ETHICOMP 2021

Moving technology ethics at the forefront of society, organisations and governments

ETHICOMP BOOK SERIES

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EDUCATIONAL SOFTWARE FOR SPEECH UNINTELLIGIBLE CHILDREN WITH DOWN SYNDROME

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INTRODUCTION

Down syndrome (DS) is a genetic disorder, which is associated with mild to severe intellectual disability and speech difficulties (Rice, 2005). Children with DS have atypical phenotypic features, including tongue anomalies, low oral-facial muscle tone, and difficulties in motor planning, resulting in severe acoustic alterations and disability of articulating some sounds (Carl, 2020). Heavy struggle with saying words and sounds was noticed among 85% of 1620 surveyed children with DS (Kumin, 2006). Being aware of their speech production deficit, they become frustrated and start using multimodal communication, combining manual signs, voice, facial expressions, and gestures (Toth, 2009). Unlike the problems with speech articulation, children with DS show excellent skills in gesture acquisition and production, compared to their peers with typical development (Deckers, 2017). Niki, the boy who successfully played the memory game (Zdravkova, 2020) and his mother managed to become proficient in Macedonian sign language (SL), establishing an easier mutual communication for the first time. This accomplishment raises the following questions: will the imposing of SL be beneficial for speech unintelligible children with DS; can educational games support understanding and acquisition of SL; how to design and assess children with DS who frequently do not master reading (Martin, 2009).

Enabling human rights, including the right to access information, to enjoy a decent life and express freely are vital to human welfare, dignity and active participation in community (UNICEF, 1989). Everyone is entitled to all these rights, embracing mentally or physically disabled, who are usually not self-reliable. Any focused, well-planned, and carefully implemented activity that improves the interaction with and among the speech unintelligible, without forcing them to leave their comfort zone and feel anxious due to the incompetence to adapt to new obligations can positively contribute to the improvement of the quality of life of these people. Since 1950s, many methods and assistive technologies intended to supplement or replace a wide spectrum of speech and language disabilities, have been developed as part of the augmentative and alternative communication (AAC) (Elsahar, 2019). Implementation of MAKATON, a sign language system that enables augmentative and alternative communication proved that their communication and socialization significantly improved (de Almeida Barbosa, 2018). All these arguments confirm that SL can be a valuable interaction alternative for speech unintelligible, including children with DS.

A plethora of applications are dedicated to SL interpreting. Popular Hand Talk Translator (www.handtalk.me), a 3D interpreter, which translates text and audio into American and Brazilian SL has already been used by half billion deaf and hard of hearing. Microsoft Translator (translator.microsoft.com) enables text-to-speech translation, and it has already been experienced by US students. It successfully converts raw spoken language and stutters into fluent American English. Microsoft also made similar feats, presenting a Kinect based system for SL translation (Chai, 2013). The Kinect sensor was later abandoned in favour of Intel Real Sense devices that provide similar features. Applications that focus on providing educational framework for SL are less popular than SL translators / interpreters. This is especially problematic when enabling learning of SL for children with intellectual

and speech disabilities. To assess the gamified education approach for children with DS, five popular applications in terms of downloads that focus on learning a SL have been assessed on several clear and distinguishable features. One aspect that is of interest for children with DS, is to create engaging environment and track the progress, usually by encouraging gamification features. Another important feature is the primary goal of the application, to enable an alternative way of communication or to establish it. The applications that rely on iconographic navigation (like ASL Fingerspelling game) are suitable for those children, who have no communication skills. The results are presented in Table 1 on the following page. They prove that educational games can significantly or partially improve interaction of both speech unintelligible and children with DS.

Table 1. SL acquisition applications and implemented approaches for visualization and learning.

Application	Availability	General features	Navigation and UI	Suitability for children with DS
SL ASL - Pocket Sign	Android, iOS	Video and image based, quizzes, progress tracking	Combination of text and iconography	Completely
ASL American Fingerspelling game	Android	Card and image-based content, quizzes, progress gamification	Combination of text and iconography	Completely
Sign Language: ASL Kids	iOS, Android	Video and image based, quizzes, progress tracking, gamification	Mainly iconographic	Completely
Hands On ASL Fingerspell with SL	Android, iOS	Learning fingerspelling, 3D hand models, quizzes and progress tracking	Text based	Partially
Mimix3D SL	Android	3D avatar, progress tracking, text to SL translation	Text based	Partially

DESIGNING EDUCATIONAL SOFTWARE FOR SIGN LANGUAGE ACQUISITION

Educational software for children with DS enabling acquisition of Macedonian SL is designed as a sequel of three games that complement each other. The goal of the first game is to demonstrate the sign language by enabling recognition and presentation of alphabets of Macedonian standard and sign language (Figure 1); the second aims to empower the acquisition of the most frequent words; the most advanced will support the creation of simple sentences.

Demonstration segment of the first game has already been created, following the nine recommendations of educational games for children with DS (Zdravkova, 2019). The application was created in HTML, powered by CSS framework for adding styles and colors, and React JavaScript library for user interface. It is currently available as a desktop application with optimized version for mobile phones and tablets. It presents SL alphabet with one hand (Figure 2), separate presentation of each letter (tab “Изучи ја азбуката”, Figure 3, left screen), matching of letters presented with SL and their written equivalent (tab “Погоди”, Figure 3, central screen) and a memory game with several levels (tab “Меморија”, simple level, Figure 3, right screen). All the written content on the screen is associated with a pre-recorded message with natural voice, bypassing illiteracy of many children with DS.

Figure 1. Home page of the Web application.

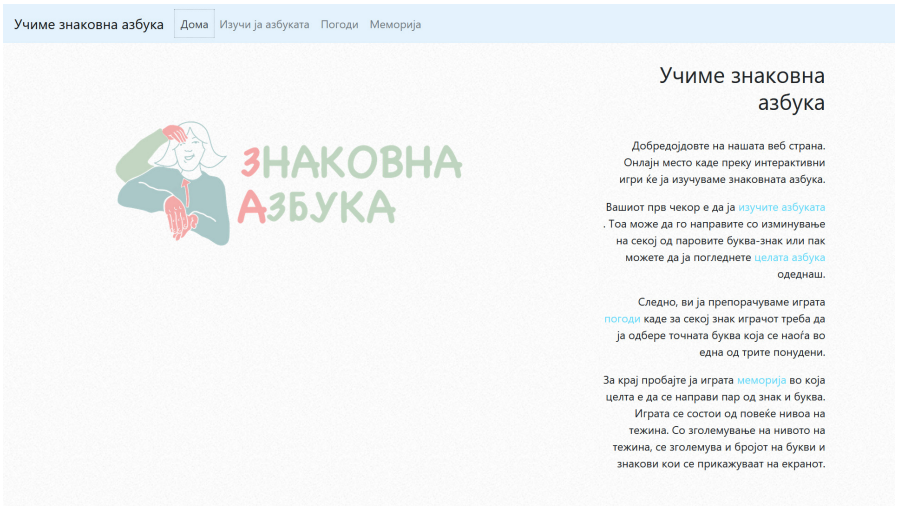


Figure 2. Web site and mobile application presenting part of the Macedonian sign language.

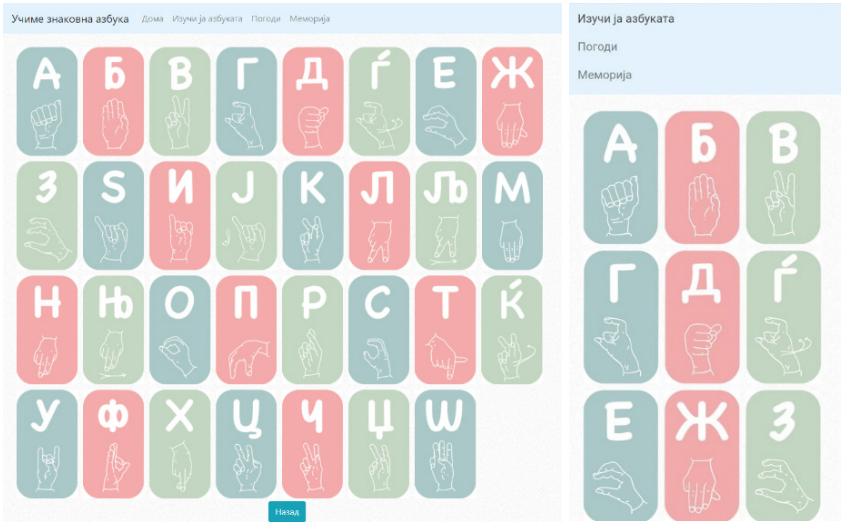
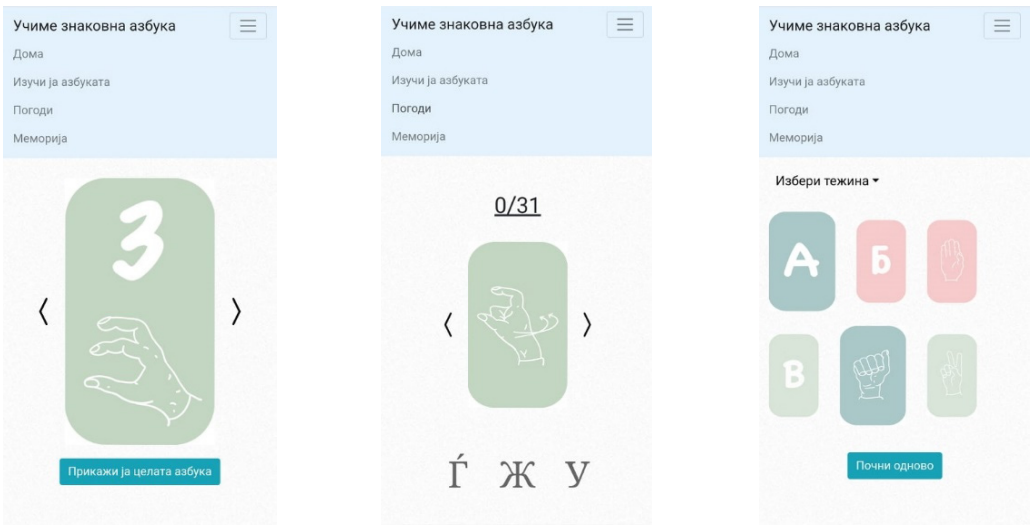


Figure 3. Presentation of both alphabets on one card, matching sign language character with the corresponding letter and memory game with one successfully matched pair.



In the next two games, the acquisition of frequent words and phrases will be enabled. Static and dynamic signs will be presented using 3D avatar visualization (Joksimoski, 2015). The assessment will initially be made by embedding the concept of memory games, based on matching an image with the corresponding sign. There are multiple approaches that can be utilized to achieve this. One approach is to use standard cameras and perform real-time analysis of the video, a field of active research. The second approach is to use specific sensors, like depth-based cameras (e.g., RealSense, Kinect).

Most of the children from day-care centre for children with DS in Skopje are speech unintelligible. They deserve equal rights to communicate and express their needs and feelings. The main prerequisites to assess the gamified approach are fulfilled. All the children with DS are eager to use multimodal communication, they are competent for gesture acquisition and production and they like playing mobile games. The day-care centre is currently closed due to Covid-19 pandemic. To start the evaluation of the application, the link has been sent to several children who are supposed to try it with assistance of their families. Except Niki, who is already familiar with the sign language alphabet, and who proudly presented his skills, other children had no interest to even try it. Therefore, the presentation is postponed for the reopening of the centre. Children feedback and suggestions by the language specialists will be crucial to make the improvements to current version and to offer it after the corrections and the enhancements on GooglePlay.

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KEYWORDS: Down syndrome, educational software, sign language, verbal apraxia.

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