryver (2014) see a future for a dictionary in a pair of glasses, so may there be a sign language dictionary interface in a pair of gloves. Before such adaptations are implemented, however, it is vital that we confirm who the users are and how online sign language dictionaries are used in practice. Kristoffersen & Troelsgård (2012)

point out that there have as yet been no major usability studies of sign language dictionaries.

The current exploratory study may be the first to report on the observed behaviour of actual users of an online sign language dictionary. The study focuses on the Online Dictionary of New Zealand Sign Language (ODNZSL), an example of a recent dictionary that makes use of many of the digital features discussed above. The next section will describe these features in more detail.

2. The Online Dictionary of New Zealand Sign Language

The project to develop the ODNZSL took place from 2008 to 2011. The project built upon existing data that were collected for the earlier print Dictionary of New Zealand Sign Language (Kennedy et al., 1997) and the Concise Dictionary of New Zealand Sign Language (Kennedy et al., 2002). The aim was initially to review and, where necessary, re-validate data from the approximately 4,500 headwords in the 1997 print dictionary and to make these data available online. The ODNZSL was launched in July 2011.

For the purpose of this paper, a brief tour of the ODNZSL website (http://nzsl.vuw.ac.nz) will give an idea of the content, structure and format of the ODNZSL as a background to the user study. A comprehensive description of the development of the ODNZSL and a discussion of some of the lexicographical challenges in its creation can be found in McKee & McKee (2013).

2.1 The Home Page

The home page (Figure 1) gives access to the 'front' and 'back' matter of the dictionary through a series of tabs, providing background information on New Zealand Sign Language (NZSL); grammatical information regarding the number system, fingerspelling alphabet, and the productive classifier morpheme system in NZSL; a help menu which also contains a glossary of terms used in the description of signs in the dictionary; advice for learners with a link to learning exercises; links to relevant organisations; and a contact form which allows users to provide feedback or ask questions.

By clicking the 'play this page in NZSL' button, the information on the home page and in the tabs can be viewed in video format signed in NZSL. English and NZSL are therefore both used not only as part of the bilingual dictionary structure but also as metalanguages. Te Reo Māori translations of each headword were added to the ODNZSL in 2013, so that all three official languages of New Zealand are now represented in the dictionary, although Te Reo Māori is not (yet) used as a metalanguage.

A ‘show me a sign’ feature provides a link to a random sign entry, in a similar way to the ‘Word of the Day’ now provided by some online dictionaries.

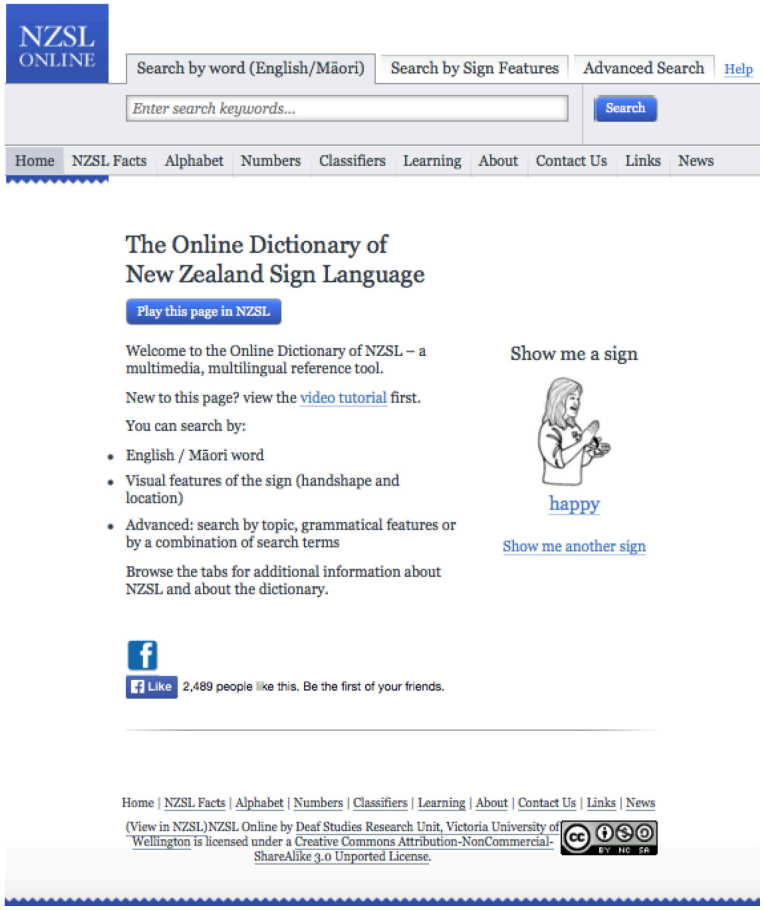

Figure 1: The ODNZSL home page

2.2 Search Methods

Three search methods are available:

- The Search by Word (English/Māori) is a standard search box, which brings up predictive text suggestions of headwords in the dictionary once the user starts typing.
- The Search by Sign Features asks users to select two main phonological features of a sign from a menu of images: the handshape and the location where the sign is produced (see Figure 2)
- The Advanced Search allows for a combination of search criteria from the above two methods, as well as a choice of topics for a thematic search and a list of five usage tags: neologism, archaic, obscene, informal and rare.

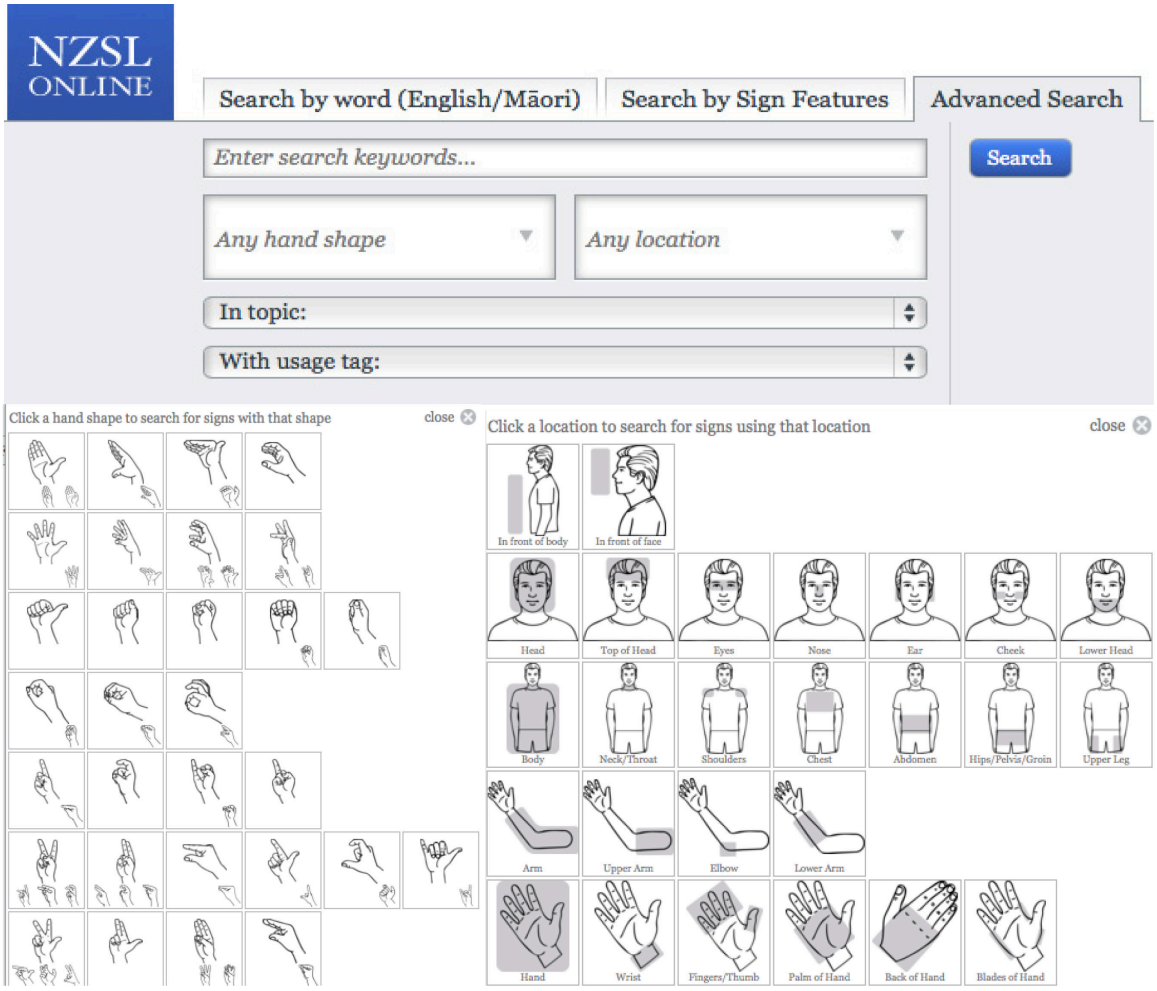

Figure 2: Search methods in the ODNZSL

2.3 Search Results

Information displayed in the search results of the ODNZSL consists of a drawing representing the sign form, followed by glosses in English and Te Reo Māori that capture the main sense(s) of the sign, a series of further translational equivalents in English, and the word class(es) to which the sign belongs. Static representations of the sign are used here instead of video files in order to speed up the loading of the search results. Due to the space the drawings take up, results are paginated with a limit of nine results displayed per page (see Figure 3). Results are displayed in alphabetical order with exact matches for the main gloss displayed first, before exact matches in the translational equivalents and partial matches in both. When there are multiple exact matches, the most frequent sign is displayed first.

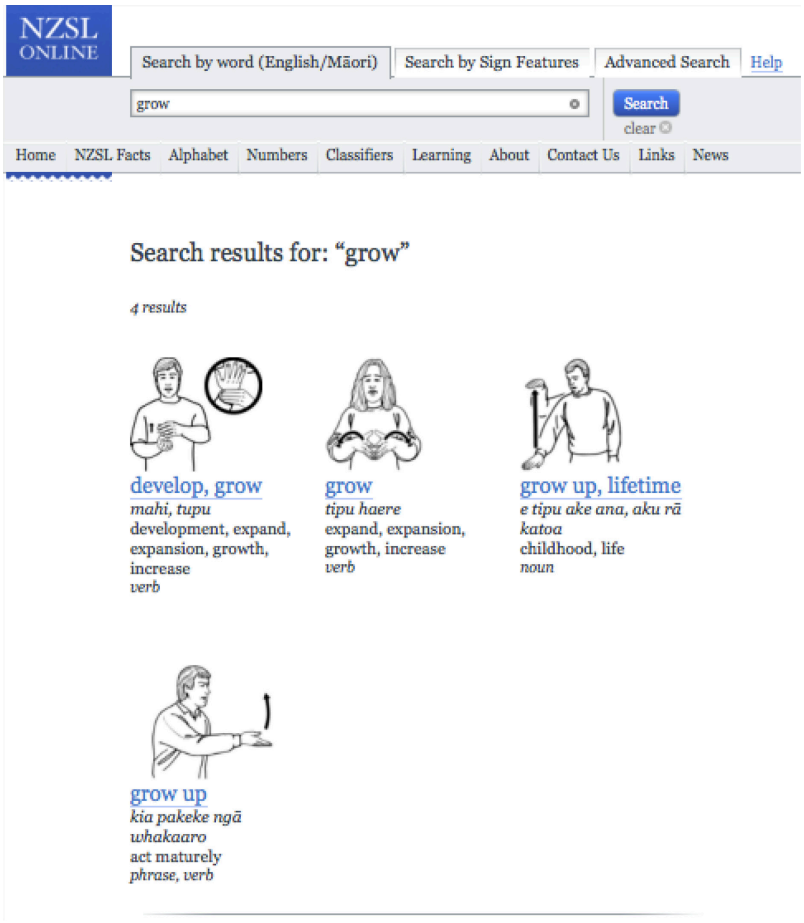

Figure 3: Search results display in the ODNZSL

2.4 The Dictionary Entry

Figure 4 shows the information that is displayed for an individual entry. Each entry contains the following elements (numbered in the figure):

1. Drawings indexing the handshape and location of the sign;
2. One or more English glosses showing the main sense(s) of the sign;
3. A number of further glosses that are either less common senses or common translational equivalents of the sign;
4. A Te Reo Māori gloss;
5. Word class information;
6. Possible inflections, hyperlinked to a glossary in the help menu;
7. A drawing of the sign;
8. A large video showing how the sign is produced;

9. Example sentences, consisting of a signed video accompanied by a translation into English, and a glossed representation of the sentence where each gloss is hyperlinked to the relevant entry in the ODNZSL;

10. A usage note and/or a hint for producing the sign where applicable.

Users also have the option to play any video in slow-motion and to add the sign (in the form of the drawing and English and Te Reo Māori glosses) to a vocabulary sheet to be printed or saved as a PDF.

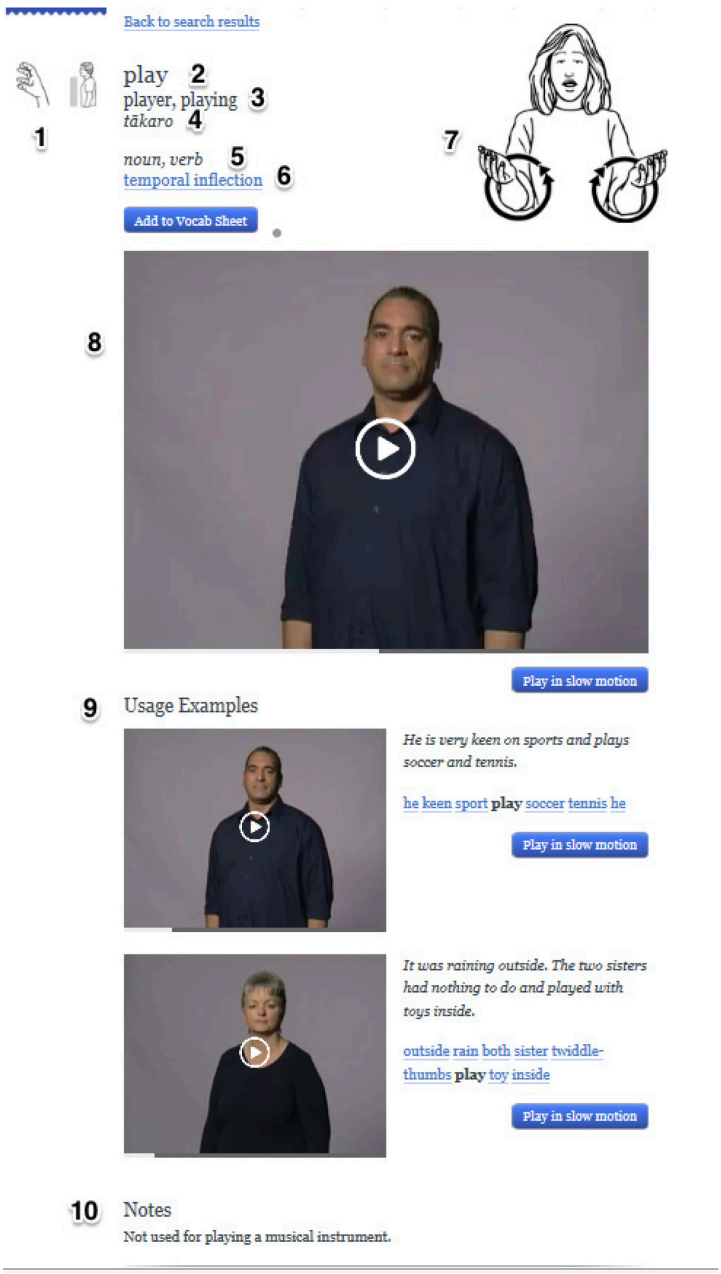

Figure 4: Individual sign entry in the ODNZSL

3. Research Questions

Since there has been little prior research on the users of online sign language dictionaries, the current study did not specify a particular user group or situation. Instead, it focused on four broad questions similar to those suggested by Tarp (2009) and Nesi (2013) as appropriate for dictionary user research:

- Who uses the Online Dictionary of New Zealand Sign Language?
- What is the users' motivation for using this dictionary?
- How is this dictionary used, and what kinds of information do users look up?
- Do users have particular problems or issues in using this dictionary?

4. Method

Log files are increasingly used as a method in dictionary user research, offering the advantage of unobtrusive observation of real-life behaviour (Tarp, 2009). In their log file based user study, de Schryver & Joffe (2004) show the potential of this method to gather detailed information to the benefit of both immediate improvements to a particular dictionary and a more thorough understanding of user behaviour in general. There are some technical obstacles in the way individual users are tracked and limitations to how log file data findings can be applied when the wider context that prompted the dictionary consultation is unknown (Bergenholtz & Johnsen, 2007; Tarp, 2009; Müller-Spitzer, 2013). For the current study, the advantages of having access to a large number of lookups from all potential users outweigh the shortcomings of using this method.

To gain a more qualitative (if subjective) perspective, the main data from the log files was supplemented with interview questions and a think-aloud protocol to probe into users' motivations and attitudes towards the dictionary, as well as examining particular user problems in more depth. Thus the study attempts to triangulate results through using mixed methods: an approach that is increasingly common in dictionary user studies (Nesi, 2013). This part of the study only involved a small number of participants: larger follow-up studies as well as those employing other methods (such as experiments with particular user groups) will be required to confirm the tentative results reported here.

4.1 Log Files

General website traffic for the ODNZSL has been tracked since its inception in July 2011 using Google Analytics, a widely available web analytics programme.

Standard information tracked by Google Analytics includes the number of visitors, how they arrived on the site, how much time they spent on the site, how many pages they viewed and what site searches they carried out. To track user interaction in more detail, 'Events' were set up to also track:

- the exact search string typed in during a search;
- instances where a user clicked on a video to view it;
- clicks on help items, including the introductory video on how to use the dictionary, the help menu, and hyperlinks to the glossary;
- instances where a user clicked on one of the glossed signs in an example sentence;
- the position of a search result of a sign entry when the user clicked on it.

Since these adaptations to the log files were not implemented until March 2014, the selected time period to collect data comprised three months between April and June 2014, a representative period which includes the most active months of dictionary use during the year. During this period, a total of 31,753 sessions were logged. The number of users was 16,296. The number of page views was 319,662, equating to an average of 10.07 page views per session.

In common with other web analytics programs, Google Analytics relies on the tracking of individual users via 'cookies'. While this method provides an improvement over logging server side requests (where cached pages, for example, cannot be easily tracked), inaccuracies may occur due to users blocking or periodically deleting cookies, or being misidentified as unique users when logging in from different devices. Google Analytics have recently implemented a 'unique user' profile that can distinguish between users from the same IP address, and conversely can trace the use of different devices by the same user. The profile also offers more in-depth demographics. However, there are ethical implications of tracing individuals in this way. If this function is implemented on a website, it is therefore recommended that website visitors are informed that their personal data is gathered from the site and asked for their consent. This may be a deterrent to people using the site. For this reason, and because this function gathers demographic data beyond what was required for the limited purposes of this study, it was decided not to make use of the 'unique user profile' function.

4.2 Think-Aloud Protocol

4.2.1 Participants

The selection of participants was based on a number of the potential user groups identified in a survey by McKee & Pivac Alexander (2008) and also reflects the categorisation by Varontola (2002) of dictionary users as:

1) Language learners
2) Non-professional users
3) Professional users

Participants were recruited through existing networks, both through distribution of an information sheet and through personal invitation to relevant groups, such as

networks of sign language interpreters, New Zealand Sign Language classes and the local deaf community. Twelve volunteers were selected. Table 1 shows the selected participants by category and their status in relation to fluency in, and use of, NZSL.

Varontola (2002) dictionary user category	**NZSL status**	**Length of time since learning NZSL**	**Amount of time spent using NZSL**	**Number of participants**
Language learners	Beginner learner (first year class)	6 weeks of course learning	4-7 hours a week	3
	Intermediate learner (second year class)	1-2 years of course learning	4-7 hours a week	2
Non-professional users	Hearing friends of a deaf person	Minor exposure; no formal learning	Very occasionally	2
	Deaf community	1 since early childhood; 1 since late teens	Daily (main language)	2
Professional users	NZSL tutors / teachers	Since early childhood (before age 3)	Daily (main language)	1
	NZSL interpreters	8-11 years, including course learning for 3-4 years	Daily (work + social)	2

Table 1: Interview / TAP participants

4.2.2 Procedure

The activity consisted of four parts:

- A short pre-interview
- A familiarising exercise
- The TAP exercise
- A follow-up interview

Pre-interview questions focused on the participants' prior language learning and dictionary use and their familiarity with sign language dictionaries.

The need for an orientation phase in the Think-Aloud Protocol is proposed by Okuyama & Igarashi (2007). In the current study, participants were asked to imagine they were in a supermarket on their regular grocery-shopping trip and to describe their thoughts while walking through the supermarket aisles selecting goods.

For the TAP part of the exercise, participants were shown the ODNZSL web page and were directed to use the dictionary as they normally would (or if they were not currently dictionary users, to treat this activity as if they were looking up information in a real situation). No specific task instructions were given, but participants were asked to look up at least three items. Both the screen and the participant were recorded. I remained present in the room during the TAP to deal with technical issues and to prompt participants to 'keep talking' if necessary.

Since some of the participants were deaf and would be using New Zealand Sign Language during the TAP, several modifications to the procedure were considered. 'Thinking aloud' may not be a feature of sign languages; although there is some evidence for a sign language-based articulatory rehearsal loop equivalent to a 'phonological loop' in spoken languages (Wilson & Emmorey, 1997), one's own signing is most likely not observed as often, or in the same way, as hearing one's own voice. Also, while navigating through the dictionary, a mouse or keyboard has to be used, which restricts the use of the hands for articulating at the same time. Since I am a fluent NZSL user myself, I sat opposite the deaf participant and provided minimal feedback cues (e.g. head nods) to encourage ongoing talk. I made no other comments. Deaf participants were also encouraged to articulate their thoughts before carrying out an action on the keyboard or mouse. All TAPs were recorded on video.

The follow-up interview probed further into participants' use of the ODNZSL in this instance and in general. Participants were asked to pinpoint information in the dictionary that they regularly use and that whichh they do not use at all; they were also prompted to explore any problems that they experienced either during the TAP or during their own use of the ODNZSL. Finally, participants were asked to name features that their ideal dictionary would include.

5. Results and Discussion

5.1 Who Are the Users?

In line with patterns for other online dictionaries (Johnsen, 2005), the ODNZSL experienced growth in both the number of sessions and the number of users every year since its inception. The proportion of new users continued to rise (see Table 2), suggesting that while the ODNZSL attracted further interest, in most cases this did not develop into regular dictionary use. We should bear in mind that the log file data may mistakenly identify returning users as new users because they visit the site from a new device or because they have cleared their cookies. However, there are also

societal factors that may have had an influence on this changing user profile. The 2013 New Zealand Census (Statistics New Zealand, 2013) noted a drop in the number of people who indicated they could have a conversation "about a lot of everyday things" in NZSL (from 24,084 in 2006 to 20,244 in 2013). A number of reasons for this decrease are noted in McKee (2014) and include a lack of support for NZSL in mainstream schools, few opportunities for deaf children to communicate with other deaf peers, and few opportunities for families to learn NZSL. Factors such as these indicate that there may now be fewer learning environments that would support regular dictionary use. Paired with this decrease, however, is a rise in awareness of NZSL by the general public. McKee (2014) also notes an increase in visibility of a 'Deaf voice' on the internet.

	Apr - Jun 2012	**Apr - Jun 2013**	**Apr - Jun 2014**
New users	8,629 (35.9%)	11,681 (37.2%)	14,567 (45.9%)
Returning users	15,390 (64.1%)	19,690 (62.8%)	17,186 (54.1%)

Table 2: New vs. returning users to http://nzsl.vuw.ac.nz

Further support for the dictionary receiving a high level of casual interest but fewer 'serious' dictionary consultations comes from an examination of the frequency and page depth statistics. A total of 45.88% of visitors were new users and therefore had only visited the website once. A further 22.07% had visited less than five times, showing that even among visitors logged as 'returning users', there are a large number of casual users. The ODNZSL has a smaller number of highly regular users: 2.88% had visited the site more than 200 times, and a further 1.45% had made between 100–200 visits. Returning users viewed more pages per visit than new users (11.14 vs. 8.81, respectively), indicating that on return visits, users engaged with the website in more depth. A total of 28.2% of users left the website after only viewing a single page, and new users were more likely to do so. At the other end of the spectrum, 13.46% of all visits involved viewing 20 or more pages. These in-depth users were more likely to be returning visitors. From the log files, it can be concluded then that although the majority of visitors to the ODNZSL are new users who do not engage with the site in much depth, there exists also a sizeable minority of highly regular users who carry out multiple queries each time they visit.

Similar patterns of usage were reported in the interview data. Non-professional dictionary users who were not involved in formal language learning were aware of the existence of the ODNZSL but had not used the dictionary beyond an occasional browse out of curiosity. Deaf NZSL users said that they very rarely used the ODNZSL to look up signs or English words for themselves, although in their role as language teachers (both teaching classes and informally 'teaching' friends, colleagues

or parents of deaf children) they were frequent dictionary users. In this case, they would look up known signs to add to a vocabulary sheet, but would not look at the entry content in any detail. Responses from beginner and intermediate learners in NZSL classes indicated that they were the most regular dictionary users and looked up several signs daily. The two sign language interpreters in this study (who can be seen both as advanced language learners and as professional users) stated that they only occasionally used the ODNZSL.

5.2 Motivations for Using the Dictionary

Although log files cannot directly reveal users' reasons for using a dictionary, some inferences can be made from examining how they arrived at the dictionary website. The largest source of traffic (65.0%) was through the use of search engines, mainly Google. Less than a quarter of visitors arrived at the dictionary website directly (through typing in its URL or having the page bookmarked). Although it may seem more likely that returning users will be more familiar with the website and will therefore access it directly, in fact they were only slightly more likely to do so than new users (22.68% vs. 20.82%). Other traffic showed a sharper contrast, with new users making up the majority of referred (11.79% new vs. 6.98% returning) and social network traffic (6.06% new vs. 2.26% returning).

The search terms that result in a visit to the ODNZSL show that many users may not be looking for the dictionary specifically. 'NZSL dictionary' was only the third most common search term, with the majority of users searching for more generic terms such as 'NZSL' or 'NZ sign language'. Other common search terms were 'learning NZSL', 'basic sign language', 'NZSL alphabet' and various permutations of 'how do you say x in sign language'.

Reasons participants gave for looking up information during the TAP comprised both communicative and cognitive situations (Tarp, 2009). The TAP did not involve a particular task: participants were left to decide which information to look up. This unguided exercise probably encouraged general browsing of the ODNZSL; many searches were sparked by the participant speaking an English word during the TAP and then wondering how this word was expressed in NZSL; others spotted interesting signs that were not related to their original search in the results and followed through. While this was not an authentic dictionary usage situation, participants also mentioned using the ODNZSL in this way outside of the exercise. An often-mentioned 'cognitive situation' was looking up signs that had previously been learned or seen for rehearsal.

Most of the communicative situations involved language production rather than reception. Users mentioned wanting to find vocabulary to have a conversation with a deaf person. For beginners, this involved looking up words or phrases to do with greetings and introductions and themes such as food or family. Intermediate learners

said they often prepared a conversation topic in advance for classes or when they knew they were going to meet a deaf person. They wanted to broaden what they could talk about by looking up new signs around a theme. This included looking up grammatical and variation information as well. One deaf user looked up information in the other language direction, i.e. wanting to express a known sign in English. Looking up signs for reception was limited to classroom situations such as translation exercises or watching a video conversation. In real-life situations, participants said they would usually clarify the meaning with the signer on the spot rather than consulting the dictionary.

The authoritative role that dictionaries have traditionally played was also evident. Many users were aware of the relatively high levels of regional and age variation in NZSL and used the dictionary to confirm whether a sign they had observed or had been taught was in common use. A deaf sign language teacher preferred to choose the particular sign variants in the ODNZSL for inclusion in teaching resources, even when she might use a different variant herself.

5.3 How Is the Dictionary Used?

5.3.1 Searching

One of the original features of the ODNZSL is its choice of search direction, allowing users to either search by word or by sign features. In a pre-compilation survey (McKee & Pivac Alexander, 2008), 45% of potential users said they would use the search by sign features alongside other methods. Log file data show that actual user behaviour is rather different: the overwhelming majority of searches (98%) were a search by English/Māori word. Searches by sign features only accounted for 0.7% of all searches, with the remainder constituting advanced searches. Although the log data does not distinguish between English and Te Reo Māori word searches, there were few of the latter, and the most frequently looked up Māori words are considered to be borrowings into the New Zealand English lexicon such as 'kia ora' (a greeting) or 'whānau' (extended family).

Together, the top 25 search terms in the ODNZSL (Figure 5) constituted 6.8% of all searches. This figure is slightly higher if misspellings and phrases containing the same words (e.g. 'my name is') are included. Beginner participants in the TAP looked up similar words and phrases, as did deaf NZSL teachers preparing for a lesson. The majority of these searches are highly frequent words or phrases in English. De Schryver & Joffe (2004) noted a similar trend in their data.

Figure 5: Most frequent search terms

Many TAP participants tried to carry out at least one search by sign features, but said they rarely or never used this search direction in their normal dictionary consultation. The exception was that some learners in classes had been given specific tasks and had been shown by their teacher how to use this search facility. Lack of familiarity with the handshape and location parameters of a sign are a barrier to the effectiveness of this search: beginner learners in the TAP said they did not know where to start, and other participants (including a deaf NZSL user who tried to use this search method to find an English equivalent for a sign) talked about the difficulties of isolating the specific features of a sign in motion.

Taken together, these findings lend further support to the conclusion that the ODNZSL's main user group is (hearing) people with an interest in learning the language, mostly at a beginner level, who mainly consult the dictionary for language production.

Over the three month period, all 4,000 entries in the ODNZSL were visited or showed up in search results at least once. This coverage demonstrates that the current dictionary content, with its focus on the most frequent signs and words, is in line with the needs of its main user group. However, given that more than 21,000 different search terms were looked for, this indicates that there are also unmet needs whereby either the dictionary content does not include the searched-for word, or the search does not identify the target.

5.3.2 Search Results

In line with the findings of other studies (e.g. Lew, Grzelak & Leskowicz, 2014), users of the ODNZSL clicked on the first search result more than half of the time (52.82%), as compared to signs appearing in the second position (20.47%) and third position (9.89%). The number of clicks on signs appearing in lower positions steadily declined. It has to be considered that signs are more likely to be displayed in early positions, since all valid searches will have at least one search result but may not have more. The same behaviour can be seen to occur for individual search results, however. For example, the most popular search query, 'hello', returns three different signs. The first search result made up 60% of the clicks, whereas both the second and third search results were selected 20% of the time.

This preference for the first search result in the ODNZSL may not signify a lack of sense discrimination on behalf of the user. For example, the most frequently clicked search result for 'fine' was the second sign with the sense 'alright, ok' rather than the first sign that has the sense of a monetary fine or punishment.

Interestingly, there is some evidence that dictionary users avoided polysemous signs in favour of signs that have a single sense. An example is that in the search results for the query 'cat', the most frequent sign, which also has the general meaning 'pet', was not selected at all whereas the second search result was selected 147 times. Similarly, a general questioning sign with the sense 'what', 'where', or 'why' was passed over in the search results in favour of a less frequent sign with the single sense 'what'.

5.3.3 The Dictionary Entry: Which Information Is Viewed?

Table 3 takes as a typical example the entry for 'play', as shown in Figure 4, to examine use of clickable elements in the entry.

As can be seen, not all page views involved further interaction with the more in-depth information on the page. The most used interactive element was the video of the sign in isolation. The ability to show signs dynamically on video rather than as a static image is hailed as one of the greatest advantages of online sign language dictionaries over printed ones (McKee & McKee, 2013). In the light of this it is interesting to find that only just over 36% of page views involved watching the video. This percentage may be somewhat lower than in other cases: the most viewed video ("how are you" – see Figure 5 – was clicked in 55.84% of all page views. Overall, the video showing the sign in isolation was viewed at least once for 93.81% of all entries, showing that this feature is on the whole well used. Example sentences were viewed considerably less often than the sign in isolation, as were slow-motion views of the videos. Hyperlinks to other content in the dictionary were used least often.

Element	**Number of views**	**Percentage of page views that include a view of this element**
Page views	263	100.00%
Video showing sign production	97	36.88%
Slow-motion video showing sign production	12	4.56%
Video example 1	9	3.42%
Slow-motion video example 1	6	2.28%
Video example 2	15	5.70%
Slow-motion video example 2	5	1.90%
Inflection hyperlink to glossary	0	0.00%
Hyperlinks to other signs in the example sentences	7	2.66%

Table 3: Views of the different elements for the entry 'play'

5.4 Problems and Issues

Looking in more detail at the consultation process shows that users experience problems during different parts of the consultation. These problems can be broadly categorised as either having to do with dictionary navigation or dictionary content.

5.4.1 Dictionary Navigation

During the TAP, participants commented extensively on technical issues such as long loading times and glitches with video playback. If a page was not displayed in seconds, participants would lose patience and click on other parts of the page, try to reload, or give up on the search altogether. This behaviour has implications for the technical design of online dictionaries, especially sign language dictionaries that are required to deal with the smooth display of large quantities of videos.

Participants also experienced difficulties as a result of being unfamiliar with the dictionary interface. Problems with using the 'Search by Sign Features' interface were

discussed in the previous section; but additional problems were encountered with more usual web navigation devices. One participant who had not used the ODNZSL prior to the TAP spent some time trying to locate the search box and commented in the follow-up interview on the layout of the home page and the need for more prominent search facilities. Other participants missed information because the results display required scrolling down. Pagination of search results was also difficult to navigate. It is significantly of note that nearly all participants indicated that the ODNZSL is the first and only online dictionary they have used; in the context of learning other (spoken) languages, they used print dictionaries, and to look up information about English, a general Google search was used instead of consulting an English dictionary (whether in print or online).

Participants' interactions with the ODNZSL interface are coloured by their more general online experiences. Log file data on search terms entered in the ODNZSL show that users searched for extraneous information, such as song lyrics, names of famous people and other proper nouns; there were also instances of terms in languages other than the three languages of the ODNZSL. Within the boundaries of ODNZSL content, it was evident that participants saw the search box as a way of searching the entire site and not just an individual word. Search terms included semantic categories (e.g. 'Natural disasters'; 'personal qualities'; 'zoo animals') and searches for more general information about NZSL (e.g. 'Fingerspelling chart'; 'numbers').

The influence of generic web searches on dictionary interface expectations can also be seen in the way search terms were entered as natural language queries. Thus, we find searches for whole phrases such as 'my name is', 'you owe me chocolate', or 'the bird flew up in the tree', and searches for inflected word forms such as 'am', 'going', 'made', or 'days'.

A final problem with inputting a search query was misspelled or mistyped information. The ODNZSL uses predictive text in the search box to assist with this issue, and some participants acknowledged that this was an advantage of online dictionaries, although in the TAP the correction suggestions were sometimes overlooked.

5.4.2 Dictionary Content

As mentioned in the Introduction, sign language dictionaries have a relatively small content. The ODNZSL contains just over 4,000 lemmas and mainly covers the most frequently used signs and concepts. It is not surprising, then, that many of the 21,000 logged search terms did not find a match in the ODNZSL. Data on these failed searches can be used to identify so-called 'lemma lacunae' (Bergenholtz & Johnsen, 2007). Indeed, since this user study, several of these 'missing' signs, such as sign equivalents for 'turtle', 'pineapple' and 'slide' have been filmed and are currently being processed for appearing online. Other search terms that failed to bring up a

result may be more difficult to resolve. Firstly, there were searches for auxiliaries, modals and forms of the verb 'to be' that do not have a parallel in NZSL. Secondly, lower frequency English words were searched for, including words from more formal and technical registers (e.g. 'Inebriated', 'totalitarian', 'prism'). Finally, some search terms were words that have only recently entered the English language and may not (yet) have an accepted equivalent in NZSL: e.g. 'minecraft', 'unfriend', and 'onesie'.

TAP participants experienced problems once search results were displayed. All categories of participants, but especially beginner learners, found it difficult to distinguish between sign variants with the same English glosses. In the ODNZSL, the most frequently used sign is shown first in the search results; however, this was not always clear to users. Other variation information (such as age, regional or register variation) is provided, when available, in the notes for an individual entry. This requires users to click on each sign in the results in turn: a somewhat cumbersome process, especially when there are instances when the information on NZSL variation is not complete. This prompted users in the follow-up interview to request more information to be displayed in the search results.

Paired with this, however, is the issue of information cost (Nielsen, 2008). Participants commented on the grammar information in the tabs being too dense and mentioned giving up looking at search results when too many were returned at once (e.g. when searching for a very common topic or handshape).

6. Conclusion

Nesi (2013) states that "the aim of all studies of dictionary use is to discover ways to increase the success of dictionary consultation." This paper has confirmed the assumption that online sign language dictionaries have diverse user groups and functions, and has looked at these user groups' consultation behaviour and motivations for using the dictionary. With a better understanding of who the users are and what problems they experience, we can now turn to the question of whether online sign language dictionaries can be improved in order to meet their users' needs.

Although casual, one-off users were found to make up the majority of ODNZSL visits, it is not towards this user group that possible changes to the dictionary should be aimed. Many of these casual users did not engage with the dictionary content in any great depth, and their visits to the ODNZSL do not reflect an ongoing authentic dictionary usage need. This high level of casual interest may nevertheless contribute to more general aims of sign language dictionaries such as supporting recognition and public awareness of the language.

Looking beyond this casual use, distinct user profiles emerged. While there was a common need of dictionary information for language production, there were also differences in the depth of information users wished to access and the frequency level of the signs they wanted to look up. Beginner language learners looked for common

phrases and frequent vocabulary and were likely to be confused by the dictionary layout and overwhelmed by excessive information. Intermediate learners, by contrast, were the most experienced in navigating the website, but wanted to look up less frequent vocabulary and requested more in-depth information on grammar and variation in order to make sense of the search results. A solution to balancing these conflicting needs would be to explore the possibility of customising the display of dictionary content for different users, as mentioned in the Introduction. By displaying the most looked for information early on in the search results (e.g., by allowing users to play the main sign video directly from the search results without needing to click through), beginner language learners can be shown the essential information in a way that keeps the information cost low. More advanced users can then click through to more detailed information.

Improvements to general navigation of the ODNZSL would also lead to increased success. However, any changes to scrolling, pagination of search results, and video display need to be weighed up against possible increased page loading times.

The ODNZSL search methods may have to be adjusted in acknowledgment of the changing behaviour of dictionary users in the digital age that was also noted by Lew & de Schryver (2014). Users expect to be able to enter natural language queries and inflected forms, for example. Adding lemmatisation of the English glosses in the ODNZSL and allowing searches for other fields (such as topics or grammar information) within the same search box may improve the 'hit' rate of search results. Although the 'Search by Sign Features' was user-tested before implementation, this search method currently has a very low success rate. Providing training for users to become familiar with this novel search method may be the first step to improvements.

In terms of dictionary content, it is unlikely that users' desire for additional comprehensive variation and usage information and coverage of technical and infrequent vocabulary can be met in the short term. However, ongoing analysis of log files can identify those missing items that could and should be added to the dictionary.

This paper has shown that user research into online sign language dictionaries has a valuable contribution to make, not only to the dictionary itself but to our knowledge about dictionary users in the digital age and how they interact with novel dictionary formats and features.

7. Acknowledgments

Presentation of this paper has been supported by a grant from the Faculty of Humanities and Social Sciences, Victoria University of Wellington, New Zealand.

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