

WordNet-Based Bulgarian Sign Language Dictionary of Crisis Management Terminology

Slavina Lozanova

Faculty of Educational Studies and the Arts
Sofia University /
Deaf Studies Institute, Bulgaria
lozanovaslavina@gmail.com

Ivelina Stoyanova

DCL – IBL
Bulgarian Academy of Sciences /
Deaf Studies Institute, Bulgaria
iva@dcl.bas.bg

Abstract

This paper presents an online Bulgarian sign language dictionary covering terminology related to crisis management. The pressing need for such a resource became evident during the COVID pandemic when critical information regarding government measures was delivered on a regular basis to the public including Deaf citizens.

The dictionary is freely available on the internet and is aimed at the Deaf, sign language interpreters, learners of sign language, social workers and the wide public.

Each dictionary entry is supplied with synonyms in spoken Bulgarian, a definition, one or more signs corresponding to the concept in Bulgarian sign language, additional information about derivationally related words and similar signs with different meaning, as well as links to translations in other languages, including American sign language.

Keywords: Online dictionary, Bulgarian sign language, WordNet, crisis management, COVID.

1 Introduction

The Deaf community is a minority community characterised by its own history (history of the Deaf), original culture (culture of the Deaf) and social life, all of which are based on a specific territorial sign language (whether officially recognised in the country or not). The Bulgarian Sign Language (BGSL) was officially recognised in Bulgaria in January 2021 as the language of the Deaf community. The official recognition guaranteed Deaf people's right to access to information and education through sign language.

However, the Deaf community is heterogeneous and the individual specifics of language development, the modes of communication, etc. vary significantly between users. There is a group of sign

language users who acquire the language in the family at an early age and it becomes their primary mode of communication. They acquire spoken language (to a various degree depending on their hearing and spoken skills) through school and speech and language therapy.

When sign language is acquired at a later age, after relatively good verbal language skills have been developed, sign language competence is built on verbal competence, and in this case sign language is used as a second language. Over time, both languages can be used simultaneously, and in some cases sign language can also play a dominant role in the deaf person's daily communication. However, predominantly in this case the verbal language influences the sign language and we observe 'signed Bulgarian' rather than the authentic sign language.

This paper presents an online Bulgarian sign language dictionary covering terminology related to crisis management. The need for such a resource became very pressing during the COVID pandemic when critical information regarding government enforced measures was delivered on a regular basis to the public. Although government briefings were supplied with sign language interpreting, many sign language users faced difficulties in understanding properly and fully the information. There were words that had no signs known to the Deaf community at large, or such signs varied significantly between users and local Deaf communities. We attempted to collect and present variations of the signs, registering preferences among the users and raising discussion within the community with respect to particular signs and their meaning.

Our approach towards building the dictionary relies on linking it to WordNet as a large lexical-semantic resource. In this way we are able to employ all the descriptive information on the concepts that is available in WordNet and the Bulgarian

WordNet (BulNet), but also to use the numerous semantic relations between concepts.

The dictionary is available freely on the internet and is aimed at the Deaf community, Bulgarian sign language interpreters, as well as interpreters of other low resourced sign languages, learners of Bulgarian sign language, social workers, sign language researchers and the wide public.¹

The structure of the paper is as follows. Section 2 discusses the challenges sign language communication poses to Deaf users in time of crisis and thus, presents the motivation behind the creation of the dictionary. Section 3 provides a brief overview of related works, mainly sign language dictionaries available online for different well resourced and studied sign languages. Section 4 outlines the steps in compiling the verbal side of the dictionary including the construction of the text corpus, its processing, keyword extraction, word sense assignment. The collection of signed speech, sign annotation and analysis of variations of signs is presented in section 5. It is followed by a description of the structure and components of the dictionary (section 6) focused on specific sign language features and their representation. The last part (section 8) gives some directions for future work both on expanding the coverage of the dictionary and improving the description of entries and the possible applications of the resources.

2 Specific features of sign language communication and standardisation with view to crisis management

When communicating through sign language, the following descriptive parameters of the performed signs are important (Valli et al., 2005; Baker, 2016):

- hadshape – the configuration of the hand(s) and the position of the fingers;
- palm orientation – the position of the palm(s) during signing;
- movement – the direction of movement or the fixed, stative position of the hand(s) during signing;
- location where the sign is performed relative to the body;
- non-manual expression – facial or body signals.

¹<https://study.deafstudiesinstitute.bg/course/view.php?id=8>

The different parameters and their combination change the meaning of the message, e.g. see examples of minimal pairs of signs². These specifics need to be taken into account when building a dictionary of sign language and especially with a view to crisis management where the precision and punctuality of the delivered message is of paramount importance. Ambiguity of signs as well as signs with similar presentation, in particular with a view to the way they appear on screen (e.g., in TV broadcast, online video, etc.), need to be analysed and avoided, if at all possible.

Crisis management applies to different situations and in dynamic circumstances – situations of crisis, evacuation, emergency, natural disasters (earthquake, fire, flood), extreme weather such as heavy rain and snow, tornadoes, etc. (Manoj and Baker, 2007). The message should be delivered efficiently and clearly in sign language by an experienced interpreter. This raises the need for standardisation so that the language used is understood over the whole territory of Bulgaria and by all sign language users irrespective of their predominant mode of communication, sign language variety acquired and level of language skills. This in turn necessitates the comparative analysis of the variations in signs in order to facilitate the standardisation process.

Standardisation can be aimed at both the verbal and the sign language used in times of crisis when communication with Deaf citizens. Standard verbal language messages can be compiled and taught to Deaf school children as well as adults in order to familiarise them with common text patterns used in warning messages in crisis situations. This type of formulaic language is used in many areas such as airplane safety messages, traffic signs, etc.

Sign language standardisation is not a random choice of formal gestures, but a complex process that takes into account a number of linguistic, pragmatic and sociolinguistic factors related to the domains of communication, the diversity of territorial and social variations, the influence and acquisition of signs from foreign sign languages, the language needs of different groups of deaf people and many others. It is essential in this process that standardisation is not at the expense of linguistic diversity and richness, which deprives the users of linguistic means and productive models for expressing meanings and their nuances. The World Federation

²<https://www.handspeak.com/learn/index.php?id=109>

of the Deaf has warned against negative trends in standardisation which in the long term alienate and deprive language communities of their authentic language³.

Standardisation is essential for the provision of quality interpreting services and is a long and controlled process based on language analysis and conscious attitude towards the language by its speakers, supported by sign linguists, interpreters and other professionals. In this sense, the standardisation of sign languages is a responsible activity, as much as the construction of literary verbal languages (for decades), as well as their enrichment and development through research, language training of native speakers and new learners.

3 Related work

There are many large dictionaries for sign languages across the world which have been made available online: American sign language (ASL)⁴, British sign language (BSL)⁵, Australian sign language (Auslan)⁶, German sign language (DGS, Langer et al.)⁷, Swedish sign language (STS)⁸, among others. Although these dictionaries are predominantly monolingual, in recent years there have been efforts to create some multilingual or linked dictionaries across several languages, either general such as Spread the Sign⁹, or domain-specific such as Hands in the Stars (specialised in astronomy)¹⁰.

For the Bulgarian sign language the largest modern dictionary is available only as a book both in printed and electronic format (Tisheva et al., 2017).

During the COVID pandemic many of the larger sign language dictionaries included the new concepts or those that gained popularity and were essential for the management of the crisis: coronavirus, COVID-19, pandemic, etc. Additional efforts have been focused on preparing informational

materials in many sign languages to inform the Deaf about the pandemic. Information materials have been developed for children as well. An example is the initiative of Rise e-books to present coronavirus stories for children¹¹.

The development of the dictionary presented in this paper relies on its linking to Princeton WordNet (Miller et al., 1990; Fellbaum, 1999) and the Bulgarian counterpart, BulNet (Koeva, 2010), modelled after the Princeton WordNet. This approach facilitates the exploration of all semantic relations within the network (Ruppenhofer et al., 2016), as well as using the links to other languages (Vossen, 2002, 2004; Bond and Foster, 2013) and resources (Shi and Mihalcea, 2005; Leseva and Stoyanova, 2020) to expand the resource and its applications in both human-oriented products (e.g., resources for language learning for Deaf users) or natural language processing (e.g., in processing multimodal content such as sign language production, machine translation, question answering, etc.).

There have been limited attempts to link sign language dictionaries to WordNet (Lualdi et al., 2019, 2021; Wright, 2021). The mapping of WordNet senses to signs faces similar challenges as the development of WordNet for other minority languages with limited resources (Bella et al., 2020).

To the best of our knowledge, no efforts exist towards building a crisis management sign language dictionary which includes Bulgarian sign language. Also, there are no initiatives at present aiming at standardisation of crisis-related terminology in Bulgarian sign language or establishing any principles and considerations regarding standardisation.

4 Selection of concepts for the Bulgarian Sign Language Dictionary of Crisis Terminology

The selection process of the key concepts to be included in the Dictionary included the following steps. First, a large text corpus of briefings and COVID-related news was compiled and automatically processed. Secondly, a list of keywords were extracted. Thirdly, the keywords were matched to candidate WordNet senses and then manually disambiguated. This process resulted in a selection of over 4,000 concepts which are then filtered down to 500 most frequent concepts in the sign language data (see section 5).

³<https://wfdeaf.org/news/wfd-statement-on-standardized-sign-language/>

⁴<https://www.handspeak.com/word/>, <https://www.signasl.org/>

⁵<https://www.british-sign.co.uk/british-sign-language/dictionary/>, <https://www.signbsl.com/>

⁶<https://auslan.org.au/about/dictionary/>

⁷<https://www.sign-lang.uni-hamburg.de/glex/intro/inhalt.html>

⁸<https://teckensprakslexikon.su.se/>

⁹<https://www.spreadthesign.com/en.gjb/search/>

¹⁰<https://www.iau.org/news/pressreleases/detail/iaul706/>

¹¹<https://riseebooks.wixsite.com/access/copy-of-coronavirus-stories>

4.1 Text Corpus: compilation and processing

The text corpus was automatically compiled by crawling the official website publishing regular briefings and news articles on COVID and the measures enforced by the government¹². A set of televised video recordings have been automatically transcribed using Google Cloud Speech-to-text API¹³. Since this process was aimed at collecting preliminary material for analysis, precision of transcriptions was not considered and no manual evaluation or editing was performed.

The compiled text corpus included 158 official briefings and 282 news articles with a total of 365 thousand words. The texts have been tokenised, lemmatised and POS-tagged using the Bulgarian Language Processing Chain (Koeva and Genov, 2011)¹⁴.

4.2 Keyword extraction and classification

For keyword extraction we apply the following procedure: (a) we filter out words from closed classes such as prepositions, pronouns, etc., as well as general stop-words with no domain specific meaning – the stoplist was compiled to include words that appear with high frequency in many different domains in the Bulgarian National Corpus (Koeva et al., 2010); (b) we use frequency ranking of full meaning words to identify keywords typical for the whole corpus; (c) we use the TF-IDF (term frequency-inverse document frequency) method to identify keywords at document level.

As a result, in the first stage we identify a list of 4,350 candidate keywords which are single words – nouns, verbs, adjectives and adverbs.

The identified keywords were manually validated and classified into six predetermined domains: (1) Healthcare, (2) Governance, (3) Statistics and data presentation, (4) Economy and finance, (5) Social care, and (6) Crisis. In about 15% of the cases words are assigned more than one domain (e.g., bg. *epidemiya* – *epidemic* is categorised both in the domains of Healthcare as well as Crisis).

Additionally, the list was expanded with 212 multiword expressions which appeared with high frequency in the text corpus and for which usually one of the components has been identified as a

keyword (e.g., we added bg. *bolnichno otdelenie* – *hospital ward* where only the adjective bg. *bolnichen* – *hospital* has been identified as a keyword).

For each selected keyword (single word or multiword expression) we compiled a list of usage examples from the text corpus allowing us to check the sense in which the word is used in the data.

4.3 WordNet sense assignment and disambiguation

For each keyword we automatically identified all potential WordNet senses that apply to it – from the Bulgarian WordNet (Koeva, 2010) we found all synsets that the keyword appeared as a literal in. Then the appropriate sense was manually selected and assigned after analysing the examples from the text corpus.

In some cases more than one sense of the word appeared in the dataset (e.g., bg. *seriozen* is met both in the meaning of *serious*: bg. *seriozno sastoyanie* – *serious condition* and *strict*: bg. *seriozni merki* – *strict measures*).

After a unique WordNet sense has been assigned to the keyword, all its synonyms (if available in BulNet) and the definition were extracted and added to the description of the keyword.

There were also cases (around 9%) where no WordNet sense was a match, or the word was not found in BulNet. In those cases the definition was created manually.

5 Sign language data collection and processing

After the preliminary lists of keywords in the different domains have been prepared, we started collecting and processing the sign language material. Principles of work has been established after the first stages of the data collection since there is very limited experience nationwide in collecting linguistic data in Bulgarian sign language.

5.1 Sign language data collection

Sign language data was collected during six online meetings with Deaf sign language users. Each meeting had a particular topic – one of the domains (see 4.2), and was lead by two Deaf moderators and was recorded in video format. All participants are displayed on the screen simultaneously (the speaker was not put in spotlight) since very often they spoke in sign language simultaneously and we wanted to collect as much data as possible. A

¹²<https://coronavirus.bg/>

¹³<https://cloud.google.com/speech-to-text>

¹⁴<http://dcl.bas.bg/dclservices/index.php>

screenshot of a recording is shown in Fig. 1 where several signers sign simultaneously (top row second from the left, middle row rightmost signer, and bottom row leftmost and rightmost signers). Some of these signs express confirmation, rejection or other evaluation on the sign performed by a moderator, which is also relevant information although we have not used it at this stage.

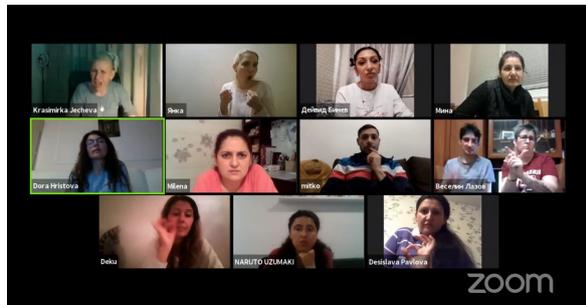


Figure 1: A screenshot of meeting recording

The participants (usually between 8 and 12) were from various cities across the country to ensure representativeness of the main regions formed around the large Deaf regional centres in Sofia, Plovdiv, Varna, Gorna Oryahovitza and Burgas.

For each meeting the moderators had prepared a list of discussion questions which involved the target concepts of the selected keywords. In some cases the concepts under observation were directly presented by the moderators using signs or in a written form, and the discussion was directly focused on the variations of the signs.

5.2 Sign language annotation

Sign language annotation of recorded meetings was performed on the ELAN platform (Crasborn and Sloetjes, 2008)¹⁵ by the authors, who are fluent in Bulgarian sign language. Each participant in the recorded meeting was assigned a separate annotation layer since many participants signed at the same time.

Fig. 2 shows an annotated short excerpt of a recording. At present we have limited the annotation to cover only relevant lexical units (target signs) belonging to the target domains in order to make the annotation process more time-efficient and manageable. In some of the discussions interesting signs typical for the domains have emerged such as names of people, organisations or medical establishments – names of major hospitals, e.g. *Pirogov Multi-profile Active Treatment &*

¹⁵<https://archive.mpi.nl/tla/elan>



Figure 2: A screenshot of ELAN annotation tool

Emergency University Hospital, newly established government structures, e.g. *National Operational Headquarters for Combating Covid-19*, or other organisations *World Health Organisation*). These signs have also been annotated and some of them included in the Dictionary.

The sign language material offers many other possibilities for annotation in future studies on Bulgarian sign language lexical system, structure of signs, communication and conversation patterns, etc.

5.3 Sign selection

After the recordings had been annotated, all occurrences of the target signs for each domain were automatically extracted and analysed in terms of frequency and variations. From them, the most representative sign variations for each keyword were selected. As representative were considered signs that: (a) were used by more than one signer; and (b) were used on more than one occasion. A single occurrence of a sign in the data does not necessarily mean that the sign is in use since it could be an occasional occurrence, individual invention or copied from a foreign sign language.

In some cases for very similar variations which are not questionable and would be understood by all sign language users (e.g., with slight variation of either handshape, palm orientation, movement or place of performance) only one of the variants was selected, usually the most specific, with the complete motion performed, or the most elaborate and thorough one. For example, the sign for *lekarstvo* – *medicine* can be performed with or without the supporting second hand (that stays in a fixed position with a flat palm up and only serves as a base for performing the sign with the main hand) – the full sign performed with both hands is recorded for the Dictionary while the simplified version is not

included, i.e. it is considered as a non-essential variation based only on simplification.

For some keywords no suitable signs were found in the data when: (a) the Deaf moderators deliberately excluded some keywords from the discussion if the signs were clear, well-established and frequently used in the language; (b) the signs were omitted from the discussion; (c) the participants did not know the sign for a given keyword; (d) the participants were not familiar with the concept under discussion. These words were not included in the Dictionary.

6 Structure of the Dictionary and components of the description

The first release of the Bulgarian Sign Language Dictionary of Crisis Management Terminology covers 600 concepts appearing with high frequency in the information regularly released by government officials and news agencies during the COVID pandemic. The entries are both single words and multiword expressions. Although primarily focused on the pandemic, the Dictionary also covers a variety of domains and terminology. In the future, the Dictionary can serve as a model for building language resources in Bulgarian sign language aimed at Deaf signers, sign language learners, interpreters, etc.

Each dictionary entry is supplied with extensive description. As a bilingual dictionary in spoken (verbal) Bulgarian and Bulgarian sign language, the Dictionary is also multimodal – it includes video presentation of the sign component and text description of the verbal component of the translational pairs.

In the description of each entry we also include information about the relation of the spoken word to other words, multilingual translational equivalents, including a translation into American sign language (ASL), text usage examples, etc. Most of the descriptive information of the verbal component is extracted from WordNet automatically. The description of the sign component is compiled manually since so far there are no available electronic and computationally processable resources for Bulgarian sign language, and there are still very limited processing tools for any sign language.

6.1 Information from WordNet

The Dictionary entries are linked to WordNet synsets (covering over 90% of the entries). From the Bulgarian wordnet we add the following compo-

nents of the description of the verbal components of the dictionary entry: (a) all synonyms of the identified keyword that appear in the synset; (b) the definition of the concept; (c) translational equivalents in other verbal languages.

Translational equivalents are extracted from various wordnets available through the Extendend Open Multilingual WordNet project (Bond and Foster, 2013)¹⁶. The wordnets are linked to the Princeton WordNet, and thus to each other and to the Bulgarian WordNet. Translations are provided wherever possible in up to 20 languages.

Moreover, the dataset is linked to one of the ASL online dictionaries – HandSpeak¹⁷. The mapping to ASL so far has been performed semi-automatically by processing the wordlist of the HandSpeak dictionary and matching it to the English translational equivalents of the Bulgarian word entry. The mapping was then verified manually.

The structure and organisation of the Dictionary allows linking to other languages as well through WordNet, and also to other sign languages through the links to ASL. However, research is still ongoing on mapping ASL to WordNet and to the best of our knowledge no data have been released so far.

6.2 Sign language specific features

Each sign is presented as a video recording and is performed by a skilled Deaf sign language user who is fluent in the language but also is experienced in presenting sign language in front of the camera. For each entry we also have recorded variants of the signs. There has been no research on sign formation in Bulgarian sign language. Although we call all signs that corresponding to a given concept 'variants', it is clear that in some cases these are new independent signs, thus we need to consider them as synonyms rather than variants.

Descriptive features (labels for handshape, palm orientation, direction of movement, etc.) of the signs have not been included in the present version of the Dictionary, but are envisaged for future releases.

A special part of the description of each dictionary entry are the relations to other words (in the verbal component) and to other signs (in the signed component). The derivationally related words, or

¹⁶<http://compling.hss.ntu.edu.sg/omw/summx.html>

¹⁷<https://www.handspeak.com/>

words that share the same root as the dictionary entry word, are relevant because very often they share the same sign. In particular, this is valid for a root word and its derivatives in other parts of speech.

For the purposes of the Dictionary we extract derivational relations from WordNet. We do not take into account the direction of derivation since it is not represented in WordNet. Derivationally related words often have similar meaning, and are often represented by the same or similar signs in the Bulgarian sign language (e.g., the sign for bg. *bolen – ill* is the same as the sign for bg. *bolest – illness*).

However, special attention should be paid to any exceptions:

- Different signs for derivationally related words with close semantics (e.g., there are different signs for bg. *lekar – doctor, medic* and bg. *lekarstvo – medicine*);
- The same signs for words that are only semantically and not derivationally related (e.g., we have the same signs for bg. *lekar – doctor* and bg. *bolnitsa – hospital*, as well as for bg. *aptekar – pharmacist* and bg. *lekarstvo – medicine*).

Similarly, attention should be paid to the cases where the same or very similar signs are used on semantically distant words. For example, the same sign is used for bg. *lineyka – ambulance* and bg. *politseyska kola – police car* (the sign is based on the siren and flashing lights of both vehicles). These also can cause confusion when used in delivering crucial information during crisis. Usually the disambiguation relies on the articulation of the signer (the signer mouths the word) or an additional sign (e.g., adding the sign for *medical* or *police*).

These irregularities pose a problem to interpreters and language learners, and this is why we consider the information relevant and beneficial to include in the dictionary. Moreover, since the main objective of the dictionary was to ensure the good quality and the high precision of the delivered information during crises, these relations provide a good starting point to investigate further and establish good practices for sign language presentation and interpreting.

6.3 Additional information

The additional information comprises:

- links to other lexical resources, most notably the online dictionaries of the Institute for Bulgarian Language where the users can find more information about the word, an alternative definition, as well as to seek information about multiword expressions;
- examples of the use of the word, excerpted from the text corpus of briefings and news articles;
- excerpts from the video recordings were added demonstrating the use of the sign in context. At present these examples apply to a small number of dictionary entries as they required manual processing and selection.

7 Online access

The Dictionary is freely available online on the educational platform of the Deaf Studies Institute¹⁸ and is distributed under Creative Commons Attribution 4.0 License.¹⁹

The Dictionary entries can be listed in two ways – in alphabetic order of the keywords or by domain (see list of domains in section 4.2) for easier access to related terms. As some words are assigned more than one domain, they appear in more than one domain-specific list. A functionality to search by word or phrase is also added on each page of the Dictionary.

Fig. 3 shows the dictionary entry of bg. *bolnitsno otdelenie – hospital ward* with the components of its description.

Under each video of a sign there is a button to confirm or reject the validity of the sign. This feedback functionality can serve as crowdsourcing validation of dictionary entries. No efforts in the direction of the validation, testing sign language users preferences or standardisation have been made so far for the Bulgarian sign language.

8 Conclusions and future work

The present paper shows the compilation process of the Dictionary of Bulgarian Sign Language for Crisis Management. The dictionary is suitable to be used by Deaf people, sign language interpreters, learners of sign language, social workers and the

¹⁸<https://study.deafstudiesinstitute.bg/course/view.php?id=8>

¹⁹<https://creativecommons.org/licenses/by/4.0/>

ЖЕСТОВ РЕЧНИК ЗА КРИЗИСНИ СИТУАЦИИ

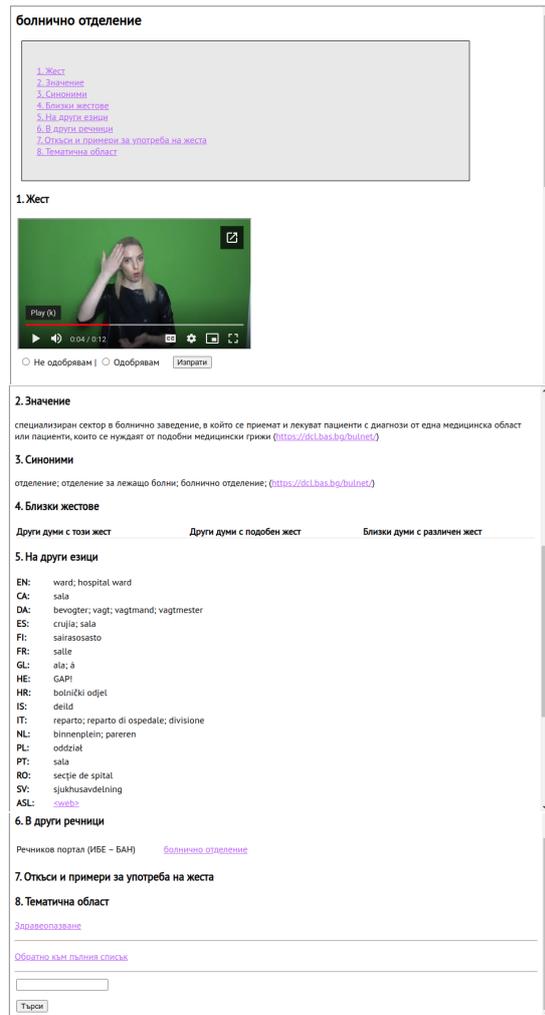


Figure 3: A screenshot of a dictionary entry (1: Sign, with Improve / Disapprove buttons underneath; 2: Definition; 3: Synonyms; 4: Similar signs; 5: Other languages, incl. ASL; 6: Information from other dictionaries; 7: Examples of usage; 8: Domain; Link to the word list; Search field)

wide public. It can accompany educational and information materials focused on crisis management. Although the selection of the concepts is based on a text corpus collected from COVID-related topics, the Dictionary covers six different domains. Moreover, the model of data collection and analysis can be applied to expand the dictionary in volume and in number of domains.

This work is also a first step towards the standardisation of Bulgarian sign language used in time of crisis which requires efficient and unambiguous information. In this respect we need more targeted efforts in collecting user feedback, observations on attitudes towards particular signs, investigating sign ambiguity, etc.

Future work will focus on adding new features to dictionary entries such as textual descriptors of sign components (handshape, palm orientation, motion, etc.). This will allow for searches by sign features (if a sign’s meaning is not known).

An interesting application of the sign language dictionary is in the field of language education for creating interactive materials and linked resources introducing new concepts and supporting the learning of Deaf children. An example of such interactive books for preschool and primary school children is shown on Fig. 4. For this purpose we need to expand the dictionary with more topics and to improve the description of dictionary entries.



Figure 4: Interactive book for language education accessing an online dictionary and its fields (image, sign, definition, etc.)

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