Semi-automatic Term Extraction for an isiZulu Linguistic Terms Dictionary*

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Abstract: The University of KwaZulu-Natal (UKZN) is compiling a series of Language for Special Purposes (LSP) dictionaries for various specialized subject domains in line with its language policy and plan. The focus in this paper is the term extraction for words in the linguistics subject domain. This paper advances the use of frequency analysis and the keyword analysis as strategies to extract terms for the compilation of the dictionary of isiZulu linguistic terms. The study uses the isiZulu National Corpus (INC) of about 1,2 million tokens as a reference corpus as well as an LSP corpus of about 100,000 tokens as a study corpus. The study is analyzed through the use of a software tool called WordSmith Tools (version 6). WordSmith Tools (hence forth WS Tools) is an integrated suite of three main programs, which include the WordList, Concord and Keywords, used in analysing words and word patterns in any given text. Using the WS Tools software a lot of qualitative and quantitative research can be done in the language. Central to this study is a computational determination of which words are typical of the linguistic domain in isiZulu and therefore stand out as preferred candidates for headword selection. Thus the study uses the corpus linguistics method as a basis for theoretical analysis. The advantage of such a theoretical approach is that a corpus is stored and queried by means of computer and computer software, which makes it easy to find, sort and count items, either as a basis for linguistic description or for addressing language-related issues and problems. Using the WS Tools software, the study shows that term extraction for the isiZulu dictionary of linguistic terms is done following reliable computational techniques in corpus lexicography.

Keywords: TERM EXTRACTION, LGP CORPUS, LSP CORPUS, WORDSMITH TOOLS, FREQUENCY, WORDLIST, CONCORD, KEYNESS, LEXICOGRAPHY, CORPUS LEXICOGRAPHY, HEADWORD SELECTION, LSP DICTIONARY

Opsomming: Semi-outomatiese term-onttrekking vir 'n isiZulu taalkundige termwoordeboek. Die Universiteit van KwaZulu-Natal (UKZN) is besig met die samestelling van 'n reeks Taal vir Spesiale Doeleindes (TSD)-woordeboeke vir verskeie gespesialiseerde vakgebiede wat strook met hul taalbeleid en -plan. Die fokus van hierdie artikel is die termontrekking vir woorde in die vakgebied taalkunde. Die gebruik van frekwensieanalise en sleutelwoordanalise as strategieë in die samestelling van die isiZulu taalkundige termwoordeboek word bevorder. Die studie gebruik die isiZulu National Corpus (INC) van ongeveer 1,2 miljoen items as 'n verwysingskorpus asook 'n TSD-korpus van ongeveer 100,000 items as 'n studiekorpus. Die studie is ontleed

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met behulp van 'n sagteware nutsprogam, WordSmith Tools (weergawe 6). WordSmith Tools (voortaan WS Tools) is 'n geïntegreerde programsuite bestaande uit drie hoofprogramme, wat WordList, Concord en Keywords insluit, en wat gebruik word in die analise van woorde en woordpatrone in enige gegewe teks. Met behulp van die WS Tools-sagteware kan baie kwalitatiewe en kwantitatiewe navorsing in die taal gedoen word. Sentraal in hierdie studie is 'n rekenaarmatige bepaling van watter woorde verteenwoordigend is van die isiZulu-taalkundige domein en daarom voorkeur geniet by trefwoordseleksie. Sodoende word die korpuslinguistiekmetode as basis vir teoretiese analise gebruik. Die voordeel verbonde aan so 'n teoretiese benadering is dat 'n korpus gestoor en geraadpleeg word deur middel van 'n rekenaar en rekenaarsagteware, wat dit maklik maak om items te vind, te sorteer en te tel, óf as basis vir taalkundige beskrywing óf om taalkundig verwante kwessies en probleme aan te spreek. Deur gebruik te maak van WS Tools-sagteware, toon die studie dat term-ontrekking vir die isiZulu taalkundige termwoordeboek gedoen word deur betroubare rekenaarmatige tegnieke in korpusleksikografie te volg.

Sleutelwoorde: TERM-ONTTREKKING, TAD-KORPUS, TSD-KORPUS, WORDSMITH TOOLS, FREKWENSIE, WOORDELYS, KONGRUENSIE, SLEUTELSTATUS, LEKSIKOGRAFIE, KORPUSLEKSIKOGRAFIE, TREFWOORDSELEKSIE, TSD-WOORDEBOEK

1. Introduction

The University of KwaZulu-Natal (UKZN) is compiling a series of Language for Special Purposes dictionaries for various specialized subject domains in line with its language policy and plan (Khumalo 2014: 1). The Language Policy and Plan of the University of KwaZulu-Natal (UKZN) is wholly informed by the country's widely acclaimed constitution, which enshrines multilingualism and provides that every official language must enjoy parity of esteem and must be treated equitably. In line with the provisions enshrined in the South African constitution section 6 (subsection 2 and 4), the Language in Education Policy of 1997, and consistent with the framework as set out in the Language Policy for Higher Education of 2002, and congruent with the Use of Official Languages Act of 2012, UKZN identifies with the goals of South Africa's multilingual language policy and seeks to be a key player in the successful implementation of this policy. Consequent to these statutory provisions UKZN has articulated this commitment through its Language Policy and Plan, which was first approved by Senate on the 2nd of August 2006. The Language Policy and Plan was recently revised and approved by Senate in November 2014.

UKZN has further taken a conscious and practical decision to develop isiZulu through its framework of functional bilingualism. Through this framework it recognizes English as the primary language of its academic program, and commits itself to the development and intellectualization of isiZulu to be a language of administration, teaching and learning, innovation and science. To this end, a detailed Language Plan monitored and evaluated by the University Language Board (ULB) is in place, and a practical Language Program has been set in motion by the University Language Planning and Development Office (ULPDO) in order to fully operationalize the University's Language Policy.

One of the major aims of the UKZN language policy is to achieve for isiZulu the institutional and academic status of English through providing facilities to enable the use of isiZulu as a language of learning, instruction, research and administration in the long term. As a result of these and other language policy objectives there has been a massive language development program, which is isiZulu corpus building and isiZulu terminology development, which are germane in the intellectualization of isiZulu. Work on the building of the isiZulu National Corpus (INC) started in the last quarter of 2014. The INC was piloted in November 2014 at 1, 1 million tokens and now stands at just under 2 million. Terminology development has taken place through arduous resource intensive statutory processes of consultation, verification, authentication and standardization. The terminology that has been standardized and approved by the isiZulu National Language Body include terminology for architecture, anatomy, computer science, corporate relations, environmental science, law, and nursing. A total of 1863 terms are now in the isiZulu Term Bank. The imperative to provide teaching and learning tool in the form of discipline specific dictionaries has thus been voiced. These will enhance cognitive capacity of both the staff and students in accessing otherwise complex scientific phenomenon, which hitherto have been contributing to the negative student performance. Specialized dictionaries are the ones that cover a relatively restricted set of phenomena. This type of dictionary covers the terminology of a particular subject field or discipline. It is also known as an LSP dictionary, which is short for Language for Special Purposes. In this paper we discuss term extraction for an isiZulu linguistic terms dictionary using a corpus linguistics method.

2. Corpus linguistics method

The study uses the corpus linguistics method as a basis for theoretical analysis. According to Sinclair (2005) a corpus is "a collection of pieces of language text in electronic form, selected according to external criteria to represent, as far as possible, a language or language variety as a source of data for linguistic research." The advantage of such a theoretical approach is that "[…] a corpus [is] stored in a computer, it is easy to find, sort and count items, either as a basis for linguistic description or for addressing language-related issues and problems" (Kennedy 1998: 11). A corpus is thus a collection of naturally occurring texts derived from real life language use in either written or spoken form, which is then processed, stored and accessed by means of computers. Such a corpus is then useful as a basis for investigating language use and for developing dictionaries, spell checkers and other human language technologies (HLTs).

The approach we espouse in this study is a corpus linguistic one. We use a language for general purposes corpus (aka LGP) as a *reference corpus* (RC) and a language for special purposes (aka LSP) as an *analysis corpus* (AC). The RC is a non-technical corpus while the AC is a domain-specific, technical corpus. The

LSP corpus used in this study comprises of the two main isiZulu grammar textbooks *Uhlelo lwesiZulu*, and *Izikhali zabaqeqeshi nabafundi*, a collection of isiZulu grammar lecture notes from academics in the School of Arts and the School of Education at UKZN, and online linguistic documents in isiZulu. Using these two corpora that are quite different in terms of content, we compare the behavior of lexical units and identify lexical units that are specific to the AC.

In order to explicate the LSP corpus further, Lynne Bowker (2002: 45) states that the LSP corpus is one that "focuses on a particular aspect of a language. It could be restricted to the LSP of a particular subject field, to a specific text type, to a particular language variety or to the language used by members of a certain demographic group (e.g. teenagers). Because of its specialized nature, such a corpus cannot be used to make observations about language in general. However, general reference corpora and special purpose corpora can be used in a comparative fashion to identify those features of a specialized language that differ from general language …"

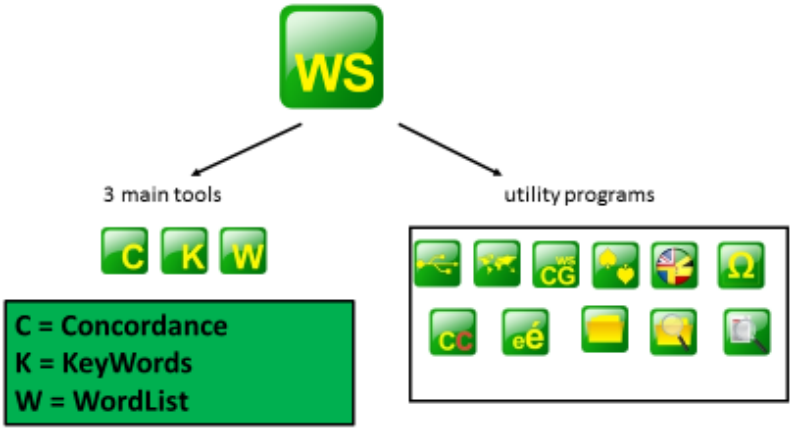
The advantages of LSP corpora are that they contain a wealth of authentic usage information. Since LSP corpora comprise of texts that have been written by subject field experts, the researchers have before them a body of evidence pertaining to the function and usage of words and expressions in the LSP of the field. With the help of corpus analysis tools, it becomes possible to sort these contexts so that meaningful patterns are revealed. An LSP corpus basically contains thousands of words that have been written by subject field experts and, as such, it can be seen to represent distilled expert knowledge.

The RC used in this study is an LGP corpus with 1 186 675 running words. The size of the RC, although still modest, can guarantee that the articles cover a wide range of subjects and that their content is heterogeneous. In contrast the AC is discipline-specific with an exclusive focus on linguistics. The AC is an LSP corpus with 111 922 running words, which comprises two isiZulu basic grammar textbooks and a collection of notes on the teaching of isiZulu grammatical structure.

Our study is analyzed through the use of a software tool called WordSmith Tools (version 6). WordSmith Tools (hence forth WS Tools) is an integrated suite of three main programs, which include the WordList, Concord and Keywords, used in analysing words and word patterns in any given text. WS Tools was developed by Mike Scott, who had earlier worked with Tim Jones to develop MicroConcord. WS Tools was first released in 1996 and the current version (version 6.0) was released in 2011. The Wordlist tool can be used to produce wordlists or word-cluster lists from a text and render the results alphabetically or by frequency order. It can also calculate word spread across a variety of texts. The Concord tool can give any word or phrase in context – so that one can study its co-text, i.e. to see what other words occur in its vicinity. The Keywords tool calculates words which are key in a text, i.e., used much more frequently or much less frequently in a given corpus (e.g. the LSP corpus) than expected in terms of a general corpus of the language (e.g. the INC). Using

the WS Tools software a lot of qualitative and quantitative research can be done in the language. Table 1 below shows the main features of the WS Tools as described above.

Table 1: Wordsmith Tools (version 6)



Central to this study is thus a computational determination of which words are typical of the linguistic domain in isiZulu and therefore stand out as preferred candidates for headword selection. Using the WS Tools software, the study will perform the following. The author will run a frequency list to determine the most frequent words in the LSP corpus. A frequency list provides an array of different types of words, tokens, or forms which make up a corpus. These can be listed from the most frequent token to *hapax legomena* (i.e. those forms that occur only once in a given corpus) or vice versa. Frequency lists are a powerful tool in corpus lexicography. They guide lexicographers on which words to include in a dictionary. Frequency lists also provide developers of second language teaching material with the most relevant words, phrases, and expressions to teach. In this study a frequency list sheds more light on the most common words in isiZulu linguistic domain. These words may be the ones which characteristically typify the domain. According to Kilgarriff (1997: 135) "The more common it is, the more important it is to know it."

3. Term extraction

The focus in this study is the term extraction for words in the linguistics subject domain. Term extraction means the automatic mining or retrieval of relevant terms from a given corpus. Term extraction remains a challenge to anyone interested in domain-specific information retrieval (Jacquemin 2001); (Bouri-

gault et al. 2001); (Drouin n.d.). The goal in this study is to extract words that are typical for the isiZulu linguistic domain. We use the keyword tool in WS version 6 to extract linguistic terms. The main goal is to reduce (not eliminate) the amount of noise in the list of candidate terms.

4. Frequency analysis

It is crucial to affirm the observation by Summers (1996: 261) that "all aspects of lexicography are influenced by frequency." This is particularly crucial in selecting word candidates for inclusion in a dictionary. Headword selection becomes informed by the frequency through a statistical analysis. We premise our analysis on the most frequent 100 words on the assumption that this would be the most typically used words. The word list flows from the most frequent word to the least frequent in a descending order. The most frequent words in the AC are given in Table 2. ***N*** stands for the number the word occupies in the list of words in the word list, and ***Freq.*** is the number of times a word occurs in the corpus.

Table 2: Most frequent 100 tokens

N	Word	Freq.	N	Word	Freq.
1	ukuthi	861	51	bona	67
2	noma	812	52	emva	67
3	bese	512	53	mina	66
4	kodwa	481	54	kubo	64
5	lapho	421	55	ziye	63
6	futhi	419	56	indawo	62
7	ngoba	409	57	kule	62
8	nje	353	58	kwezinye	62
9	ke	342	59	nayo	62
10	ukuba	296	60	kusho	59
11	lokhu	279	61	ngenhla	59
12	khona	262	62	nokuthi	59
13	phela	255	63	yini	59
14	naye	236	64	ala	58
15	ngo	236	65	izakhi	58
16	kanti	231	66	nazo	58
17	kanye	213	67	wena	57
18	ngaye	190	68	leli	56
19	lapha	189	69	isimo	55
20	kahle	187	70	lesi	54
21	no	178	71	laba	53
22	zonke	157	72	zona	53
23	njengoba	152	73	ngazo	52

24	ake	148
25	sithi	148
26	kuye	147
27	na	138
28	ukuze	137
29	lezi	132
30	kanje	131
31	ngokuthi	130
32	lusizo	121
33	usuke	117
34	ngayo	116
35	kube	115
36	kuthi	110
37	ngabe	89
38	lo	87
39	ngu	87
40	manje	85
41	uye	82
42	ba	80
43	kanjani	80
44	lokho	76
45	yakhe	75
46	yonke	73
47	njalo	72
48	lowo	71
49	bonke	70
50	baye	67

74	uhlelo	52
75	wonke	52
76	enye	51
77	lezo	51
78	zakhe	51
79	lolu	50
80	nga	50
81	thina	50
82	yona	49
83	nazi	48
84	ngaso	48
85	ngakho	46
86	yena	45
87	kuze	44
88	kude	43
89	kulo	43
90	kuwo	43
91	nabo	43
92	aba	42
93	kepha	41
94	uzobe	41
95	konke	40
96	siye	40
97	kuzo	38
98	labo	38
99	sakhe	38
100	sika	38

Table 2 shows that the ten most frequent words in the AC are *ukuthi*, *noma*, *bese*, *kodwa*, *lapho*, *futhi*, *ngoba*, *nje*, *ke*, and *ukuba*. All these words are function or grammatical words, which belong to a closed word class. The closed word classes include concords, pronouns, numerals, connectives etc. This top ten word list is not unique as function words commonly dominate all frequency lists. It is therefore the case that functional words are normally removed from the word list in order to retain content words. Table 3 below shows the list of the most frequent 100 tokens after excluding the function words.

Table 3: Most frequent 100 tokens excluding function words

N	Word	Freq.
1	u	829
2	e	550
3	lapho	421

N	Word	Freq.
51	lusizo	121
52	usuke	117
53	ngayo	116

4	ngoba	409
5	isibonelo	387
6	nje	353
7	ke	342
8	ukuba	296
9	ulimi	290
10	lokhu	279
11	khona	262
12	amagama	260
13	o	257
14	phela	255
15	naye	236
16	kanye	213
17	indlela	204
18	umuntu	201
19	kukhona	196
20	ubunye	191
21	ngaye	190
22	njll	190
23	isigaba	189
24	lapha	189
25	kahle	187
26	unkamisa	180
27	kakhulu	173
28	abantu	163
29	zonke	157
30	ubuningi	154
31	njengoba	152
32	ake	148
33	sithi	148
34	kuye	147
35	isenzo	143
36	amabizo	142
37	kusuke	142
38	phakathi	139
39	na	138
40	ibhola	137
41	igama	137
42	ukuze	137
43	lezi	132
44	kanje	131
45	ibizo	130
46	ngokuthi	130

54	kube	115
55	la	114
56	le	111
57	onkamisa	111
58	kuthi	110
59	isakhi	104
60	ndlela	101
61	umntwana	101
62	izibonelo	100
63	kolimi	100
64	leyo	100
65	abanye	99
66	isuke	99
67	kuphela	99
68	yolimi	98
69	izenzo	96
70	izib	96
71	ezinye	95
72	isabizwana	95
73	ngaphandle	95
74	into	94
75	iziqu	94
76	umakoti	94
77	zisuke	90
78	ngabe	89
79	abe	88
80	umusho	88
81	lo	87
82	ngu	87
83	imisindo	86
84	izintombi	86
85	ana	85
86	manje	85
87	ongwaqa	85
88	ubaba	84
89	umoya	84
90	kuba	83
91	kufanele	83
92	uye	82
93	ekhaya	81
94	eqondisayo	81
95	ongenazwi	81
96	ba	80

47	umfana	129	97	kanjani	80
48	ingane	127	98	ukusetshenziswa	80
49	emshweni	126	99	izivumelwano	79
50	inkathi	122	100	isib	77

Table 3 shows the same data as Table 2 with the exclusion of function words. The removal of function words reveals content words that could define the genre. The list of content words reveals clearly the genre of linguistics. For example *u, e, o;* (vowels); *isibonelo* (example); *ulimi* (language), *amabizo* (nouns); *indlela* (mood), *ubunye* (singular) etc. are typical linguistic words. The frequency list has somewhat helped to isolate words that are typical. Other words on the top 100 wordlist are not particular to the discipline. Such words include *ngoba*, *umuntu*, *ngaye* and others. This is not unusual since the top 100 words are not isolated on any measure that isolates words that are typical to a text. In order to achieve this we use the keyword analysis.

5. Keyword analysis

We use the keyword analysis in order to identify words particular to the isi-Zulu linguistics domain. This is done through the calculation of keyness, which isolates words which are key to the AC. According to Mike Scott (2006: 92) keyness is "calculated by comparing the frequency of each word in the word list of the text under investigation with the frequency of the same word in the reference word list." Calculations are done using the Keyword tool of WS Tools. The output is a list of keywords, or words whose frequencies are higher in the AC than in the RC. Table 4 below shows the top 100 words most typical in the linguistic domain extracted through the Keyness tool.

Table 4: Top 100 linguistic tokens

N	Keyword	English gloss	Freq.	Keyness
1	isibonelo	example	387	1515,82
2	i	vowel *i*	1002	1424,26
3	a	vowel *a*	1005	1172,94
4	bese	and	512	875,18
5	ulimi	language	290	773,57
6	uma	if	1179	659,00
7	—	—	—	—
8	—	—	—	—
9	unkamisa	vowel	180	557,61
10	phela	finish	255	510,56
11	e	vowel *e*	550	488,01
12	njll	etc.	190	485,03
13	u	vowel *u*	829	473,92
14	ubunye	singular	191	465,09

15	emshweni	in sentence	126	423,19
16	isigaba	noun class	189	413,95
17	kusuke	from	142	400,56
18	ongenazwi	voiceless	81	392,36
19	ibizo	noun	130	374,68
20	amabizo	nouns	142	368,78
21	amagama	words	260	365,93
22	yolimi	linguistic	98	364,73
23	ubuningi	plural	154	361,18
24	onkamisa	vowels	111	357,17
25	izibonelo	examples	100	356,86
26	kolimi	linguistic	100	356,86
27	isakhi	morpheme	104	351,84
28	zisuke	from	90	350,20
29	isuke	from	99	349,82
30	umusho	sentence	88	341,03
31	usuke	from	117	329,89
32	inkathi	tense	122	324,55
33	isenzo	verb	143	322,38
34	noma	or	812	313,96
35	umakoti	bride	94	309,01
36	onezwi	voiced	63	303,29
37	zenkulumo	of speech	73	299,87
38	o	vowel *o*	257	295,88
39	ongwaqa	consonants	85	293,59
40	iziqu	stem	94	290,38
41	usizo	help	121	281,57
42	konkamisa	on vowels	74	280,32
43	isabizwana	substantive	95	279,64
44	imisindo	sounds	86	273,14
45	umkhongi	negotiator	54	268,64
46	intombi	girl	52	258,69
47	isib	e.g.	77	256,67
48	umfana	boy	129	246,03
49	ngaye	through him	190	239,20
50	abantu	people	48	238,79
51	iqhikiza	full-grown girl	53	235,40
52	izib.	e.gs	96	230,55
53	eqondisayo	inductive mood	81	225,76
54	ukusetshenziswa	used	80	223,45
55	izakhi	morphemes	58	223,20
56	basuke	left	76	222,65
57	izib	e.gs	93	220,98
58	inkomo	cows	70	220,66
59	izivumelwano	agreements	79	219,54
60	unsinini	alveolar	46	219,34
61	sokukhomba	demonstrative	69	218,52
62	yenkulumo	of speech	68	218,48
63	isibanjalo	copulative	68	212,35
64	ana	reciprocal suffix	85	212,06
65	izintombi	girls	86	211,83

66	ziye	gone	63	201,67
67	ingane	child	127	201,46
68	ungwaqabathwa	click sounds	42	199,62
69	zamabizo	nominal	57	196,35
70	isandiso	locative	64	195,85
71	imisho	sentences	63	195,60
72	sithi	we say	148	190,00
73	qaphela	note	65	189,02
74	isiqalo	prefix	63	188,05
75	zesenzo	of verbs	48	187,20
76	isiqu	stem	66	184,66
77	indlela	mood	204	179,69
78	onguputshu	plosive	36	179,09
79	ngonkamisa	are vowels	62	178,77
80	umgudu	cavity	54	176,52
81	ukwakhiwa	morphology	61	171,50
82	ukulandula	negation	58	171,44
83	izenzo	verbs	96	170,55
84	izilimi	languages	71	165,12
85	umkhwenyana	bridegroom	42	162,97
86	udwendwe	que	34	154,04
87	iphimbo	tone	56	153,57
88	sesenzo	verbal	48	153,35
89	izibanjalo	copulatives	47	151,25
90	zabomdabu	of tradition	33	144,03
91	baye	gone	67	142,51
92	ibhola	ball	137	141,52
93	emabizweni	in nouns	44	140,74
94	izingcezu	morphemes	44	140,74
95	sebizo	nominal	45	138,87
96	senhloko	subjectival	49	135,74
97	zezenzo	verbal	48	135,02
98	ndlela	mood	101	134,62
99	intombazane	girl	27	134,32
100	esuke	from	39	132,81

6. Discussion

The 100 keywords in Table 4 are a more typical reflection of the linguistics discipline when juxtaposed with those in Table 3. The keyness tool has successfully extracted terms which are key to the domain of linguistics from the corpus. The list includes the vowels *a, e, i, o, u,* **(3, 11, 2, 38, 13)**; language *ulimi* **(5)**; vowel *unkamisa* **(9)**; singular *ubunye* **(14)**, in a sentence *emshweni* **(15)**; noun class *isigaba* **(16)**, voiceless *ongenazwi* **(18)**; noun *ibizo* **(19)** nouns *amabizo* **(20)**; consonants *ongwaqa* **(39)**; indicative mood *eqondisayo* **(53)**; agreements *izivumelwano* **(59)**; copulative *isibanjalo* **(63)** click sound *ungwaqabathwa* **(68)**; cavity *umgudu* **(80)**; tone *iphimbo* **(87)**; subjectival *senhloko* **(96)**; **etc.**

The top 100 wordlist suggests that the keyness analysis is crucial in iso-

lating data that is domain specific. The results of these experiments are useful as potential candidates for headword selection are highlighted. The study has shown that term extraction for the isiZulu dictionary of linguistic terms is done following reliable computational techniques in corpus lexicography.

7. Conclusion

We explored frequency and keyword analysis in generating domain specific candidates for headword selection. Using such statistical approach is faster, reliable and free from human error or bias. It is clear from the study that corpora are useful in enhancing the dictionary microstructure and the keyness list will form the basis for headword selection for the isiZulu linguistics terms dictionary. Term extraction thus reduces the amount of noise in the list of candidate terms. Native speaker intuition is used to compliment this vital computational resource.

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