# INFORMACIJSKA DRUŽBA

Zbornik 26. mednarodne multikonference

Zvezek H

# INFORMATION SOCIETY

Proceedings of the 26th International Multiconference

Volume H

## Digitalna vključenost v informacijski družbi

## Digital Inclusion in Information Society

Urednika • Editors:
Matjaž Debevc, Ines Kožuh

11. oktober 2023 | Ljubljana, Slovenija • 11 October 2023 | Ljubljana, Slovenia

IS2023

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# PREDGOVOR MULTIKONFERENCI INFORMACIJSKA DRUŽBA 2023

Šestindvajseta multikonferenca Informacijska družba se odvija v obdobju izjemnega razvoja za umetno inteligenco, računalništvo in informatiko, za celotno informacijsko družbo. Generativna umetna inteligenca je s programi kot ChatGPT dosegla izjemen napredek na poti k superinteligenci, k singularnosti in razcvetu človeške civilizacije. Uresničujejo se napovedi strokovnjakov, da bodo omenjena področna ključna za obstoj in razvoj človeštva, zato moramo pozornost usmeriti na njih, jih hitro uvesti v osnovno in srednje šolstvo in vsakdan posameznika in skupnosti.

Po drugi strani se poleg lažnih novic pojavljajo tudi lažne enciklopedije, lažne znanosti ter »ploščate Zemlje«, nadaljuje se zapostavljanje znanstvenih spoznanj, metod, zmanjševanje človekovih pravic in družbenih vrednot. Na vseh nas je, da izzive današnjice primerno obravnavamo, predvsem pa pomagamo pri uvajanju znanstvenih spoznanj in razčiščevanju zmot. Ena pogosto omenjanih v zadnjem letu je eksistencialna nevarnost umetne inteligence, ki naj bi ogrožala človeštvo tako kot jedrske vojne. Hkrati pa nihče ne poda vsaj za silo smiselnega scenarija, kako naj bi se to zgodilo – recimo, kako naj bi 100x pametnejši GPT ogrozil ljudi.

Letošnja konferenca poleg čisto tehnoloških izpostavlja pomembne integralne teme, kot so okolje, zdravstvo, politika depopulacije, ter rešitve, ki jih za skoraj vse probleme prinaša umetna inteligenca. V takšnem okolju je ključnega pomena poglobljena analiza in diskurz, ki lahko oblikujeta najboljše pristope k upravljanju in izkoriščanju tehnologij. Imamo veliko srečo, da gostimo vrsto izjemnih mislecev, znanstvenikov in strokovnjakov, ki skupaj v delovnem in akademsko odprtem okolju prinašajo bogastvo znanja in dialoga. Verjamemo, da je njihova prisotnost in udeležba ključna za oblikovanje bolj inkluzivne, varne in trajnostne informacijske družbe. Za razcvet.

Letos smo v multikonferenco povezali deset odličnih neodvisnih konferenc, med njimi »Legende računalništva«, s katero postavljamo nov mehanizem promocije informacijske družbe. IS 2023 zajema okoli 160 predstavitev, povzetkov in referatov v okviru samostojnih konferenc in delavnic, skupaj pa se je konference udeležilo okrog 500 udeležencev. Prireditev so spremljale okrogle mize in razprave ter posebni dogodki, kot je svečana podelitev nagrad. Izbrani prispevki bodo izšli tudi v posebni številki revije Informatica (http://www.informatica.si/), ki se ponaša s 46-letno tradicijo odlične znanstvene revije. Multikonferenco Informacijska družba 2023 sestavljajo naslednje samostojne konference:

- Odkrivanje znanja in podatkovna središča
- Demografske in družinske analize
- Legende računalništva in informatike
- Konferenca o zdravi dolgoživosti
- Miti in resnice o varovanju okolja
- Mednarodna konferenca o prenosu tehnologij
- Digitalna vključenost v informacijski družbi – DIGIN 2023
- Slovenska konferenca o umetni inteligenci + DATASCIENCE
- Kognitivna znanost
- Vzgoja in izobraževanje v informacijski družbi
- Zaključna svečana prireditev konference

Soorganizatorji in podporniki konference so različne raziskovalne institucije in združenja, med njimi ACM Slovenija, SLAIS za umetno inteligenco, DKZ za kognitivno znanost in Inženirska akademija Slovenije (IAS). V imenu organizatorjev konference se zahvaljujemo združenjem in institucijam, še posebej pa udeležencem za njihove dragocene prispevke in priložnost, da z nami delijo svoje izkušnje o informacijski družbi. Zahvaljujemo se tudi recenzentom za njihovo pomoč pri recenziranju.

S podelitvijo nagrad, še posebej z nagrado Michie-Turing, se avtonomna stroka s področja opredeli do najbolj izstopajočih dosežkov. Nagrado Michie-Turing za izjemen življenjski prispevek k razvoju in promociji informacijske družbe je prejel prof. dr. Andrej Brodnik. Priznanje za dosežek leta pripada Benjaminu Bajdu za zlato medaljo na računalniški olimpijadi. »Informacijsko limono« za najmanj primerno informacijsko tematiko je prejela nekompatibilnost zdravstvenih sistemov v Sloveniji, »informacijsko jagodo« kot najboljšo potezo pa dobi ekipa RTV za portal dostopno.si. Čestitke nagrajencem!

Mojca Ciglarič, predsednica programskega odbora
Matjaž Gams, predsednik organizacijskega odbora

# FOREWORD - INFORMATION SOCIETY 2023

The twenty-sixth Information Society multi-conference is taking place during a period of exceptional development for artificial intelligence, computing, and informatics, encompassing the entire information society. Generative artificial intelligence has made significant progress towards superintelligence, towards singularity, and the flourishing of human civilization with programs like ChatGPT. Experts' predictions are coming true, asserting that the mentioned fields are crucial for humanity's existence and development. Hence, we must direct our attention to them, swiftly integrating them into primary, secondary education, and the daily lives of individuals and communities.

On the other hand, alongside fake news, we witness the emergence of false encyclopaedias, pseudo-sciences, and flat Earth theories, along with the continuing neglect of scientific insights and methods, the diminishing of human rights, and societal values. It is upon all of us to appropriately address today's challenges, mainly assisting in the introduction of scientific knowledge and clearing up misconceptions. A frequently mentioned concern over the past year is the existential threat posed by artificial intelligence, supposedly endangering humanity as nuclear wars do. Yet, nobody provides a reasonably coherent scenario of how this might happen, say, how a 100x smarter GPT could endanger people.

This year's conference, besides purely technological aspects, highlights important integral themes like the environment, healthcare, depopulation policies, and solutions brought by artificial intelligence to almost all problems. In such an environment, in-depth analysis and discourse are crucial, shaping the best approaches to managing and exploiting technologies. We are fortunate to host a series of exceptional thinkers, scientists, and experts who bring a wealth of knowledge and dialogue in a collaborative and academically open environment. We believe their presence and participation are key to shaping a more inclusive, safe, and sustainable information society. For flourishing.

This year, we connected ten excellent independent conferences into the multi-conference, including "Legends of Computing", which introduces a new mechanism for promoting the information society. IS 2023 encompasses around 160 presentations, abstracts, and papers within standalone conferences and workshops. In total about 500 participants attended the conference. The event was accompanied by panel discussions, debates, and special events like the award ceremony. Selected contributions will also be published in a special issue of the journal Informatica (http://www.informatica.si/), boasting a 46-year tradition of being an excellent scientific journal. The Information Society 2023 multi-conference consists of the following independent conferences:

- Data Mining and Data Warehouse - SIKDD
- Demographic and Family Analysis
- Legends of Computing and Informatics
- Healthy Longevity Conference
- Myths and Truths about Environmental Protection
- International Conference on Technology Transfer
- Digital Inclusion in the Information Society - DIGIN 2023
- Slovenian Conference on Artificial Intelligence + DATASCIENCE
- Cognitive Science
- Education and Training in the Information Society
- Closing Conference Ceremony

Co-organizers and supporters of the conference include various research institutions and associations, among them ACM Slovenia, SLAIS for Artificial Intelligence, DKZ for Cognitive Science, and the Engineering Academy of Slovenia (IAS). On behalf of the conference organizers, we thank the associations and institutions, and especially the participants for their valuable contributions and the opportunity to share their experiences about the information society with us. We also thank the reviewers for their assistance in reviewing.

With the awarding of prizes, especially the Michie-Turing Award, the autonomous profession from the field identifies the most outstanding achievements. Prof. Dr. Andrej Brodnik received the Michie-Turing Award for his exceptional lifetime contribution to the development and promotion of the information society. The Achievement of the Year award goes to Benjamin Bajd, gold medal winner at the Computer Olympiad. The "Information Lemon" for the least appropriate information move was awarded to the incompatibility of information systems in the Slovenian healthcare, while the "Information Strawberry" for the best move goes to the RTV SLO team for portal dostopno.si. Congratulations to the winners!

Mojca Ciglarič, Chair of the Program Committee
Matjaž Gams, Chair of the Organizing Committee

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# PREDGOVOR

Danes, v dobi razmahajoče digitalizacije, postaja digitalna vključenost ključni steber naše informacijske družbe. S širjenjem dostopa do digitalnih tehnologij in spletnih storitev na vse večje število posameznikov, vključno z osebami z različnimi oblikami oviranosti, se poudarek na zagotavljanju dostopnosti, jasnosti, razumljivosti in uporabnosti tehnologij le še krepi. Vse večje število posameznikov potrebuje prilagojene rešitve, da bi lahko v celoti sodelovali v digitalni dobi in izkoristili njen polni potencial. Hkrati pa se moramo globoko zavedati potreb in zahtev tistih, ki potrebujejo podporo pri komunikaciji ter lažjem vključevanju v družbeno, socialno in delovno okolje.

In prav to je osrednja tematika prve hibridne in obenem dostopne konference "Digitalna vključenost v informacijski družbi – DIGIN 2023", ki se je izvajala v sodelovanju z evropskim centrom virov o dostopnosti – AccessibleEU. Konferenca je združila priznane slovenske raziskovalce in praktike iz različnih področij, ki so delili svoje rešitve, spoznanja in metode za dosego popolne digitalne vključenosti. Cilj konference je bil raziskati in premagati ovire, s katerimi se srečujejo osebe z različnimi oblikami oviranosti ter ustvariti digitalno okolje, ki bo dostopno za vse.

Vsebine, ki so v pričujočem zborniku, so neprecenljiv vir znanja in inspiracije za vse udeležence. Z njimi bomo bolje razumeli, kako lahko podporno tehnologijo izkoristimo za izboljšanje kakovosti življenja posameznikov in omogočimo, da se vsi enakopravno vključijo v digitalno dobo. Prepričani smo, da bomo skupaj ustvarili pomembno premikanje proti bolj vključujoči in dostopni digitalni prihodnosti!

Uredniški odbor

# FOREWORD

Today, in the era of digitalization, digital inclusion is becoming a pivotal pillar of our information society. As access to digital technologies and online services continues to expand to an ever-growing number of individuals, including those with various forms of disabilities, the emphasis on ensuring accessibility, clarity, comprehensibility, and usability of technology only strengthens. An increasing number of individuals require tailored solutions to fully participate in the digital age and harness its full potential. At the same time, we must deeply acknowledge the needs and requirements of those who require support in communication and seamless integration into the social, societal, and work environments.

And precisely this is the central theme of the first hybrid and accessible conference, "Digital Inclusion in the Information Society – DIGIN 2023," conducted in collaboration with the European Accessibility Resource Centre – AccessibleEU. The conference brought together esteemed Slovenian researchers and practitioners from various fields who shared their solutions, insights, and methods to achieve complete digital inclusion. The conference's goal was to explore and overcome the barriers faced by individuals with various forms of disabilities and to create a digital environment accessible to all.

The contents within this compendium serve as an invaluable source of knowledge and inspiration for all participants. Through them, we will gain a better understanding of how assistive technology can be leveraged to improve the quality of life for individuals and enable everyone to be equally included in the digital era. We are confident that together, we will make significant strides toward a more inclusive and accessible digital future!

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# Online Notes – A Real-Time Speech Recognition and Machine Translation System for Slovene University Lectures

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## ABSTRACT

The paper presents Online Notes, a system involving speech recognition and machine translation that provides a real-time transcription of Slovene speech during a lecture and its machine translation into English. It was developed by researchers at the University of Ljubljana to fulfil two principal goals: (1) to allow non-Slovene-speaking university students to attend lectures held in Slovene; and (2) to enable students with disabilities (particularly the hard-of-hearing) to attend lectures that would be otherwise inaccessible to them. We present the motivation behind the development of the system, its functionality, some results and impressions obtained from the pilot lectures conducted in the last two years, and finally, our plans for future work.

## KEYWORDS

speech recognition, machine translation, university lectures, Slovene

## 1 INTRODUCTION

In accordance with the development strategy adopted by the University of Ljubljana for the periods 2012-2020 and 2022-2027, the University has undertaken a series of measures in order to achieve its goals of fostering academic excellence, credibility and autonomy, with a strong focus on internationalization, equal opportunity, solidarity, and inclusiveness [4]. The internationalization of the University has long been a source of heated debates both among experts and in the public, with opponents warning that the introduction of more English lectures would have a negative effect on the development of Slovene, and advocates proposing it as a necessary measure in order for the University to become more active in the international academic sphere, competitive, inclusive and accessible. The strategy of inclusiveness does not refer to only non-Slovene-speaking students, however, but students with disabilities as well: one of the strategic activities of the University (according to its 2022-2027 development plan [5]) focuses on providing systematic support for the accessibility of studies to individuals with special needs. The results of a survey conducted by the University of Ljubljana in February 2021 ([3] show e.g. that approximately 38% of students with disabilities are dyslexic, 2% are hearing-impaired, 4% are sight-impaired, and 13% are cognitively impaired.

One of the projects financed by the University to tackle both the issues of internationalization and inclusiveness is Online Notes. We begin the paper by outlining the project, then continue by describing the system (with short descriptions of its components and its interface), the workflow of the pilot lectures used to test the system between 2021 and 2023, and the preliminary results of the testing phase. We conclude by describing our plans for future work.


*Information Society 2023, 9–13 October 2023, Ljubljana, Slovenia*


## 2 PROJECT DESCRIPTION

The Online Notes project is a collaboration between the Laboratory for Data Technologies at the Faculty of Computer and Information Science of the University of Ljubljana, and the Centre for Language Resources and Technologies of the University of Ljubljana. The project is aimed at developing a system for the real-time speech recognition and automatic translation of Slovene lectures, which will help non-Slovene-speaking students to attend lectures held in Slovene, as well as provide transcriptions and recordings of lectures for students with disabilities.

The project encompasses the following activities: (a) the development of ASR-models for the domain of Slovene university-level lectures; (b) the development of the system back-end and front-end; (c) the organization of pilot lectures at the University of Ljubljana; and (d) collecting user feedback.

## 3 THE ONLINE NOTES SYSTEM

The Online Notes system (or ON for short) consists of several components presented in the following subsections.

The components of ON can be divided into three groups; (1) client-side applications, (2) back-end services and (3) speech services. Client-side applications consist of (a) an application for audio streaming, (b) a web application for users (students and lecturers; see 3.5 and 3.4), and (c) a web application for administrators (see 3.6). The main back-end component connects the building blocks (i.e. speech services), stores audio, transcripts and translations to a database/file system, provides real-time data using a message broker and exposes functionalities to client-side applications via an API, protected by an identity and access management (IAM) service. The speech services consist of a speech recognition service, a punctuation service and a translation service.

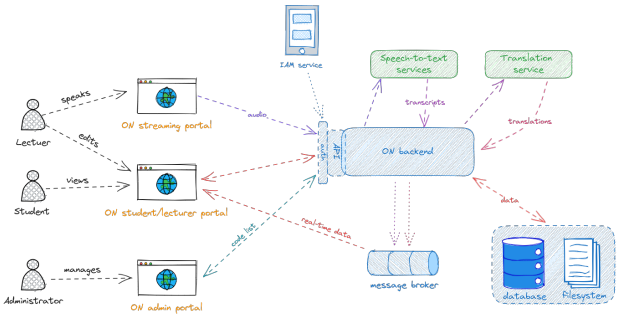


**Figure 1: High-level overview of ON system architecture.**

## 3.1 Speech Recognition

The speech recognition model that has been developed within the project is based on the Kaldi toolkit [6] and uses Weighted Finite-State Transducers (WFST) for training and decoding. All steps (including data preprocessing and training) follow the recipe provided by Kaldi. Speech recognition starts with waveform-reading and feature extraction from the audio, which is then presented with a Mel spectrogram. The data is processed by the acoustic model (based on librispeech chain recipes), which returns a probability matrix of subword units (phonemes) over time. The probability matrix is decoded with a language model (a statistical n-gram model in ARPA format, created using the kenlm toolkit), which results in the recognized text. Because this text lacks punctuation, it is sent to the punctuator, which is implemented as a separate service that inserts punctuation into the text.

Currently, two distinct speech recognition models are used within the ON system: one that is tailored to social science lectures (ON-DR) and one for technical science lectures (ON-NT). In the Kaldi framework, the acoustic model and the language model can be built independently, therefore the two speech recognition models share a common acoustic model, but have domain-tuned language models. The acoustic model was trained on approximately 200 hours of orthographically transcribed speech. The language model is being continuously updated and the current training dataset consists of approximately 2M sentences and a lexicon of 1.3M words.

The base for the language model is a corpus of texts pertaining to the field(s) of university lectures. The content of university-level lectures is highly specialized, so it was important to adjust the language model accordingly.

To do so, we contacted all lecturers at the University of Ljubljana through a common mailing list and collected a number of audio- or video-recordings of lectures from previous years (when recordings were more frequent because of the COVID-19 pandemic). The recordings were first automatically converted to text, then manually corrected to get the correct transcriptions. In case no recording material for a specific field was available, we used other materials for the subcorpus, such as theses, journals, and research papers. The process was repeated multiple times during the course of the project for each pilot lecture (more on this in section 4.1): each time the obtained transcriptions were added to either the ON-NT or ON-DR corpus, gradually expanding both language models. Once the text corpus is compiled, a lexicon of tokens and their corresponding pronunciations that match the chosen subword unit while training is prepared.

## 3.2 Machine Translation

Each final hypothesis (represented as a paragraph, or a block of text with punctuation) returned by the speech recognition service is then translated and displayed parallel to the Slovene text. Each segment is translated separately to minimize the delay in the display of translations. Currently, two machine translators are supported, i.e. an external commercial neural machine translator, as well as a translation service that was developed at the University of Ljubljana within the Development of Slovene in a Digital Environment (RSDO) project for the Slovene-English language pair. It is based on the AAYN model from the NVIDIA NeMo toolkit. The model was trained on a Slovene-English corpus consisting of 40 million aligned sentences. While the system has been tested for the Slovene-English language pair, in the future, the plan is to allow students to choose their preferred target language when using an external machine translator.

## 3.3 Interface

The ON front-end is designed as a web portal with a single entry site where users can log in with their digital identities provided by the University of Ljubljana. Based on their account type (student or lecturer), the log-in redirects them to one of the two different sites with differing functions. In addition, a separate administrator site is also available, along with a streaming site (where live lectures are recorded). We briefly present all components in the subsections below.

The general workflow of the system is designed in the following manner: (1) lectures are scheduled in the ON system by an administrator, (2) a lecturer runs the ON speech-recognition and machine-translation system during their scheduled lecture through the streaming site; students can access the real-time transcriptions and translations during the lecture through the student site; (3) once the lecture is complete, the lecturer can edit the transcription and translation (if necessary) through the lecturer site; (4) the recording, (edited) transcription and (edited) translation are archived in the system and can be accessed again at a later date through the student or lecturer site; the lecturer also has an option to hide the lecture from further view.

## 3.4 Lecturer Site

The lecturer site consists of an overview page (Figure 2) with a list of all lectures archived in the ON system by the lecturer so far; and an editing page (Figure 3), where the lecturer can edit the ASR-output (left column) and its machine translation (right column) for a specific lecture. The lecturer can move through the transcription by clicking on the audio progress bar at the bottom of the page. The audio is synchronized with the Slovene transcription and the text is color-highlighted when listening to the audio to facilitate the editing process. The lecturer can also add attachments to the lecture (presentation slides, notes, figures, etc.),

## 3.5 Student Site

The student site is similar to the lecturer site. The homepage consists of an overview of courses and lectures that the student is subscribed to (Figure 4), while the lecture page (which is accessed by selecting one of the lectures from the list) shows the Slovene transcription and its machine translation in the same way they are displayed to the lecturer (see Figure 3). However, students cannot edit the text. During live lectures, the transcription and

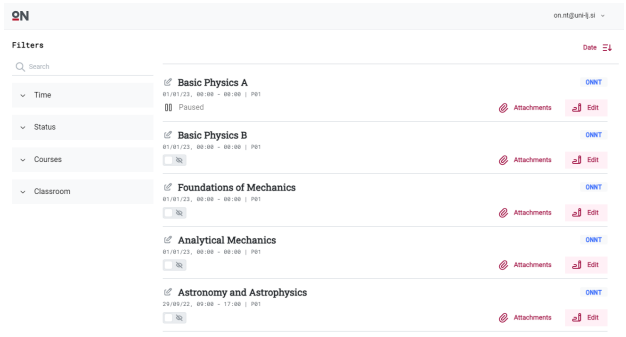


**Figure 2: ON lecturer site with an overview of available lectures.**

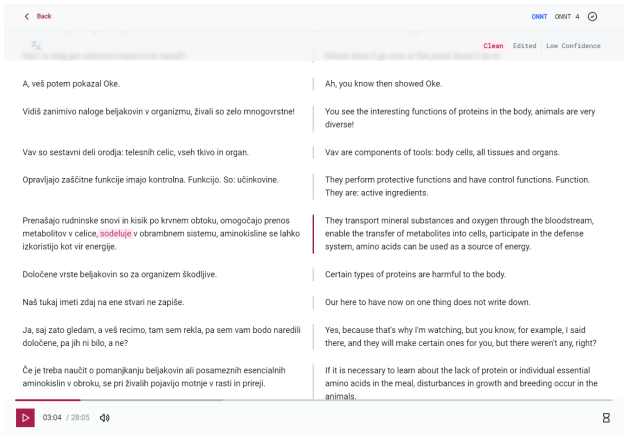


**Figure 3: Editing page of the ON lecturer site.**

translation are shown in successive blocks of text appearing at the bottom of the page.

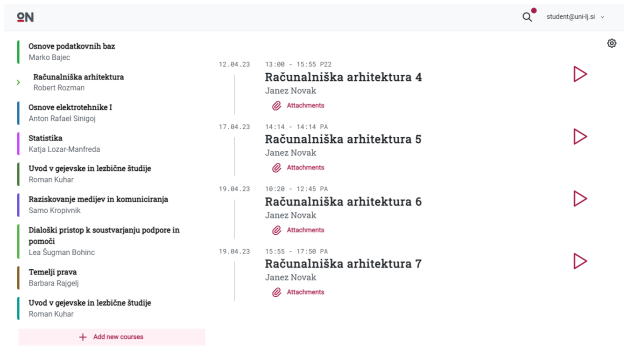


**Figure 4: Overview page of the ON student site.**

## 3.6 Administrator Site

The administrator site (Figure 5) is separate from the lecturer and student sites and allows for lectures to be scheduled in the Online Notes system. The administrator can manage the passwords for lecturer accounts, add new courses to their accounts, assign individual lectures to different classrooms, etc.

The administrator site is designed for a designated administrator at the faculty level that is responsible for scheduling lectures for different lecturers, while lecturers simply run the ON system from the streaming site at the start of their lecture.


**Figure 5: The ON administrator site.**

# 4 PILOT LECTURES

## 4.1 Workflow

To test the Online Notes system in real-life situations, a number of pilot lectures were organized through multiple calls for interested lecturers at the University of Ljubljana. In collaboration with the IT-staff of individual faculties, we first tested the sound equipment available in the relevant lecture room. If the equipment was inadequate, we used our own setup (a laptop and a pin microphone).

Before the lecture, the recordings of previous lectures with the same or similar content that were provided by the lecturers were transcribed and processed (in order to improve the ASR-models, as described in section 3.1).

During the lecture(s), the students were given access to the live transcriptions and translations; in some lectures, the ON output was also projected to the screen. In two cases, the ON system was used for every lecture held in that course in that semester.

## 4.2 First Impressions and Further Feedback

Since 2021, a total of 29 pilot lectures (with two consisting of multiple lectures) have been held at 8 different faculties of the University of Ljubljana so far, with several more planned for the 2023-2024 scholastic year. The lectures included both the fields of humanities and social sciences (e.g. the Faculty of Arts, the Faculty of Social Sciences) as well as STEM subjects (e.g. the Faculty of Mathematics and Physics, the Faculty of Computer and Information Science).

While the feedback has been predominantly positive, the use of the system has shown several potential problems that need to be addressed before a more widespread implementation. These range from minor bugs and features to be implemented (e.g. the implementation of a sensible profanity filter for machine translations, as these are often unpredictable and sometimes result in unwarranted obscenities in the translated text) to purely technical issues that require action on the part of the faculties themselves, such as outdated operating systems on lecture room computers or insufficient hardware.

Currently, we are working on surveys and interviews to obtain more feedback from lecturers (not just on the live version of Online Notes, but the post-lecture editing phase as well) and students, particularly Erasmus students and students with disabilities. When it comes to students with disabilities, We have already received general feedback on the use of WCAG Guidelines in

terms of the overall interface design, e.g. the use of appropriate contrast ratio for the sight-impaired and the accessibility of different interface elements by keyboard. However, this feedback was not specific to the Online Notes system, but in general. For a more focused test of the user-experience for students with disabilities, we intend to perform a pilot lecture to receive feedback on the actual use of the platform. Unfortunately, setting up such a pilot lecture has not yet been successful because of difficulties finding willing candidates who at the same time attend lectures that are more suitable for the use of the ON system.

The latest evaluations of the ASR-models done on a sample of the transcriptions of pilot lectures at the end of 2022 show that the speech recognition features word-error rates (WER) between approximately 12.6% and 32%, depending on multiple factors, such as the complexity of the topic (e.g. successful ASR is more difficult with non-linguistic elements such as formulae in mathematics and physics) and the lecturer's speech rate, clarity, and degree of standardness (e.g. non-standard and dialectal speech is still insufficiently supported by our current ASR-models). Successful speech segmentation is also a problem, as speech segments do not necessarily coincide with semantically coherent units, which causes additional problems downstream with machine translations. No systematic machine translation evaluation has been conducted yet since our priority is to resolve as many ASR-issues as possible and then tackle machine translation. However, one of the teachers who used the Online Notes system for an entire semester deemed the translations suitable enough to be published as subtitles on their videos (with some corrections), which indicates that automatic translations are reasonably useful; however, this also varies from subject to subject.

## 5 CONCLUSION AND FUTURE WORK

While the pilot version of Online Notes has been received positively by the lecturer community at the University of Ljubljana (with some lecturers even integrating the use of the system in their own workflows, e.g. using transcriptions for the preparation of subtitles for video-recordings of their lecture on public video platforms) and the students (for instance, two Erasmus students successfully passed an exam in a course held in Slovene by using the ON translations as study aids), the evaluations have shown that there is still room for improvement. Translating transcriptions of spontaneous spoken speech is a difficult task, particularly in Slovene, where spoken language frequently differs significantly from written standard language both in terms of vocabulary and pronunciation. In the future, we intend to adapt our ASR-models to non-standard pronunciations and expanding the pronunciation dictionaries in order to increase ASR-accuracy. We also intend to expand our pronunciation dictionaries by integrating the ON system with other language resources developed at the University of Ljubljana, such as the Sloleks Morphological Lexicon of Slovene [1], the Digital Dictionary Database of Slovene [2], and the Slovenian Terminology Portal [7]. This will reduce the need for processing transcriptions in order to cover the vocabulary required for good ASR-results. Depending on how willing the participating lecturers are to correct the automatic transcriptions, we may implement an incremental training workflow using corrected outputs to provide more improvements to the system.

Additionally, different segmentation methods must be tested in order to avoid segmentation-related problems in machine translation, e.g. speech segments that are either too short or too long (which also causes problems with translation delay; in some cases, it took more than 30 seconds for a very long segment to be displayed and translated, which made it more difficult to follow the lecture). Uneven and delayed segmentation causes problems for students with disabilities as well and needs to be addressed to increase user-friendliness.

However, several other, non-technical aspects need to be taken into account as well. To a certain extent, the successful use of ON depends on the degree to which the speaker adapts their speech to the limitations of the tool; for instance, by consciously avoiding segmented speech with numerous false starts, filler words and so on. These become particularly evident in the translation, where the frequent Slovene filler word *ne* (which is homonymous with *ne* meaning 'no' or 'not') sometimes causes the translation to be diametrically opposed to what the speaker actually said.

By the end of the project, we intend to develop the Online Notes system so that it can be successfully implemented at the University in order to (1) help increase the accessibility of lectures for people with disabilities; (2) contribute to the internationalization of the University of Ljubljana by allowing non-Slovene-speaking students to attend Slovene lectures; (3) allow teachers to archive their lectures and edit their transcriptions/translations; and (4) contribute to the wider language infrastructure for Slovene.

## 6 ACKNOWLEDGMENTS

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# Digitalna vključenost študentov s posebnimi potrebami v visokošolskem izobraževanju

## Digital Inclusion of Disabled Students in Higher Education

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## POVZETEK

Vse več študijskih aktivnosti poteka v digitalnem okolju ali pa so tradicionalne oblike študijskega procesa podprte tudi z digitalnimi orodji. V nekaterih primerih digitalno okolje študentom s posebnimi potrebami omogoča dostopnejši in enakovrednejši študij, a ostajajo področja, na katerih se določene skupine še vedno srečujejo z nepremostljivimi ovirami. Določene ovire izhajajo iz digitalnih orodij; določene obstajajo na sistemski ravni in na ravni izvajalcev; določene izhajajo tudi iz študentov samih. Opisali bomo nekatere najizrazitejše ovire in njihov vpliv na uspešnost opravljanja študijskih obveznosti študentov s posebnimi potrebami.

## KLJUČNE BESEDE

digitalna dostopnost, IKT, podporna tehnologija, študenti s posebnimi potrebami, visokošolsko izobraževanje

## ABSTRACT

In higher education, more and more courses are held online or traditional campus courses involve digital tools to enhance teaching and learning. In some cases, digital environments enable disabled students to access and participate on more equal terms, yet specific groups of disabled people still face barriers in accessing digital learning environments and resources. Barriers are present on different levels, ranging from accessibility of the digital tools themselves, having clear policies and procedures on the level of institutions or academic staff awareness about digital accessibility to the knowledge and skills of disabled students. We will discuss some most common barriers and the way they influence students' academic performance.

## KEYWORDS

digital accessibility, ICT, assistive technology, disabled students, higher education

## 1 UVOD

Raziskava *EVROŠTUDENT* [1] je pokazala, da je v Sloveniji 21 % študentov poročalo o zdravstvenih težavah ali invalidnosti. 56 % sodelujočih v raziskavi meni, da je institucionalna podpora nezadostna ali le delno zadovoljiva. Zagotavljanje digitalne dostopnosti je pomemben del institucionalne podpore študentom. Zaradi vse večje digitalizacije visokega šolstva je treba razmisliti, kako lahko različni ljudje dostopajo do digitalnih informacij, spletnih učnih okolij in študijskega gradiva izbranih študijskih področij, razmisliti pa je treba tudi o dostopnosti informacijske tehnologije, ki se uporablja na visokošolskih institucijah in med študenti. Predpisi na področju visokega šolstva [6], invalidskega varstva [7] in digitalne dostopnosti [8] nam nalagajo, da se tudi v digitalnem okolju prilagodimo raznolikosti študentske populacije, prav tako pa moramo upoštevati raznolikost zaposlenih. Digitalna dostopnost visokošolskega prostora je večplastna in zahteva načrtno ter usklajeno delovanje različnih deležnikov.

V prvi vrsti gre za poznavanje dostopnosti razvijalcev digitalnih izdelkov in storitev, da so ti zasnovani po kriterijih digitalne dostopnosti. V času pandemije covda-19, ko se je celoten izobraževalni proces preselil na splet in je bilo treba za nadomeščanje nekaterih aktivnosti, ki bi se sicer odvijale v predavalnici, hitro najti digitalna orodja, je imelo veliko študentov težave z nedostopnostjo teh programov oz. aplikacij. Tudi skrbniki IKT-področja na visokošolskih institucijah morajo poznati minimalne standarde dostopnosti, da zakupijo licence programov, ki jih lahko uporabljajo tudi uporabniki s posebnimi potrebami. Ker veliko invalidov za dostop do informacij in storitev v digitalnem okolju uporablja podporno tehnologijo, lahko tudi tukaj prihaja do težav, saj včasih nadgradnja teh pripomočkov ne dohaja hitrosti nadgradnje orodij v splošni uporabi. Naslednji člen v verigi so oblikovalci vsebin in gradiv v spletnih učilnicah: profesorji, asistenti in drugo visokošolsko osebje. Če ne poznajo osnovnih načel oblikovanja dostopnih informacij, tudi dostopni programi niso koristni. Zadnji v tej verigi so študenti s posebnimi potrebami. Njihovo znanje in spretnost pri uporabi IKT-tehnologije ter prilagojenih pripomočkov prav tako vplivata na možnost dostopa do določenih vsebin ter aplikacij. Njihovo znanje je odvisno od več dejavnikov: časa in intenzitete nastale invalidnosti ali bolezni, rehabilitacije, ustreznega usposabljanja za delo s temi pripomočki in pogostosti njihove uporabe.

Tako lahko vidimo, da so na vseh ravneh potrebni ozaveščanje in usposabljanje, povezovanje in sodelovanje vseh deležnikov ter upoštevanje uporabniških izkušenj.

## 2 DOSTOPNOST ŠTUDIJSKEGA GRADIVA

Za uspešen študij morajo vsi študenti imeti zagotovljene enake možnosti dostopa do študijskega gradiva. Z uporabo digitalnih gradiv in spletnih učilnic so se te možnosti precej izboljšale. Študijski programi uporabljajo raznoliko študijsko gradivo: od spletnih strani, videoposnetkov, besedilnih datotek, predstavitev

in podobno. Za dostopnost študijskih gradiv naj bi bili odgovorni pedagoški delavci, ki nimajo niti vseh potrebnih tehničnih sredstev niti zadostnega znanja o oblikovanju dostopnih gradiv.

Najpogostejša oblika elektronskega študijskega gradiva, ki se pojavlja v spletnih učilnicah, so pdf-datoteke. Če so ti dokumenti ustrezno oblikovani in shranjeni kot besedilo, za večino študentov niso težavni. Velikokrat se zgodi, da so dokumenti shranjeni kot slike – še posebej, kadar gre za skenirane strani brez OCR-ja, ali pa niso ustrezno oblikovani in označeni. V tem primeru jih slepi in slabovidni študenti, ki uporabljajo bralnike zaslona, ne morejo prebrati. Težave predstavljajo tudi študentom s specifičnimi učnimi težavami, ki si za lažje branje, obdelavo in pomnjenje gradivo dodatno prilagajajo svojim potrebam, tako da spremenijo obliko pisave, razmik med vrsticami, barvo ozadja ter besedila in podobno. Ti sicer gradivo lahko preberejo, a jim to vzame precej več časa in napora.

Prav zato na *Društvu študentov invalidov Slovenije* svetujemo, da je gradivo študentom s posebnimi potrebami na voljo v izvornih oblikah, kot so *MS Word, PowerPoint* ali *Excel*, vendar je tudi pri uporabi teh programov treba poznati in paziti na dostopno oblikovanje dokumentov. V sklopu projekta *PRAVA SMER*, ki smo ga na *Društvu študentov invalidov Slovenije* izvajali med pandemijo covida-19, smo objavili priporočila za pripravo dostopnih študijskih gradiv; do njih lahko prosto dostopamo na naši spletni strani pod zavihkom *Visokošolsko osebje.*

V nadaljevanju podajamo nekaj konkretnih primerov, ki so bili zbrani na skupinskih spletnih posvetih s študenti in v okviru individualnih svetovanj študentom med študijem na daljavo. Začnimo s primerom slepe študentke, ki pri delu z računalnikom in branju gradiv uporablja bralnik zaslona *JAWS*. Pri predelovanju gradiv, ki jih je prejela v obliki *PowerPoint*-dokumentov, in pri reševanju nalog, ki jih je dobila v *Wordovem* dokumentu, nikakor ni mogla rešiti dela nalog, saj snovi, ki bi obravnavale dotične naloge, ni našla. Drugi študenti s tem niso imeli težav in so povedali, da je na drsnicah vsa snov. Izkazalo se je, da je bila težava v tem, da nosilec predmeta, ki je pripravil *PowerPoint* predstavitev, ni uporabil zgolj prednastavljenih postavitev drsnic, temveč je namesto oblikovanja novih postavitev v obstoječo drsnico vstavil okvirčke z besedilom. Slednji so bralnikom zaslona nedostopni, saj jih zaznavajo kot sliko, ki ji je treba dodati nadomestno besedilo. Tako so bile informacije na drsnici za videče študente vidne, slepa študentka pa jih s pomočjo podporne tehnologije ni mogla prebrati. Profesor je tako, čeprav povsem nenamerno in nezavedno, postavil slepo študentko v neenakovreden položaj.

Študenti velikokrat prejmejo gradivo v obliki pdf-dokumentov. V nekaterih primerih so to delovni listi, ki jih videči študenti natisnejo in izpolnjujejo v papirnati obliki, medtem ko slepi in slabovidni delovne liste raje izpolnjujejo digitalno. Ko takšen dokument ni ustrezno oblikovan in označen z različnimi vrstami zaznamkov (z naslovi, odstavki, s povezavami, tabelami, slikami, polji obrazca, z vrstnim redom branja ipd.) ter ne vsebuje polj za vnos besedila, slep ali slaboviden z njim ne more delati. Enako velja za skenirane knjige, članke, skripte in ostalo obsežnejše študijsko gradivo. Študenti s posebnimi potrebami začnejo zaradi nedostopnosti gradiv in potrebnega časa za prilagajanje v dostopne oblike pri študijskem delu zaostajati za drugimi študenti.

Velikokrat si študenti sami prilagajajo nedostopno gradivo v dostopne oblike. Nekaterim slepim študentom zdaj pomagajo tudi osebni asistenti, nekaterim priskočimo na pomoč na *Društvu študentov invalidov Slovenije,* vendar so naše kapacitete zaradi pomanjkanja osebja zelo omejene. Z enakimi težavami se srečujejo tudi visokošolske institucije.

Naslednji primer je primer močno slabovidne študentke, ki je prejela gradivo za delo na vajah v pdf-obliki, čeprav je imela v odločbi zapisano, da naj bi študijsko gradivo prejela v njej dostopni obliki, torej v *Word*-formatu. Gradivo ni bilo avtorsko delo nosilca predmeta, temveč eksterno skenirano gradivo, ki so ga uporabljali kot dodatno gradivo za podporo študijskemu procesu. Po pogovoru z nosilcem predmeta ji je bilo svetovano, naj vse pdf-dokumente odpira v *Wordu*, kar pa zanjo še vedno ni rešilo težav z dostopnostjo dokumenta. Pri pretvorbi je namreč prišlo do večjih popačenj strukture dokumenta, ki so vplivala tako na preglednost in logičnost gradiva kot na razumevanje vsebine.

Določene visokošolske institucije v tujini imajo posebne oddelke, zadolžene za področje digitalne dostopnosti; tako sodelujejo s službami za podporo študentov invalidov in z akademskim osebjem. Prav tako imajo interne ali eksterne službe, ki preverjajo dostopnost digitalnih informacij in jo popravljajo oz. izboljšujejo. Od akademskega osebja se pričakuje, da bo gradivo, ki ga pripravljajo sami, na voljo v dostopni obliki, za drugo gradivo pa je odgovornost deljena. Tako na primer učitelj ne povsem dostopen desetstranski članek v pdf-obliki prilagodi sam, medtem ko 100 strani dolgo publikacijo prilagaja posebna služba.

## 3 DOSTOPNOST SPLETNIH UČILNIC

Tudi spletna učna okolja so lahko le delno dostopna. Težave pri branju lahko povzroča nepravilna struktura strani, ki ne uporablja naslovov ali podnaslovov oz. so ti napačno uporabljeni. Težavni so lahko nezadosten kontrast, uporaba slik v ozadju, uporaba nepravilno strukturiranih tabel, grafični elementi brez dodanih alternativnih opisov ipd. Za vse, ki uporabljajo bralnike zaslona, je pomembno, da vedo, ali je besedilo, ki ga slišijo, naslov, podnaslov, odstavek, seznam, tabela in podobno. Brez ustreznih označb bralnik zaslona celotno besedilo na strani prebere kot enoten odstavek, ki je pomensko težje razumljiv.

Poleg podajanja osnovnih informacij o predmetu, gradiv in navedenih obveznosti lahko v *Moodlu* potekata tudi preverjanje in ocenjevanje znanja. Po eni strani je treba razmisliti o vrsti nalog in o njihovi dostopnosti vsem študentom; morda nekaterim skupinam študentov povzročajo težave. Naloge, ki jih je treba rešiti v omejenem času, ali naloge, ki ne omogočajo vračanja na prejšnji odgovor, lahko določenim študentom povzročajo veliko težav. V tem primeru so to študenti s specifičnimi učnimi težavami, študenti s težavami ohranjanja pozornosti ali z anksioznostjo. Tem časovni pritisk in brezpogojni vrstni red izpolnjevanja vprašanj povzročata nepotreben dodaten stres, kar lahko močno zmanjšuje njihovo učinkovitost. Zanje je priporočljivo, da čas odgovarjanja na posamezno vprašanje ni

omejen in da lahko najprej rešijo vprašanja, ki jih znajo, ter se nato vrnejo na tista, ki jim povzročajo težave.

Pomembno je poznavanje dodatnih orodij, s pomočjo katerih lahko učitelji posameznim študentom s posebnimi potrebami znatno olajšajo delo in jim pri študiju zagotovijo po odločbi dodeljene prilagoditve. Z individualnimi nastavitvami lahko posameznim študentom dodelijo daljši čas oddaje naloge ali jim dovolijo več poskusov reševanja naloge. Nekaj napotkov v zvezi z dostopnim preverjanjem znanja v spletni učilnici *Moodle* je zbranih v priporočilih za dostopno preverjanje znanja v *Moodlu*, objavljenih na spletni strani *Društva študentov invalidov Slovenije* pod zavihkom *Visokošolsko osebje*.

# 4 DOSTOPNOST DIGITALNIH ORODIJ IN KOMPATIBILNOST S PODPORNO TEHNOLOGIJO

Tehnologija zadnja leta zelo hitro napreduje. To mnogokrat pomeni, da dizajn in razvoj podporne tehnologije zaostajata za razvojem tehnologije v splošni rabi. Situacija se zadnje čase sicer izboljšuje, a razvoj dostopne tehnologije v splošni rabi in razvoj podporne tehnologije ne potekata vedno usklajeno. Prav tako so v fazi zasnove digitalnih orodij pogosto premalo poudarjeni vsi potrebni vidiki dostopnosti. Oviro pa predstavlja tudi cena; ne le z vidika finančne dosegljivosti licenčne opreme v splošni rabi, temveč tudi oz. predvsem zaradi visokih stroškov podporne tehnologije, ki je ne krije zdravstvena zavarovalnica in si jo morajo študenti s posebnimi potrebami priskrbeti sami.

Študenti so imeli največ težav z dostopnostjo in rabo podporne tehnologije med študijem na daljavo zaradi covida-19, saj sta hiter prehod na različne platforme videopredavanj in uporaba drugih digitalnih orodij za sodelovanje povzročila, da so bili študenti s posebnimi potrebami preobremenjeni z iskanjem informacij, kako uporabljati ta orodja. Slepi so na primer morali poiskati informacije, kako jih upravljati s pomočjo tipkovnice. Imeli so tudi težave z dostopanjem do deljenega zaslona in s preklapljanjem med orodji znotraj programa, kot so klepet, postavljanje vprašanj ali reševanje anket. Študenti s težavami z osredotočanjem in ohranjanjem pozornosti so iskali rešitve, kako zmanjšati moteče elemente, kot je pojavljanje sporočil, medtem ko so imeli gluhi in naglušni študenti težave s spremljanjem predavanj, saj ta niso bila podnaslovljena ali tolmačena v slovenski znakovni jezik – sledenje predavateljevi sliki in branje z ustnic sta bila pogosto otežena.

Prav tako je predstavljala težavo poplava različnih aplikacij in učnih orodji: od *Kahoota*, *H5P*, *Mentimetra* do različnih orodij v *Moodlu*, saj so študenti, ki uporabljajo podporno tehnologijo, le s težavo dohajali druge študente. Posledično so doživljali dodaten stres in breme pri iskanju rešitev, kako jih uporabljati.

# 5 ZAKLJUČEK

Študenti na splošno poročajo, da so jim zaposleni v visokošolskih institucijah pripravljeni prisluhniti in pomagati, vendar pogosto nimajo dovolj znanja o tem, kako izvesti te prilagoditve. O podobnih ugotovitvah na osnovi nacionalne raziskave v ZDA poročajo tudi Jeannis idr. [2], v kateri 30,8 % študentov meni, da je ena od ovir pri študiju pomanjkanje znanja o posebnih potrebah in prilagoditvah med visokošolskim osebjem, medtem ko jih kar 66,4 % poroča, da so zaposleni nadvse pripravljeni pomagati in prilagoditi študij njihovim potrebam. Študije, ki jih navajajta Langørgen in Magnus [3], kažejo, da je študijska uspešnost študentov s posebnimi potrebami trenutno bolj odvisna od pripravljenosti posameznikov v visokošolskem okolju, da pomagajo tem študentom, kot pa od proaktivnega pristopa visokošolskih institucij, da zagotavljajo vključujoče študijsko okolje za raznolike skupine študentov na sistemski ravni.

Študije iz tujine kažejo [4], da obstaja precejšen razkorak med predpisi in dejansko implementacijo digitalne dostopnosti v visokošolskih institucijah. Ovire dostopanja do učnih okolij in študijskih gradiv študentom s posebnimi potrebami preprečujejo ali močno ovirajo sodelovanje ter vključevanje v vse vidike študijskega procesa, kar vpliva tudi na njihovo (manjšo) študijsko uspešnost [5].

Ukrepi, s katerimi lahko visokošolske institucije izboljšajo digitalno dostopnost [4], so:

- preverjanje obstoječega stanja glede digitalne dostopnosti spletnih strani; sistema za upravljanje učenja (LMS); digitalnih vsebin in gradiv, kamor se vključi tudi študente in zaposlene s posebnimi potrebami.
- Priprava akcijskega načrta izboljšav, ki temelji na predhodnih ugotovitvah obstoječega stanja.
- Upoštevanje standardov dostopnosti že v fazah naročanja in nakupa digitalne opreme, da se že pri naročilu določi, naj ponudniki zagotovijo skladnost orodja s standardom EN 301 549 V3.2.1 oz. s smernicami WCAG 2.1 do nivoja AA, kot narekuje zakonodaja.
- Imenovanje osebja, ki bo na ravneh institucije ali oddelkov odgovorno za digitalno dostopnost.
- Izobraževanje osebja in študentov o standardih digitalne dostopnosti in o težavah z digitalno nedostopnostjo.

Mehanizmi zagotavljanja digitalne dostopnosti na večjih visokošolskih institucijah v tujini vključujejo delovno mesto koordinatorja digitalne dostopnosti, ki povezuje ostale deležnike znotraj institucije; utečen sistem naročanja, ki upošteva vidike dostopnosti; akcijski načrt izboljšanja digitalne dostopnosti in sistem nadzora ter evalvacije napredka.

Zagotavljanje dostopnosti je torej dolgoročna zaveza. Potrebna sta povezovanje in sodelovanje večine služb institucije, da dostopnost postane del vseh vidikov visokošolskega okolja – tako grajenega, informacijskega, pedagoškega in družbenega.

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# Exploring Digital Literacy and the Use of ChatGPT among Students with Disabilities

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## ABSTRACT

This paper examines the level of digital and algorithm literacy, and the use of ChatGPT as a study aid among students with disabilities. Twenty-seven respondents filled out an online survey questionnaire. The results revealed a high proficiency in digital and sufficient level in algorithm literacy, with participants valuing ChatGPT for studying and problem-solving. While perceived as accessible, participants suggested additional features to enhance their user experience – subtitles, text-to-speech conversion and content summaries, and the integration of voice assistants. The study highlights the potential of chatbots to support students with disabilities in the education process.

## KEYWORDS

People with disabilities, chatbots, conversational agents, digital literacy, education, usability

## 1 INTRODUCTION

Accessibility and usability are, in tight interplay, crucial for people with disabilities (PwD) to participate actively in society and have equal access to educational opportunities. Lower levels of education, followed by lower employment rates, have been recorded consistently among PwD in comparison to people without disabilities [1].

Although Information and Communication Technologies (ICT) can contribute to accessibility improvement, PwD, on the contrary, often face digital divide and digital exclusion [2, 3]. ICT thus works as an additional barrier, instead of being a facilitator of participation [3]. Recently, Artificial Intelligence chatbots, or conversational agents (CAs), have been found to solve some accessibility issues, mostly by providing a personalised experience or enhancing the learning process [4-7].

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In the usage of all assistive technologies the role of digital and algorithmic literacy should not be overlooked, particularly in the context of special requirements of PwD [7]. Prior research has also found that some challenges faced by SwD, such as inadequate social skills, can be solved with AI tools, e.g. social robots [8].

Accordingly, the purpose of this paper is to examine what is the level of digital and algorithm literacy among students with disabilities (SwD), as a part of PwD, and, further, how they use CAs, and to what extent they perceive them as useful and accessible study aids. The study focused primarily on ChatGPT, due to its exponentially increasing user base and previously identified features with high potential for educational use [9].

## 2 ARTIFICIAL INTELLIGENCE CONVERSATIONAL AGENTS

### 2.1 Definition of AI Conversational Agents

Chatbots are Artificial Intelligence systems for Human-Computer Interaction [10]. The computer software uses Natural Language Processing, and converses through text or voice in one or more languages [11]. While numerous chatbots are currently available, ChatGPT soon became the fastest growing consumer application with over a million active monthly users [12].

Currently, the free version of ChatGPT provides many functionalities [9] that could be used for educational purposes and SwD. Users can request information via written conversation, which is saved, and can later be recalled for specific topic-related information. The input can be in numerous languages and text complexities (e.g. simple, academic). The same applies to the text generated by the chatbot, along with various speaking styles, such as professional and engaging. As ChatGPT is based on Natural Language Processing, the conversations are highly similar to human communication. The bot can elaborate ideas, recall prior statements, apologise for mistakes, which was not previously possible. Furthermore, user interaction supplies the bot with additional information, which also improves the communication with users by recognising communication patterns. Students could also benefit from receiving prompts and directions for writing assignments, or

detailed feedback on assignments. Another benefit of ChatGPT is its ability to research a wide range of topics, and organise unstructured data into structured information.

## 2.2 Contextual Use of Conversational Agents

Chatbots have been examined increasingly in the context of education, travel, research, journalism and other uses [7, 9, 13-18]. In recent years, large parts of education have been conducted via digital tools, e.g. homework assignments, class attendance reports, etc. [7, 14], which could be expanded further.

In the travel context, chatbots were found to provide user-centric or personalised recommendations [13] as opposed to general information found through search engines, which could also apply to education. As chatbots emulate human interaction and hold conversations similar to humans, they could suit students who prefer to obtain information through conversation instead of researching various sources independently. Students are able to ask general or specific questions and receive elaborate feedback [9].

Winkler and Söllner [18] recognised chatbots as beneficial for individual student support, such as when the lecturer is unable to respond adequately to large groups of students. These tools also encourage students to be more proactive and seek information on their own, improving their academic performance further.

Although chatbots have been present in general use for several years, their use in education has been expanding in the past five years, ranging from a very limited tool [18, 19] to becoming a valuable study aid both for students and teachers [7].

## 2.3 Limitations of Artificial Intelligence Conversational Agents

The main challenges of chatbots are related to the limited training data and use of raw text without hyperlinks and citations, which can lead to incorrect responses. They are also unable to comprehend human emotions fully, due to their training for specific tasks. Selection of training data can also contribute to the model's biased output. Lastly, AI tools pose a danger of plagiarism on assignments among students [9] and make identification of human and AI authorship difficult [21].

Haleem et al. [9] proposed development of niche instead of generic models for a more limited set of information. CAs should also be avoided for tasks requiring significant users' input. Among ethical concerns remain the users' difficulty to identify true and false information due to human-like conversations. Some also rely on the CAs' output without proper validation and verification, while the output is often generated randomly statistically [21].

# 3 DIGITAL AND ALGORITHM LITERACY

Apart from digital accessibility, digital illiteracy is also a major problem of technology implementation [7]. Digital literacy can be defined with six components; (a) Understanding of graphical interfaces in digital devices, (b) Creating new media, (c) Navigation in digital media, (d) Critical thinking, (e) Communication and collaboration, and (f) The ability to process and evaluate information in real-time [20, 22]. Similarly, Cortina-Pérez et al. [23] defined digital literacy with three dimensions; (a) Information skills (information management and interpretation), (b) Use of digital tools (the skills and competencies to operate digital devices), and (c) Digital transformation (evaluation and production of information, understanding of copyright law).

On one hand, digital illiteracy can be present in educators, who are trained insufficiently in new technologies [23]. On the other, digitally illiterate students are at risk of understanding and creating materials incorrectly, unable to navigate nonlinear information sources, or evaluate the validity of information [24]. The importance of digital literacy has been expanded further with the increasing role of algorithms on the Internet. Algorithm literacy should be perceived as a part of digital literacy, and can be defined as "awareness of the use of algorithms in online applications, platforms, and services, knowing how algorithms work, being able to evaluate algorithm decision-making critically, as well as having the skills to cope with, or even influence, algorithm operations" [25]. Due to its importance, algorithm literacy should be taught as part of digital literacy for SwD [26].

# 4 METHODS

## 4.1 Procedure

Data were obtained with an online questionnaire in July 2023. The participants were invited through Slovene local and national associations for PwD, either visual, auditory, mobility or cognitive impairments. The study was conducted with the approval of the IRB at the University of Maribor (038-13-148/2023/5 FFUM), due to collecting health information. Participation was voluntary and anonymous.

## 4.2 Measuring Instrument

The questionnaire obtained the socio-demographic characteristics of participants (gender, age and current level of schooling). Participants who were currently not students were excluded from the study. Participants were also asked about the field of study they are currently undertaking [27]. Participation was limited to SwD.

The second part of the questionnaire obtained data on participants' purposes and frequency of Internet use [28]. The next part examined participants' digital literacy with questions adapted from Kaeophanuek et al. [29]. Participants were asked about their information abilities, use of digital tools and digital transformation. The fourth part examined algorithm literacy, adapted from [25] with a series of true/false statements.

The fifth part was aimed at ChatGPT use for general and education purposes. Some questions were adapted from [30] and [31]. Lastly, perceived ChatGPT usability was examined with an adapted chatbot usability scale [32]. Participants could also suggest other features they would benefit from.

## 4.3 Research Questions

Based on the presented theoretical frame, the following research questions were defined:
RQ1: What is the level of digital literacy among SwD?
RQ2: What is the algorithm literacy among SwD?
RQ3: How do SwD use ChatGPT?
RQ4: How SwD perceive the usability of ChatGPT?

### 4.4 Participants

The questionnaire was completed by a total of 27 participants, of whom 67% were men (n=18) and 33% were women (n=9). Most participants were younger than 18 (26%, n=7) or older than 26 years (37%, n=10). Others were aged 18-20 (15%, n=4), 21-23 (18%, n=5) or 24-26 (4%, n=1). The majority of participants were currently in a 3-year vocational secondary school (44%, n=12), followed by a gymnasium or other 4-year secondary school (15%, n=4), students in Bachelor's (15%, n=4) or Master's programmes (15%, n=4), 2-year lower vocational school (7%, n=2), or a PhD programme (4%, n=1).

Most participants were enrolled in ICT programmes (37%, n=10), engineering programmes (19%, n=5), followed by business and administration (11%, n=3), social sciences, agriculture, tourism, arts and humanities (7%, n=2) or law (4%, n=1). Participants reported visual (35%, n=12), hearing (17%, n=6), movement (20%, n=7), cognitive (20%, n=7) or other disabilities (6%, n=2). Six participants reported having multiple disabilities.

Among the participants with hearing impairments, most reported profound hearing loss (over 90dB) (n=3), and one participant reported severe hearing loss (71-90 dB). Two participants were unsure of the degree of their hearing loss.

## 5 RESULTS

### 5.1 Internet use

Participants were asked to assess their Internet use for various activities. Most often (three or more times per day) they used it for studying (37%), browsing social media (33%), listening to music or podcasts (30%) and communication (19%). Other common activities included independent learning (e.g. programming, Photoshop), which was done once per day or less often (37%), the same as searching for information and problem-solving (33%). Most estimated to use between one and three hours per day studying or learning (n=9), or less than an hour (n=7).

### 5.2 Digital and Algorithm Literacy

Digital literacy was examined with three indicators (information competencies, use of digital tools and digital transformation) to address RQ1 and RQ2. Participants exhibited the highest proficiency in the use of digital tools (M=4,08, SD=0,58), particularly in awareness about the advantages, disadvantages and impact of Internet use (M=4,59, SD=0,63). They also exhibited high willingness to learn and adapt to new technologies (M=4,44, SD=0,64), and awareness on the importance of ethical Internet use and prevention of cyber harassment (M=4,41, SD=0,79).

Furthermore, participants exhibited considerable proficiency in information skills (M=3,82, SD=0,77), with notable strengths in their ability to verify the information`s accuracy (M=4,11, SD=1,12). They also reported a high capacity to share data files online (M=4,0, SD=1,33), assess reliable information sources (M=4,0, SD= 0,83), and distinguish between facts and opinions (M=4,0, SD=0,96). Lastly, participants also demonstrated an above average level of proficiency in the domain of Digital Transformation (M=3,5, SD=0,83), particularly with regard to awareness on copyrighted videos (M=4,22, SD=1,08) and their ability to create content while avoiding plagiarism (M=3,59, SD=1,18).

Algorithm literacy was assessed with 11 true/false statements. On average, participants recognised 6,52 statements correctly. Most participants were able to discern accurately that algorithms offer both opportunities and risks (89%, n=24). Furthermore, they concurred that user behaviour on the Internet can impact the functioning of algorithms (63%, n=17), and that personalised content aligns with users' pre-existing opinions (63%, n=17). Conversely, it was acknowledged that algorithms are unable to recognise incomplete search results and correct them automatically (59%, n=16). Among the incorrect responses, a considerable number of participants assumed erroneously that algorithms operate independently of human involvement (52%, n=14). No participant identified all statements correctly, two identified 10 statements, three identified 9 statements and four participants identified either 8 or 7 statements. 14 participants identified below the average number of statements.

The results also show a significant difference in recorded digital and algorithm literacy (p=.001), with significantly higher values for digital (M=3,8, SD=0,66) than algorithm literacy (M=1,4, SD=0,18). There was no significant correlation between ChatGPT use and perceived usability.

### 5.3 ChatGPT use and perceived usability

In response to RQ3, ChatGPT was previously used by most participants (59%, n=16). Most have used it previously for studying or other assignments (85%) and a third uses it often or very often (at least in ¾ of cases). The next common use is thr developing of creative ideas or problem-solving, used by 74%. Many use it on every occasion necessary (22%). Two thirds of participants use ChatGPT for chatting, many of them very often (19%).

When asked to assess the usefulness of ChatGPT for studying, most participants found it very useful (33%, n=9), useful (29%, n=8), or neither useful nor useless (26%, n=7).

Participants also evaluated the capabilities and constraints of ChatGPT. The predominant consensus was that the tool produces correct responses consistently (M=3,44, SD=1,18), followed by the ability to produce contextually relevant responses (M=3,41, SD=1,3). ChatGPT also generates meaningful responses (3,11, SD=1,42) and credible and correct information (M=2,96, SD=1,48). The features that were least often recognised were to provide relevant sources (M=2,74, SD=1,34) and genuine sources (M=2,78, SD=1,25). Participants also assessed the usability of ChatGPT (RQ4). Most praised its usability, as they found the way to talking to the tool easily (M=3,56, SD=0,84).

They also reported an easy start to the conversation (M=3,48, SD=1,0), it was clear and easy to understand communication (M=3,44, SD=0,93) and maintaining of the conversation context consistently (M=3,33, SD=0,92). Some features were recognised as less accessible, as they had to ask questions several times to receive the correct answer (M=2,96, SD=1,19).

Participants have provided some recommendations for enhanced usability and accessibility of ChatGPT. Several proposed the implementation of subtitles (M=2,89, SD=1,15), text-to-speech conversion (M=2,81, SD=1,07), or the capability to provide content summaries (M=2,78, SD=1,21). Less frequently mentioned, likely due to the limited sample size, was sign language interpretation (M=2,52, SD=1,08). Additionally, some participants emphasised the need for different contrast settings for people with visual impairments, and recommended the integration of voice assistants, e.g. Siri.

## 6 CONCLUSION

This study investigated the use of ChatGPT and its perceived usability for educational purposes among SwD. The results indicate that the participants demonstrated a high level of digital literacy (RQ1). They exhibited the highest proficiency in the use of digital tools. They also showed awareness about the impact of Internet use, the importance of ethical Internet use, and the ability to verify information accuracy. Such a level of digital literacy is tied with the sufficient understanding of the role of algorithm literacy shown by the participants (RQ2). They recognised the opportunities and risks of algorithms, and the alignment of content personalised with users' opinions. Most participants reported using ChatGPT for studying, developing creative ideas, and problem-solving (RQ3). They found ChatGPT to be highly useful for their academic work, and appreciated its ability to produce correct and contextually relevant responses consistently. Participants perceived ChatGPT as highly useful (RQ4), as they engaged in conversations easily, and found the tool's communication clear and easy to understand. The least favourable characteristic was the need to ask questions several times to receive the correct answer. Participants suggested additional usability and accessibility features, such as subtitles, text-to-speech conversion and content summaries, and the integration of voice assistants.

We examined the potential of ChatGPT for educational and other uses among SwD. The findings support the importance of inclusivity of chatbots to facilitate the learning process, but also presents ethical dilemmas, such as biased results and uncritical use of information. The results are limited by the small sample size and limited number of participants with each disability type. While the study did not identify participants' challenges in using ChatGPT, future works should also address this issue.

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# General Strategies for Improving Accessibility of E-commerce

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## ABSTRACT

This paper focuses on the accessibility challenges in e-commerce and strategies for their remediation on a high level with the main purpose of promoting further in-depth research. It also offers some general applicable guidelines for e-commerce to start improving their accessibility. It highlights the significance of organizational culture, commitment, awareness, training, and collaboration with accessibility specialists and individuals with disabilities. The paper categorizes the challenges based on the main user journeys that are essential for e-commerce, explores potential causes, and provides generalized best practices for implementing accessibility on a strategic level. Solutions include prioritizing accessibility within company culture, allocating resources, implementing change management strategies, raising awareness, defining roles and responsibilities, offering role-based accessibility training, integrating accessibility into project management and reporting, collaborating with external specialists, and actively involving people with disabilities.

## KEYWORDS

Accessibility, E-commerce, European Accessibility Act, WCAG, Accessibility culture

## 1 INTRODUCTION

E-commerce and financial independence are crucial for everyone, but they can have a particularly life-changing impact on individuals with disabilities who have historically faced difficulties in navigating the physical world. Around 87 million people in the EU have some form of disability and around 45 million of them feel discriminated against [1]. This indicates that inaccessible online services discriminate against individuals who typically derive the greatest advantages from them.

Directive (EU) 2019/882 of the European Parliament and of the Council of 17 April 2019 on the accessibility requirements for products and services (The European Accessibility Act, EAA) [2] covers products and services that have been identified as being the most important for people with disabilities while being the most likely to have diverging accessibility requirements across EU countries.

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The scope of the EAA includes consumer banking services and e-commerce services that will need to be accessible no later than after the transitional period ending on 28 June 2030 [2].

With the revised Payment Services Directive (PSD2) [3] e-commerce and digital banking became even more interconnected [4], therefore they should be analyzed together.

This paper aims to examine common accessibility challenges in e-commerce. We will categorize and analyze them based on typical user journeys that often pose obstacles for people with disabilities.

Furthermore, we will discuss their probable causes. Finally, we will examine possible practical measures on an organizational level that can either avert these challenges from arising in the first place or remediate the existing ones.

## 2 METHODS

Firstly, we conducted a review of existing articles and research papers on accessibility to gather insights and perspectives. Additionally, we examined publicly available accessibility audits to gain a broader understanding of common accessibility issues and challenges.

Furthermore, we leveraged our own extensive experience in conducting accessibility audits and counselling for different organizations and platforms, allowing us to provide firsthand insights and recommendations. To ensure a user-centric approach, we actively sought direct feedback from individuals with disabilities [5], who shared their experiences and highlighted areas for improvement.

Moreover, we relied on statistical data obtained from both automated and manual accessibility testing studies. This quantitative information enabled us to identify trends and patterns in accessibility issues, as well as providing a more data-driven analysis.

By combining these various sources and methods, this paper should provide a robust and generalized foundation for the observations and recommendations presented in this article and encourage further, more detailed, research and discussions.

## 3 PARTS OF THE USER JOURNEY WITH ACCESSIBILITY CHALLENGES AND SUGGESTED SOLUTIONS

### 3.1 Presales and advertising

Digital advertisements are frequently displayed through various platforms such as search engine result pages, social media, inside mobile applications, and anywhere on the internet. Unfortunately, accessibility is often overlooked during the creation and serving of these ads [6].

Home pages that utilize the common Google AdSense system had 17.7 more errors on average [7], as a relevant example. Typical issues include low text contrasts, blinking animations, videos missing captions, missing keyboard support, total invisibility to screen readers, and so on.

To ensure accessibility of presales and advertising, it is important to select creative agencies and advertising platforms that adhere to accessibility standards. Verification of their compliance should be a part of systematic responsible procurement processes.

For in-house advertisements, creators should ensure compliance with accessibility standards before publishing them on advertising platforms. It is also important to recognize the varying accessibility support capabilities of different social media platforms and provide necessary workarounds when required [8].

## 3.2 Public-facing websites or native mobile applications

The 2023 report on the accessibility of the top 1,000,000 home pages, WebAIM's Million project [7] reports that 96.3% of home pages had detected WCAG 2 failures, discovered with automatic accessibility testing. Automatic accessibility testing can only discover up to 30% of all WCAG failures (16 out of the 50 Success Criteria under WCAG 2.1 Level AA [9]), so these numbers are often even higher.

Evaluating accessibility of native mobile applications is usually a manual approach, which is difficult to scale and therefore mass evaluation studies comparable to website studies do not yet exist. In a study of 479 Android apps in 23 business categories, 94.8% of them had automatically detectable accessibility issues [10]. Based also on our experience and available reports from the public sector applications [11], the accessibility of native mobile applications seems to be similar to the web with most of them being inaccessible.

In the past four years, the number of webpages with detectable WCAG (Web Content Accessibility Guidelines) failures has decreased by only 1.5%, from 97.8% [7]. It also appears that some e-commerce platforms have more accessibility issues compared to the previous year [7]. This could suggest a worsening of awareness and concern for accessibility.

Experts recommend that the management of organizations take the necessary steps to assess of the current accessibility situation. They also propose conducting accessibility audits to determine the state of accessibility. These audits also serve to track progress during improvement cycles and provide content for accessibility statements, which also need to be created and maintained.

Additionally, it is important to clearly define roles and responsibilities related to accessibility within the organization [12]. The individuals in these roles should receive appropriate role-based training on accessibility to effectively address issues they are (co)responsible for.

Project management should provide the necessary support to ensure that proper processes are in place and respected. This includes prioritizing accessibility alongside other planned activities, monitoring and reporting progress and allocating resources accordingly. This will allow for both the development of new functionalities with integrated accessibility from the start and the fixing of existing inaccessible functionalities. Organizational policy on accessibility is strongly suggested [13].

## 3.3 Customer onboarding

Customer onboarding typically involves multi-step online forms that may require users to provide additional documentation manually or through digital authorization and signing. More than 45% of webpages tested in WebAIM Million still have basic form accessibility issues, for example missing form input labels [7].

Complex forms and components tend to come with more accessibility challenges. While reusable web components and design systems are the recommended best practice when they integrate accessibility [14], it is important to exercise caution and not solely rely on self-declared statements in their documentation [15], as they can be incorrectly reporting conformance.

Advanced custom-made components that can compromise accessibility require input from accessibility specialists and users with disabilities before they can be used [16]. Neglecting this due to lack of awareness or prioritization leaving accessibility to the end is a common cause of accessibility challenges and barriers. Using native components and simplifying where possible is advised instead of re-creating custom components [17].

Automatically generated documents such as contracts and invoices, usually made as Portable Document Format (PDF) documents [18], are another potential accessibility challenge when not tested for accessibility.

Communication channels such as email also need attention or quickly become potential sources of accessibility challenges as well [19].

Once again, a systematic approach works best. All roles involved need to be properly trained, aware of their responsibilities, and continuously cooperate to reach sustainable accessibility.

## 3.4 Customer Self-Service

Self-Service refers to a protected part of an online portal or a mobile application where customers authenticate so that they can manage their accounts, such as tracking deliveries, handling banking transactions, exporting transactional data, managing credit cards, and similar. Most customers (73%) want to be able to solve issues on their own [20] before contacting support. Forty-five per cent of people with disabilities in a Deloitte survey [21] believe that banks can elevate their experience by making digital banking channels more accessible.

Sixty-seven per cent of accessibility issues originate before coding, in wireframes and design specifications [22], so it is vital to implement accessibility earliest. As product details solidify, fixing problems becomes harder and more expensive [23].

With authentication and authorization services, complex dynamic components, rich visualizations, report generation, data exports, third-party components, and all other parts that are needed for efficient customer self-service products and services need proper and early planning, implementation, and maximum coverage of automatic and manual testing to be able to satisfy accessibility requirements, acceptance criteria, and conformance to standards.

Different roles with support from accessibility specialists and people with disabilities need to plan, cooperate, and test, particularly during the early stages, so that efforts yield the best results with accessibility implementation.

### 3.5 Customer support

Customer support in e-commerce involves assisting customers with their online purchases, financial transactions, and resolving a variety of other queries.

Accessibility is crucial for customer satisfaction and retention [24]. It involves providing an inclusive experience through diverse contact options and staff need to have training and solutions to offer alternatives when requested. Customers may prefer utilizing customer support through various channels such as phone calls, SMS, email, ticketing systems, video calls, and chat, so best practice is to offer them multiple channels and especially respect their preferences for communication.

Awareness and training of support staff around accessibility is decisive in customer satisfaction and in preventing legal consequences when dealing with accessibility complaints.

### 3.6 Third parties

Third-party solutions are pre-built tools provided by external companies for web and mobile platforms. They offer components or even full features such as authentication, authorization, chats, polls, forms, and so on. Overall, these solutions save time and resources and outsource parts of products or services.

Such solutions are also often a source of accessibility challenges [25]. Therefore, it is vital to ensure their accessibility before integration, otherwise the product or service risks inheritance of accessibility challenges. It is also recommended to create a vendor accessibility policy [26] that requires conformance of all third-party solutions before they can even be considered.

Providing possibilities of user-generated content is another potential source of accessibility challenges [27] and needs to be planned for as well.

Again, all involved roles need to be aware of their responsibilities and follow procurement and integration processes that consider accessibility beside other priorities.

## DISCUSSION

Sustainable accessibility efforts require more than mere technical conformance. It is essential for companies to cultivate a culture that comprehends, supports, and integrates accessibility [28]. This practice not only aligns with moral obligations but also offers various benefits to businesses, such as enhanced branding, increased customer retention, and broader market reach. Accessibility expands market reach by attracting and retaining customers with disabilities, but calculating the economical return on investment is challenging [29]. Accessibility not only enhances the online experience for all users but also improves brand reputation and reduces legal liabilities [30].

To ensure accessibility is prioritized, it must be integrated into the executive strategy. In large organizations, the appointment of a Chief Accessibility Officer can be advantageous, overseeing the accessibility programme [31]. Nonetheless, executives themselves need to demonstrate effective change management and allocate adequate resources to constantly enhance processes and integrate accessibility within company roles and responsibilities. Evaluating products and services for accessibility is crucial, and the Web Content Accessibility Guidelines [32], along with their Evaluation Methodology [33], serve as a solid foundation for establishing key performance indicators, useful for continuous monitoring and managing progress.

Furthermore, it is imperative for all employees to receive awareness and role-based training to effectively improve and maintain accessibility. Collaboration with experienced external accessibility specialists and early involvement of individuals with disabilities are vital components, especially when internal resources are still building competence [34].

In the light of the upcoming European Accessibility Act, organizations without an existing executive strategy for accessibility are strongly advised to begin implementing the suggested activities promptly or risk falling behind. Complex systems often result in technical and procedural debt, necessitating even more required resources. These complexities can also impact the integration of third-party solutions, thereby prolonging accessibility efforts.

The paper provides a concise overview of complex subjects, encouraging further research and hopefully inspiring others in this important area.

## CONCLUSION

In conclusion, sustainable accessibility efforts require cultivating a culture of accessibility, beyond technical compliance. Accessibility offers benefits to businesses, including enhanced

branding, increased customer retention, and broader market reach. Prioritizing accessibility requires integration into the executive strategy and ideally appointing a Chief Accessibility Officer to lead the programme of larger organizations. Evaluating products and services for accessibility using the Web Content Accessibility Guidelines is crucial but only a baseline. All employees should receive awareness and role-based training on accessibility. Collaboration with external accessibility specialists and early involvement of individuals with disabilities are key for long-term accessibility efforts. Integration of third-party solutions impacts overall accessibility and should also be taken into consideration. Organizations without an existing executive strategy for accessibility must start implementing suggested activities rapidly and the insights offered in this paper offer an introductory overview with quality sources that can be used for detailed research.

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# Dostopnost informacijskih rešitev – ključ za opolnomočenje oseb z invalidnostmi

IT solutions accessibility – the key to empowering people with disabilities

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## POVZETEK

V zadnjih desetletjih je razvoj tehnologije povsem spremenil naša življenja. Digitalni svet je postal pomemben del posameznikovega življenja. Omogoča medsebojno komunikacijo, izboljša priložnosti za izobraževanje in zaposlitev ter ponuja različne možnosti sprostitve.

Digitalizacija je pripeljala do velikih sprememb tudi v poslovnem svetu. Hiter in enostaven dostop do podatkov ter možnost oddaje digitalnih podatkov, za katere je skladno s pooblastili odgovoren vsak pooblaščeni posameznik, omogočata samostojno opravljanje del.

Vendar to žal ne velja za vse. Programske rešitve v veliki večini namreč niso narejene z mislijo na to, da morajo omogočati enako uporabnost za vse uporabnike, ne glede na njihove morebitne oviranosti.

Zato se v realnem svetu osebe z invalidnostmi, v članku smo se osredotočili na področje vida, slepoto in slabovidnost, srečujejo s številnimi ovirami ter omejitvami pri uporabi rešitev, kar jih postavlja v neenakovreden položaj.

## KLJUČNE BESEDE

Programske rešitve, dostopnost, opolnomočenje, diskriminacija.

## OPTIONAL: ABSTRACT

Over the last decades, the development of technology has completely transformed our lives. The digital world has become an essential part of people's lives. It enables us to communicate with each other, improves education and employment opportunities and offers a variety of ways to relax.

Digitalization has also led to major changes in the business world. Fast and easy access to data, the possibility of submitting digital data for which each authorized individual is responsible in accordance with the mandate, allows independent work to be carried out.

However, this is unfortunately not the case for all. Most software solutions are not designed with the idea that they should be equally usable by all users, regardless of any handicaps they may have.

Therefore, in the real world, people with disabilities - in this article we have focused on vision, blindness, and visual impairment - face many barriers and limitations in using solutions, which puts them in an unequal position.

## KEYWORDS

IT solutions, accessibility, empowerment, discrimination.

## 1 Pomen dostopnosti produktov in storitev IKT

Produkte in storitve IKT uporabljamo na vseh področjih življenja. Na delovnem mestu uporabljamo raznovrstno programsko opremo, ki nam omogoča komunikacijo, vpogled v evidence in dokumente, načrtovanje ter izvedbo delovnih nalog. Z iskanjem informacij na spletu in uporabo sistemov načrtujemo izrabo prostega časa, obenem tudi rezerviramo in plačujemo nastanitvene zmogljivosti. Za vsakodnevno življenje opravljamo nakupe prek spleta, spremljamo procese dostave, uporabljamo elektronsko bančništvo, oddajamo elektronske vloge in prejemamo elektronske odločbe.

Lahko rečemo, da je v zadnjih letih IKT za veliko večino oseb postal ključni element vsakodnevnega življenja – tako v zasebnem in poslovnem življenju kot tudi za opravljanje večine vsakodnevnih opravil. Nedostopni produkti in storitve pa določenemu delu oseb vendarle preprečujejo enakovredno uporabo ter s tem enake možnosti, kot jih imajo drugi.

Ko gledamo službeni del časa, nedostopnost IKT produktov zmanjšuje ali celo onemogoča njihove zmožnosti, ne pa sposobnosti, samostojnega opravljanja nalog, kar smatramo kot neposredno diskriminacijo [1]. To je v neskladju tako z nacionalno kot tudi evropsko ustavo in zakonodajo. Enako velja, ko gre za naša opravila, ki jih imamo z javno upravo in širše javnim sektorjem.

Pri preživljanju prostega časa so tovrstne omejitve enako problematične, osebam z invalidnostmi in oviranostmi povzročajo težave ter ovirajo njihovo samostojnost. Žal se v EU zakonodaja tega področja še ne dotika, zaradi česar je zelo malo rešitev sploh dostopnih. Odločitve so prepuščene etičnim in ekonomskim interesom ponudnikov.

Evropska komisija je vse prej omenjeno že prepoznala in tako ob zaključku tisočletja začela pripravljati ukrepe. Tako je od leta 1999 na tem področju sprejela kar nekaj direktiv in standardov, katerih namen je predvsem preprečevanje diskriminacije pri uporabi produktov in storitev IKT.

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Osnova za to je 19. člen Pogodbe o delovanju Evropske unije [2], pozneje prenesen v Ustavo EU, ki določa ukrepe proti diskriminaciji, med drugim na podlagi invalidnosti. Prav na podlagi tega člena je Evropska komisija novembra 1999 sprejela protidiskriminacijski sveženj [3], ki je privedel do direktive na področju zaposlovanja in poklica, ki prepoveduje diskriminacijo iz vseh razlogov iz 13. člena prej omenjene pogodbe.

Leta 2005 je Evropska komisija Evropskemu inštitutu za telekomunikacijske standarde (European Telecommunications Standards Institute – ETSI) in Evropskemu odboru za elektrotehnično standardizacijo (European Committee for Standardization – CEN-CENELEC) podala mandat, imenovan M 376 [4], s katerim je organizacijam naložila pripravo standarda za dostopnost produktov in storitev IKT.

Med cilji uvedbe standarda je bilo navedeno: »Izdelki IKT morajo biti zasnovani na dostopen način, da jih lahko invalidi in starejše osebe uporabljajo ter imajo od njih enake koristi kot vsi drugi. S tem se ne bo le olajšalo dela industrije, temveč bo tudi povečalo trge ter potencialnim kupcem zagotovilo boljše izdelke in storitve. Vključitev zahtev glede dostopnosti v javna naročila bo predstavljala spodbudo za proizvajalce, da razvijajo in ponujajo dostopne naprave, aplikacije in storitve, kar bo koristilo invalidom in starejšim, hkrati pa tudi drugim uporabnikom.«[4]

Na tej osnovi je bil, sicer z zamudo, leta 2014 objavljen standard EN 301 549 [5], ki opredeljuje zahteve za dostopnost in storitev IKT. Standard, ki se redno dopolnjuje in sledi trendom na področju digitalne dostopnosti, je dosegljiv tudi v slovenskem prevodu SIST EN 301 549.

Eno od pričakovanj predlagateljev je bilo, da bo uvedba zahtev po dostopnih IKT rešitvah v procesih javnih naročil spodbudila razvoj dostopnih rešitev, ki bodo dostopne tudi zasebnemu sektorju; prav takšne izkušnje so imeli v ZDA ob uvedbi zahtev glede dostopnosti v okviru »Section 508« [6].

Evropska komisija je torej že več kot pred dvajsetimi leti prepoznala pomen dostopnosti produktov in storitev IKT za preprečevanje diskriminacije v vsakdanjem življenju ter pri zaposlovanju.

V ta namen je sprejela vse potrebne standarde in direktive, ki organizacijam javnega sektorja zapovedujejo uporabo teh standardov tako v procesih javnega naročanja (Zakon o javnem naročanju – ZJN-3, ki velja od leta 2016) kot tudi pri razvoju in vzdrževanju spletišč ter mobilnih aplikacij (Zakon o dostopnosti spletišč in mobilnih aplikacij – ZDSMA, ki velja od leta 2018).

Podjetja s področja IKT v Evropi in Sloveniji bi morala torej vse od leta 2016 poznati področje digitalne dostopnosti, pri tem pa imeti osnovno zavedanje in strokovno znanje za razvoj kot tudi implementacijo dostopnih rešitev.

Toda kakšno je trenutno stanje?

## 2 Stanje dostopnosti v Sloveniji

Petnajst let izkušenj na področju digitalne dostopnosti, sodelovanje z invalidskimi organizacijami in končnimi uporabniki z oviranostmi ter vsakodnevno delo na tem področju nam omogočajo vpogled v stanje dostopnosti informacijskih rešitev v Sloveniji.

Šele zadnja leta se o dostopnosti vedno več govori in piše. Lahko rečemo, da je tudi vedno več zavedanja in naporov, usmerjenih v zagotavljanje dostopnih spletnih strani. Pomembna novost je, da **se zaznavajo pozitivne spremembe le na področju spletnih strani organizacij javnega sektorja, ki so zavezanci po Zakonu o dostopnosti spletišč in mobilnih aplikacij (ZDSMA)**.

Več kot dve leti pred ZDSMA je začel veljati Zakon o javnem naročanju (ZJN-3), ki je v 3. točki 68. člena, kjer so podane tehnične specifikacije, natančno opredelil naslednje:

»(3) Pri vseh predmetih naročanja, ki jih bodo uporabljale fizične osebe, bodisi splošna javnost bodisi uslužbenci naročnika, naročnik pri pripravi tehničnih specifikacij upošteva merila dostopnosti za invalide ali zahteve za oblikovanje, prilagojeno vsem uporabnikom, razen v ustrezno utemeljenih izjemnih primerih. Kadar zahteve v zvezi z obvezno dostopnostjo določa neposredno veljaven pravni akt Evropske unije, naročnik tehnične specifikacije glede kriterijev dostopnosti za invalide ali zahtev za oblikovanje, prilagojeno vsem uporabnikom, določi s sklicevanjem na ta akt.«[7]

Vendar se po naših izkušnjah prav to ključno določilo v Sloveniji ni nikoli uveljavljalo, če gledamo z vidika omogočanja enakosti pri uporabi IKT storitev in rešitev. Morda obstajajo izjeme, a stanje dostopnosti rešitev, spletnih strani in slabo stanje poznavanja tega področja kot tudi primanjkljaj strokovnosti razvijalcev na tem področju potrjujejo naše prepričanje.

Navsezadnje pa imajo posledice nespoštovanja in neizpolnjevanja zahtev glede dostopnosti v okviru javnega naročanja daljnosežne posledice, torej takšne, ki podaljšujejo in razširjajo diskriminacijo oseb z invalidnostmi na več področjih – od zaposlovanja, samostojnosti, urejanja upravnih zadev do marsičesa drugega.

## 3 Posledice dosedanjega neizpolnjevanja zahtev glede dostopnosti

Še leta 2023 se soočamo z dejstvom, da IT podjetja nimajo niti ustreznega zavedanja o pomenu digitalne dostopnosti niti ustreznih strokovnih znanj s področja digitalne dostopnosti. Posledično tudi njihove rešitve niso ustrezno dostopne – žal niti tiste, ki jih prodajo ali oddajo organizacijam javnega sektorja, čeprav bi, glede na zakonske zahteve, brez dvoma, morale biti. Tako imajo tudi vsi zavezanci po ZDSMA velike težave z izpolnjevanjem zahtev zakona.

Z zelo veliko stopnjo verjetnosti lahko trdimo, da bi bila raven zavedanja in strokovnih znanj s področja digitalne dostopnosti, v primeru doslednega upoštevanja zahtev ZJN-3 od 1. 4. 2016, torej več, kot sedem let, v tem trenutku na ustrezni ravni ali vsaj občutno višji, kot je zdaj. **To je dobesedno sedem nepovratno izgubljenih let razvoja. Tako poimenovanje lahko tudi ustrezno argumentiramo.**

Digitalizacija javnega in zasebnega sektorja je bila v zadnjih sedmih letih zelo aktivna. Aktivnosti se nadaljujejo in celo intenzivirajo. Ob tem se tudi leta 2023 rešitve razvijajo na enako nedostopen ali celo bolj nedostopen način, kot so se vse predhodne.

Namesto da bi po sedmih letih razvoja imeli v Sloveniji na voljo skupek rešitev, ki bi bile enako dostopne vsem, se je razširil in se razširja skupek nedostopnih rešitev. Enako velja za naslednje – namesto da bi v Sloveniji imeli širok krog strokovnjakov na vseh področjih razvoja, ki standarde digitalne dostopnosti obvladajo, obstaja le peščica strokovnjakov s tega področja. Teh sedem let je izgubljenih tako z vidika razvoja dostopnih rešitev, razvoja kompetenc kot tudi najosnovnejšega

razširjanja zavedanja o pomenu digitalne dostopnosti za ciljne skupine in družbo kot celoto.

Upoštevajoč dejstvo, da se še dandanes skoraj nihče ne drži zahtev ZJN-3, raven zavedanja in strokovnih znanj s področja digitalne dostopnosti še vedno ne raste dovolj hitro. Prepričani smo, da se bo brez hitrega ukrepanja vseh deležnikov razvoj nedostopnih rešitev nadaljeval vsaj še nekaj let. S tem se bo nadaljevala in poglabljala tudi diskriminacija, saj se vse digitalizira.

Dejstvo je, da bi se diskriminacija nadaljevala tudi, če bi se jutri začel razvoj nove generacije informacijskih rešitev. Tak razvoj traja dolgo, upoštevajoč primanjkljaj strokovnosti na tem področju, pa odpira vprašanje, koliko bi bile razvite rešitve v resnici dostopne.

## 4 Težave oseb z invalidnostmi in organizacij, ki jih zaposlujejo

Težave in diskriminacija, ki jo omenjamo, seveda ne izvirajo iz hipotetičnih situacij, temveč iz izkušenj in rednega sodelovanja z osebami z invalidnostmi ter invalidskimi organizacijami. Poglejmo primer ene take organizacije in težave, s katerimi se soočajo.

Pred leti smo imeli na projektu Zveze društev slepih in slabovidnih Slovenije (v nadaljevanju Zveza), ki je reprezentativna invalidska organizacija in tudi delodajalec osebam z invalidnostmi, precejšnje težave z iskanjem dostopnega sistema za evidenco delovnega časa, saj smo imeli zaposlene tako slabovidne kot tudi slepe. Izziv je bil že najti registrator na fizične tipke, saj so bile rešitve z zasloni na dotik namreč vse po vrsti popolnoma nedostopne.

Ob iskanju nove rešitve nekaj let pozneje stanje ni bilo veliko boljše. Registratorjev s tipkami ni več, rešitve na mobilnih telefonih in osebnih računalnikih niso ustrezno oziroma popolnoma dostopne. Še manj so dostopne rešitve za urejanje in administracijo evidenc.

Leta 2022 je Zveza začela izvajati projekt Informatizacija Zveze. Za izvedbo projekta je od Ministrstva za javno upravo, tako kot mnoge druge nevladne organizacije, prejela tudi sredstva. Poglavitna razlika med Zvezo in večino ostalih organizacij je, da so ostali lahko kupili in po potrebi delno prilagodili rešitve, ki so že na voljo na trgu. Zveza je zaradi nedostopnosti rešitev morala v razvoj lastne rešitve, saj so le tako lahko zagotovili, da so njihovi zaposleni na delovnem mestu ustrezno opolnomočeni.

Ob upoštevanju načel univerzalnega oblikovanja in ustreznih tehnoloških rešitev je v današnjem času mogoče zagotoviti informacijske rešitve, ki zagotavljajo skoraj popolno samostojnost pri delu oseb z različnimi vrstami invalidnostmi in oviranostmi.

Samostojen vpogled v podatke, samostojna oddaja in podpisovanje vlog, samostojno potrjevanje vlog ter samostojen pregled skoraj vseh vrst dokumentov je v primerjavi s časi papirnatega poslovanja še pred desetletjem nepredstavljiv korak naprej.

Prek sodobnih rešitev lahko zaposleni dandanes dostopajo do digitalnih evidenc organizacije, na primer: do potnih nalogov, naročilnic, raznih poročil in obračunov. Vsi podatki so shranjeni v besedilni obliki, kar pomeni, da je njihova predstavitev lahko pripravljena na vsem dostopen način. Slepim prek bralnikov zaslona in govorne sinteze ali brajeve vrstice, slabovidnim v obliki povečanega teksta v ustreznih kontrastih, kognitivno oviranim v obliki predstavitve ključnih poenostavljenih podatkov.

A tudi tu je bila Zveza v neenakem položaju. Digitalizirali so lahko le del postopkov, tudi te ne nujno optimalno oziroma v podrobnosti, sam proces je bil kompleksnejši, čaka jih še veliko razvoja, da bodo lahko v enakem položaju kot neka organizacija, ki (nedostopno) rešitev kupi ali najame na trgu. Tudi strošek vzdrževanja in nadaljnjega razvoja aplikacije na ključ je v vsakem primeru višji od stroška vzdrževanja in nadgradenj programskega paketa.

Hkrati pa mora Zveza za poročanje po programih uporabljati tudi rešitve, ki so bile v preteklih letih razvite s strani ministrstev in niso popolnoma dostopne. Te rešitve uporabljajo tudi uporabniki z invalidnostmi, kar jih postavlja v neenak položaj z ostalimi zaposlenimi.

Namesto da bi se organizacija lahko ukvarjala s svojo osnovno dejavnostjo in poslanstvom, se mora ukvarjati tudi z iskanjem in razvojem rešitev, ki jih bodo lahko uporabljali njihovi zaposleni.

## 5 Kako izboljšati stanje

Da bi čim prej izšli iz tega, za mnoge nevzdržnega, stanja, je potreben precejšen in usklajen napor različnih deležnikov.

- Spremljati in preverjati je treba 68. člen Zakona o javnem naročanju (ZJN-3), opozarjati organizacije na neskladnosti ter doseči, da se začnejo določbe dosledno upoštevati.
- Spremljati in preverjati je treba primopredaje rešitev, razvitih na podlagi javnih naročil. So te rešitve res ustrezno dostopne? Primopredaja nedostopnih rešitev ne sme biti opravljena oziroma se morajo podati in po potrebi uveljavljati ustrezne garancije glede dobre izvedbe posla tudi na tem področju.
- Za izvedljivost predhodnih točk je treba začeti z aktivnim informiranjem vseh deležnikov, naročnikov v okviru javnega sektorja ter njihovih dobaviteljev storitev in opreme glede področja digitalne dostopnosti, zakonskih ter tehničnih zahtev in standardov s tega področja.
- Organizacije je treba spodbuditi, da začnejo z razvojem dostopnih rešitev. V okviru rešitev, financiranih iz nacionalnega ali evropskega proračuna, bi moral biti omogočen le razvoj rešitev, dostopnih vsem, brez izjem. Nedostopne rešitve ne bi smele biti upravičen strošek.
- Invalidskim organizacijam in organizacijam, ki zaposlujejo osebe z invalidnostmi, bi morali s finančnimi spodbudami in strokovnimi pomočmi omogočati vzpostavitev primerov dobrih praks – tako na primerih spletišč organizacij kot tudi razvoja ali prilagoditev informacijskih rešitev.
- Omogočiti in spodbujati je treba usposabljanje vseh deležnikov, vpletenih v produkcijo storitev ali produktov, ter s tem zagotoviti celostno izvajanje dostopnosti, kjer vsak deležnik dobro pozna svoje odgovornosti ter kako se te medsebojno prepletajo z odgovornostmi ostalih deležnikov.

Seveda bi bilo za vse do zdaj naštete točke potrebno sodelovanje vseh deležnikov s tega področja. Naj omenimo le

delodajalce, ponudnike rešitev, ministrstva, reprezentativne invalidske organizacije, strokovne organizacije, višje šole in univerze, ponudnike certificiranj in druge.

Za doseg celostne dostopnosti in upoštevanje dobrih praks je tako nujno treba spodbuditi dvig kompetenc s področja digitalne dostopnosti pri vseh deležnikih in na vseh ravneh. Zahteve dostopnosti je treba upoštevati že v prvih korakih snovanja razvoja ali prenove informacijskega sistema (premik na levo), ne pa šele na koncu, ko je produkt končan, kakršna je dandanašnja praksa. Dokler izvajalci, prav tako pa tudi naročniki, nimajo dovolj internih kompetenc, da lahko presodijo dostopnost, je nujno vključevanje zunanjih specialistov dostopnosti ter reprezentativnih invalidskih organizacij. Trajnostna dostopnost, ki se mora prilagajati novim tehnologijam in standardom, pa priporoča, da se sodelovanje ohranja tudi takrat, ko so interne kompetence že precej samostojne.

Podjetja, ki se ukvarjajo z načrtovanjem in razvojem informacijskih rešitev ter načrtovanjem in razvojem spletnih strani, bodo morala ustrezno usposobiti:

- projektne vodje, ki bodo morali skrbeti za skladnost skozi celoten proces razvoja in ustrezno usklajevati deležnike, vključene v proces, ter po potrebi vključevati tako strokovnjake s področja digitalne dostopnosti kot tudi uporabnike z invalidnostmi;
- sistemske analitike, ki morajo v svoje zahteve vključiti tudi zahteve s področja digitalne dostopnosti, in morajo to ustrezno tudi upoštevati;
- raziskovalce in oblikovalce uporabniške izkušnje (UX), ki je ključna komponenta univerzalnega oblikovanja in zagotavljanja enako dostopnih rešitev za vse;
- oblikovalce, ki morajo upoštevati načrtovano uporabniško izkušnjo in jo v fazi oblikovanja dosledno udejanjiti ter pri tem upoštevati vse zahteve in dobre prakse standardov dostopnosti;
- programerje, ki morajo zagotoviti dostopnost končnih rešitev in ob tem tudi opozoriti na morebitne nedoslednosti ali pomanjkljivosti opredelitev glede dostopnosti v predhodnih korakih;
- testerje, ki morajo poleg funkcionalnih testiranj glede na zahteve sistemskih analitikov upoštevati tudi zahteve glede dostopnosti;
- osebe, ki skrbijo za vsebino in uredniški del strani, ker je dostopnost možna le s sodelovanjem oblikovanja, programiranja in vsebin, ki upoštevajo standarde dostopnosti.

Ob hitrem ukrepanju, ustreznem financiranju in usklajenem delovanju vseh deležnikov je preboj mogoče doseči že v nekaj letih. Tovrsten preboj je po našem mnenju nujen, da se začne stanje na področju dostopnosti IKT rešitev vendarle izboljševati.

Hitro ukrepanje, ki je po našem mnenju nujno, je lahko le začasne narave in je morda vzdržno v nekem srednjeročnem obdobju treh do petih let. Za zagotavljanje teh srednjeročnih ukrepov bi se morala zagotoviti tako notranja sredstva organizacij kot tudi sredstva nacionalnega in evropskega proračuna. Za namen digitalizacije je v prihajajočem obdobju namenjeno precej sredstev.

# 6 Dolgoročno zagotavljanje kakovosti in kontinuiran razvoj

Povsem na mestu je vprašanje, ali obstajata ustrezno zavedanje in politična volja za usklajen pristop ter financiranje spodbude preskoka v srednjeročnem obdobju. Brez tega se bo namreč uvajanje digitalne dostopnosti občutno zavleklo.

Dolgoročno bodo morale vse organizacije najti ustrezne interne rešitve. V tujini se to rešuje predvsem s specializiranimi delovnimi mesti, kot so direktor dostopnosti oziroma koordinator dostopnosti ali skrbnik dostopnosti, ki imajo širšo odgovornost glede dostopnosti, kot so aplikacije in/ali spletne strani, ter omogočajo dostopnost celotne organizacije. Na univerzah na primer skrbijo tudi za dostopnost učnih gradiv in učnega procesa za vse študente.

Za zagotavljanje ustreznih internih rešitev bo potrebno zavedanje glede dostopnosti na vseh ravneh, ki se dolgoročno najlažje in najceneje doseže z uvedbo ustreznih predmetov v programe srednješolskega in visokošolskega izobraževanja.

Podobni ukrepi bodo zaradi Zakona o dostopnosti produktov in storitev za invalide (ZDPSI) potrebni tudi na strani zasebnih delodajalcev, kot so banke, spletne trgovine, prevozniki in drugi, ki jih bodo zaobjele zahteve zakona.

Prvi korak na tem področju se sicer že izvaja. Center za poklicno izobraževanje (CPI) pripravlja NPK »Menedžer digitalne dostopnosti«, ki v dobri meri pokriva kompetence in delovne obveze profilov, ki jih omenjamo v tem poglavju.

Kako hitro bodo organizacije prepoznale potrebe po tovrstnih kadrih oziroma tovrstnem pristopu k celovitemu reševanju digitalne dostopnosti ali dostopnosti na splošno, je odvisno od uspešnosti širitve zavedanja in ponotranjenja realnih potreb v širšem krogu javnih in zasebnih organizacij v Sloveniji.

Seveda upamo, da se bo dolgoročno zakonodaja razširila na širši krog deležnikov, za katere pa bo samo zagotavljanje dostopnosti, zlasti zaradi širšega poznavanja v družbi in stroki, veliko lažje.

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# Bridging Communication Gaps through the Talking Hands Project: An In-depth Analysis

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## ABSTRACT

Talking Hands project, operating under the Erasmus+ KA220-YOU cooperation partnerships in adult education, seeks to change the landscape of sign language learning. This article presents a comprehensive overview of the project's goals, research rationale of the Inception Workshops that was made by each project partner, its findings and implications for bridging communication barriers between deaf individuals and their associates. The project's multi-faceted approach aims to enhance inclusivity and digital transformation within European society. Each partner conducted an Inception workshop with target groups, which included friends, family members, and experts from organizations that work with deaf people, in order to identify the thematic areas that interested them the most and come to a consensus. Local particularities, patterns, and variations were documented.

## KEYWORDS

Talking Hands project, Erasmus+ KA220-YOU, Inceptions Workshop, adult education, sign language learning, Deaf Culture, Children of deaf adults, Family members, Support Workers, Educational Path, multi-faceted approach, inclusivity, digital transformation, European society, open online platform.

## INTRODUCTION

Sign language plays a crucial role in enabling effective communication for the deaf community. However, communication barriers persist due to limited sign language proficiency among the hearing population. The Talking Hands project addresses this challenge by leveraging the potential of digital education.

This article delves into the project's inception, research objectives for Inception Workshop, its findings, and implications for promoting inclusivity and digital preparedness.

To comprehend the challenges faced by the deaf community and the dynamics of interactions between deaf and hearing individuals, the Talking Hands project initiated a comprehensive research phase. This research aimed to identify communication barriers and foster awareness about the challenges within the community. By conducting Inception Workshops, the project engaged with 120 participants, including deaf individuals, family members, support workers, and educators. The research employed a structured questionnaire to explore personal and professional data, challenges faced, educational paths, and topics for online sign language lessons. This research approach offered multifaceted insights into the complexities of communication barriers.

## 1 ABOUT TALKING HANDS PROJECT

Talking Hands project endeavors to develop an open online platform for learning sign language. Aligned with the Erasmus+ KA220-YOU cooperation partnerships in adult education, the project aims to offer high-quality learning opportunities to adults while addressing digital transformation and inclusion priorities set by the European Union. There are 7 Partners organizations that come from 6 different countries: Slovenia, Italy, Greece, Sweden, Poland and Croatia[3].

Project addresses digital transformation through the development of digital readiness, resilience, and capacity, as well as inclusion and diversity in all fields of education, training, youth and sport. It focuses on improving the availability of high-quality learning opportunities for adults and on facilitating communication between deaf individuals, their relatives, friends, and colleagues who wish to learn the fundamentals of sign language.

Project's open online platform offers a flexible and adaptable approach to learning, allowing learners to choose thematic topics non-sequentially. This approach enhances digital access and flexibility, catering to various learning needs and mitigating physical constraints

Objectives of the Talking hands project are [1]:

- To develop a methodology, to collect and record sign language lessons from the languages of the participating countries, including the international sign language.
- To provide these lessons freely online in a non-formal and flexible educational context, along with other useful learning materials related to sign language lessons and Deaf Culture.

- To offer learning opportunities to family members and friends of deaf individuals who wish to enhance their competences, as well as to deaf individuals who wish to access supplementary learning.

Foreseen Results of the project [1]:

- Inception workshops by each partner.
- Methodology Guide: A methodology guide was created based on the outputs of the Inception Workshops, which were provided by each partner in the form of reports. It included 28 lessons recorded in all sign languages, divided into 7 topics, matching the number of partner organizations. This methodology guide was designed for "non-experts" and encompassed sign languages from all partner organizations. Each session required students to engage for approximately 60 minutes.
- Recording of lessons: Consequently, following the aforementioned methodology guide, the recording of lessons was organized by each partner in their own country's sign language, based on the collectively agreed-upon structure.
- Creating a web platform.
- Dissemination.

## 2 INITIAL RESEARCH PURPOSE

Based on initial research, the Talking Hands project intends to assess the existing status of both hearing and deaf individuals in terms of their approach and attitude toward this Culture. The goal is to comprehend how Deaf and Hearing people currently interact in daily life, emphasizing the difficulties they encounter and the support they eventually receive.

Thanks to the Inceptions Workshops created by the 7 Partner Organizations, 120 answers from participants were collected through questionnaires. All the Partners agreed that there is a need to spread awareness of the present problems facing Europe.

The questionnaire was designed to examine four key topics, including [1]:
- Personal and Professional data (age, country, profession, interaction description with the Deaf Culture)
- Identification of Problems & Support received (encountered issues in any circumstances of social life and eventually support received
- Education Path (This section investigates the educational path of the TG)
- Topics suggested for the online lessons (the most requested thematic that experts would like to learn through online Sign Language course).

Primary data was collected through field research conducted by all partners. The research was built based on the involvement of the target group at the local/regional/national level.

According to the project application, the questionnaire had to be handed out to at least 20 participants in each country. Analysis of the comments and recommendations gathered by the target groups and stakeholders who participated came next. The ultimate distribution of the subjects, classes, and associated educational material is set in the Methodology guide. All partners engaged in internal fine-tuning to ensure the maximum integration of the findings from their regional reports and to create a common structure for the lessons that is generated, in order to offer a variety of learning opportunities [1].

The participants answered a total of 8 open questions belonging to one common Google Form Questionnaire, translated into the 6 partnership languages (Slovenian, Italian, Greek, Swedish, Polish, Croatian).

## 3 RESEARCH RESULTS

The European analysis of expert feedback provided a nuanced understanding of the interactions between target groups and sign language within the Deaf Culture. The analysis revealed distinct participant categories, each with varying levels of sign language proficiency. Communication barriers emerged as a central theme, impacting essential areas such as medical contexts, public services, and education. This analysis underscored the urgency of addressing communication challenges to foster inclusivity.

The European analysis acquired 120 expert answers in all, ranging in age from 20 to 60+, with the following Deaf Culture identifications and interactions [1]:
-Deaf individuals, Deafblind
-Coda (Children of Deaf Adults) and family members
-Support personnel, teachers, and sign language interpreters
-Hearing people (friends or coworkers) to deaf or hard of hearing people.

The EU analysis reveals one characteristic of the target group: all participants have interacted with deaf culture for a long time—some from birth, others for more than 30 years—and all have some level of sign language proficiency.

Deaf individuals and deafblind persons who regularly communicate with other deaf people, signers, oralists, and hearing people are all active members of the deaf community and engage in familial and friendly exchanges. While some of them learned sign language later in life because they were born into hearing households without sign language knowledge, others were born into deaf homes and are fluent sign language communicators.

A significant difference between the analyzed countries can be seen when looking at the profile segment of family members at the European level from the perspective of sign language proficiency; in some of them, communication between the parties is limited and is implemented through written communication. Other family members claimed that they gradually lost a large portion of their sign language proficiency due to life events like moving, switching jobs, or changing schools. However, in the long run, they were able to participate in a learning platform remotely in order to practice and reinforce concepts that they had forgotten. The Children of Deaf Adults

who have emerged and are actively participating in this culture on a daily basis, according to Coda profiles, all have a solid command of Sign Language. Some of them have also gained expertise and have become interpreters in a variety of employment settings[1].

Regarding the profile category, the majority of support workers interviewed interact regularly with members of this culture through their work environments; some of them work for the National Deaf Authority as interpreters and have more than 25 years of experience; others train school teachers in workshops on sensory disabilities; and still others are employed by local organizations of the deafblind to create educational programs for these individuals and their families. Others have experience teaching family members who are not proficient in sign language, working with them to improve their skills.

The field research also allowed for the depiction of the exchanges from the viewpoint of a friend, coworker, or a hearing person. Overall, we can say that most of them have excellent relationships with persons who are hard of hearing yet struggle to communicate because of their poor sign language proficiency. They treat someone who has hearing loss the same as any other hearing person, showing that they have grown accustomed to the mode of communication. They take care to talk clearly and avoid covering their mouths with their hands.

## 4 DIFFICULTIES ENCOUNTERED

Communication difficulties were identified as pervasive issues, affecting both deaf and hearing individuals. The prevalence of auditory stimuli in public spaces created challenges for deaf individuals. The lack of sign language knowledge among hearing individuals further exacerbated communication breakdowns. The study illuminated regional dialects within sign language, adding complexity to communication. The research emphasized the need for institutional preparedness and robust support mechanisms to ensure inclusivity and accessibility [1].

The research phase progressed to analyzing the communication experiences of the Target Group during the communication phase, considering both the perspectives of deaf and hearing individuals.

Participants universally reported past communication difficulties, with common challenges arising in various aspects of life such as public services, hospitals, personal interactions, and professional settings.

Deaf individuals highlighted the impact of living in predominantly hearing environments, where auditory cues overshadow visual ones. This disparity, evident in places like stations and airports, posed obstacles due to predominantly auditory announcements.

The inability of most hearing individuals to use sign language created a significant communication barrier. Deaf respondents expressed a desire for hearing people to learn basic phrases and overcome the fear of interacting with them. Lip reading and written communication were fallbacks, but their limitations became evident, especially for congenitally deaf individuals dealing with complex vocabulary, abstract concepts, and synonyms.

The variable nature of sign language, influenced by local dialects, posed challenges, particularly among self-taught learners compared to formal courses.

In healthcare settings, including the pandemic, communication breakdowns were rampant due to a lack of knowledge about sign language among medical professionals and the barrier posed by masks. Restrictions on deaf relatives as mediators further hindered effective communication.

Similar issues arose in public offices, educational institutions, and areas where hearing individuals had guaranteed access to information. Learning sign language proved difficult, leading many to prefer professional interpreters in critical scenarios.

European hearing individuals acknowledged struggles in communicating with deaf acquaintances, especially before learning sign language. Making initial contact with deaf individuals and comprehending them posed difficulties. Adjusting speaking pace for lip reading was common.

Access to sign language courses was inadequate, exacerbated by the shift to online learning after Covid-19. Existing resources mostly offered vocabulary without grammar, limiting independent learning opportunities.

In education, schools often lacked preparation to accommodate deaf students, resulting in communication gaps and dependence on peers for assistance.

The experiences of Children of Deaf Adults (CODAs) emphasized their pivotal role as interpreters. Some hearing individuals claimed no communication issues with the deaf, possibly influenced by biases.

Across EU countries, participants faced a dearth of support in dismantling communication barriers. Institutional unpreparedness led to interpreter shortages in public spaces and legal contexts. Private services filled the void but at a cost. Deaf individuals primarily relied on family support, despite its limitations in nuanced deaf communication.

## 5 EDUCATION PATH OF TARGET GROUP

The educational paths of target group members showcased diversity, with deaf individuals learning from birth or formal education. Family members and friends varied in their sign language proficiency. Codas, as children of deaf adults, played a pivotal role in bridging communication gaps. The inclusion of sign language in schools and workplaces was recommended to enhance communication and promote inclusivity.

### 5.1. Lesson's Topics

Participants presented their ideas for content that would greatly facilitate communication with the deaf and hard of hearing, described in the graphic:

**Table 1: Most popular topics**

| Topics | Percentage |
|---|---|
| Let's get to know each other (Greetings, Introduce yourself, Daily life, Weather, Work) | 17,4% |
| Leisure time (Hobbies, Sport, Culture) | 15,1% |
| Health care, Emotional feeling, Medical Terms | 14% |
| Living at home (List of grocery, Kitchen, Bathroom) | 7% |
| Alphabets / Numbers | 7,1% |
| Family & Friends | 5,8% |
| How to approach to Deaf | 5,8% |
| Character traits | 3,5% |
| Science | 2,3% |
| COS | 2,3% |
| Children's activities | 2,3% |

Source:[1]

The majority of those surveyed expressed a desire to improve their daily interactions with the deaf, as well as a desire to learn sign language and communicate in it in order to participate in and share the most significant aspects of their lives. Participants' strong interest in learning sign language highlighted the importance of meaningful communication with deaf individuals. The most popular lesson topics included greetings, introductions, daily life, leisure activities, medical terms, and alphabets/numbers. These preferences reflected a desire to address fundamental aspects of communication and foster deeper connections.

## CONCLUSION

The Talking Hands project's inception workshop laid a strong foundation for addressing communication challenges faced by the deaf community and their associates. By offering accessible and flexible sign language lessons, the project aims to empower individuals, foster inclusivity, and embrace digital transformation. The project's multi-faceted approach holds promise for bridging communication gaps and enhancing social cohesion within European society.

Learning Sign Language (SL) is a complex journey that mirrors acquiring any foreign spoken language. This visual language presents captivating challenges, particularly when pursued through online platforms. A fundamental approach recommends engaging with the deaf community and practicing daily for effective learning. Each National Sign Language exhibits unique characteristics, encompassing distinct vocabulary and grammar, setting them apart from spoken languages and even international sign language. For instance, Italy's SL displays diverse dialects corresponding to regions, whereas Europe typically experiences greater uniformity.

Facial expressions play a significant role in the Mediterranean-rooted Greek sign language, while the Japanese version employs fewer expressions. Specific gestures exclusive to regions, further underscore the individuality of sign languages. Online platforms were reviewed by a Polish participants who emphasized the importance of clarity, convenience, and intuitive usability for effective learning.

To ensure the success of SL projects, complete involvement of the deaf community is essential. Cultural appropriation by the hearing community must be avoided, and projects should emphasize the recognition of the deaf community as a linguistic minority rather than mere integration. Encouraging SL courses in schools and workplaces was also advocated.

The positive aspects of a web-based SL course were highlighted, enabling learning from home or work while fostering family involvement. A crucial recommendation pertained to communication changes for hearing individuals: comprehending that sign language is visual-spatial, with eyes and hands as the primary communication channels, necessitating a shift from verbal-sound communication.

In summary, learning Sign Language involves a challenging yet fascinating journey comparable to acquiring spoken languages. National Sign Languages possess unique characteristics, and online platforms must prioritize clarity and ease of use. Ensuring the involvement of the deaf community, avoiding cultural appropriation, and encouraging SL courses were emphasized. The adoption of a web-based course was welcomed, and a crucial recommendation urged hearing individuals to adapt to the visual-spatial nature of sign language.

## ACKNOWLEDGMENTS

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# Tehnična izvedba tolmačenja znakovnega jezika na televiziji

## The Technical Execution of Sign Language Interpretation on Television

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*(Oče treh gluhih otrok, certificirani tolmač slovenskega znakovnega jezika in prvi gluhi sodni tolmač v Sloveniji, uporabnik mednarodnega znakovnega jezika. Z več kot 20 leti izkušenj učitelj strokovno-teoretičnih in praktičnih predmetov grafične in medijske smeri z nazivom svetnika v šolskem sistemu. Zaposlen na Zavodu za gluhe in naglušne Ljubljana. Direktor neprofitnega Zavoda Hiša slovenskega znakovnega jezika, Zavoda za sodobno dostopnost za gluhe, naglušne in osebe s polževim vsadkom. V svoji 25-letni karieri je deloval kot presojevalec in svetovalec na področju dostopnosti za televizijo in splet. Član strokovnega sveta, kjer zastopa interese oseb za gluhe in naglušne v Zavodu A11Y.si. Glavni in odgovorni urednik klasične televizije TIPK TV, specializirane za ciljno občinstvo za gluhe in naglušne. S svojim strokovnim znanjem pomaga pri prilagoditvah spletnih portalov, namenjenih gluhim. Prejemnik priznanja jabolko navdiha RS v letu 2022 za navdihujoča dejanja za skupnost gluhih in krepitev solidarnosti v družbi.)*

## POVZETEK

Članek raziskuje izzive in smernice glede dostopnosti tolmačev znakovnega jezika (ZJ) na televiziji in spletnih platformah. Poudarja pomembnost prisotnosti tolmačev ZJ na televiziji za gluhe in naglušne gledalce, obenem pa se osredotoča na vprašanja, kot so velikost, pozicioniranje, ozadje in naloge tolmačev ZJ ter njihov vpliv na dostopnost in razumevanje vsebin. Znakovni jezik je ključno komunikacijsko orodje, za učinkovito tolmačenje pa je potrebno izpopolnjeno znanje in spoštovanje etičnih standardov.

Poleg tega članek obravnava tehnične vidike, kot so velikost in pozicioniranje tolmača ZJ na televiziji, poudarjajoč pomembnost enakomerne osvetlitve, ozadja, kontrasta ter razmerja med velikostjo tolmača in drugimi elementi na zaslonu. Predstavlja praktične smernice za optimalno vidnost tolmača ZJ na zaslonu.

Sklep članka izpostavlja pomanjkljivosti v trenutnih tehničnih rešitvah za vključevanje tolmačev ZJ na televiziji in poziva k večji pozornosti do tehničnih in vsebinskih izzivov. Poleg tega avtor predstavi namen in cilj Zavoda Hiša slovenskega znakovnega jezika, ki se ukvarja z dostopnostjo za gluhe in naglušne ter ponuja rešitve za izboljšanje kakovosti storitev dostopnosti za to skupino uporabnikov.

## KLJUČNE BESEDE

dostopnost, tolmači znakovnega jezika, televizija, spletna platforma, medijske vsebine.

## ABSTRACT

**The Technical Execution of Sign Language Interpretation on Television**

The article explores the challenges and guidelines regarding the accessibility of sign language interpreters on television and online platforms. It underscores the significance of the presence of sign language interpreters on television for deaf and hard of hearing viewers, focusing on issues such as size, positioning, background, and roles of sign language interpreters, and their impact on accessibility and comprehension of content. Sign language is a crucial communication tool, and effective interpretation requires advanced knowledge and adherence to ethical standards.

Furthermore, the article addresses technical aspects, such as the size and positioning of the sign language interpreter on television, emphasizing the importance of uniform lighting, background, contrast, and the relationship between the interpreter's size and other elements on the screen. It presents practical guidelines for optimal visibility of the sign language interpreter on the screen.

The conclusion of the article highlights shortcomings in current technical solutions for integrating sign language interpreters on television and calls for increased attention to technical and content-related challenges. Additionally, the author introduces the mission and objectives of the Institute for Slovenian Sign Language, which focuses on accessibility for the deaf and hard of hearing and offers solutions to enhance the quality of accessibility services for this user group.

## KEYWORDS

accessibility, sign language interpreters, television, online platform, media content.

# 1 OPREDELITEV ZNAKOVNEGA JEZIKA IN POKLICA TOLMAČ ZNAKOVNEGA JEZIKA

Tolmači za znakovni jezik se vključujejo v televizijske programe. To je postalo opazneje med pandemijo covida-19, ko je družba postala še bolj ozaveščena o prisotnosti gluhih, naglušnih in uporabnikov znakovnega jezika v našem okolju. Izkušnje vključevanja tolmačev ZJ na televiziji segajo v osemdeseta leta 20. stoletja, čeprav se v nekaterih virih omenjajo tudi sedemdeseta in celo šestdeseta leta 20. stoletja.

Tolmači ZJ so najopaznejši, ko so na televiziji postavljeni v spodnji desni ali zgornji desni kot ekrana. Uporabljajo se različni okviri, vključno s krogi in kvadrati, danes pa sodobna tehnologija omogoča tudi postavitev tolmača ZJ v formatu slika v sliki (angl. »picture in picture«).

Dostopnost medijskih vsebin se razširja v spletno okolje, vključno s spletnimi pretočnimi predvajanji v živo, kar je izjemno pozitivno. Pomembno je, da so nacionalni mediji na televiziji vse bolj pozorni na vključevanje tolmačev ZJ. Tehnologija je napredovala do te mere, da ni več tehničnih ovir za umeščanje tolmačev ZJ na televizijo. Zagotoviti je treba zadostno kadrovsko znanje in strokovnost za to posebno področje, ki ga srečujemo tako v Sloveniji kot tudi v tujini.
Predstavil bom tehnične smernice za umestitev tolmačev ZJ, pred tem pa še kriterije dela tolmačev ZJ, specifičnosti znakovnega jezika ter pričakovanja gledalcev za ustrezno in kakovostno televizijsko vsebino v znakovnem jeziku.

Znakovni jezik gluhih izhaja iz uporabe rok, mimike obraza, oči, ustnic in gibanja telesa, da se lahko izražajo ideje, čustva in sporočilnost. Uporablja se tudi prstno abecedo. Je vizualni jezik za gluhe in njihovo ključno komunikacijsko sredstvo. Razlikuje se po izrazih, gibanju in celo strukturi stavkov. Vsak znakovni jezik je dinamičen in se razvija znotraj gluhe skupnosti, nanj pa vplivata tudi lokalna kultura in zgodovina. Nima enake slovnice kot govorni jezik, niti na istem geografskem, kulturnem in zgodovinskem območju ne, saj je neodvisen od govorjenja in se oblikuje znotraj gluhe skupnosti.

Prejemanje informacij in znanja s pomočjo znakovnega jezika gluhih je omejeno, informacijska vrednost je majhna, nujno je potrebna standardizacija jezika. Pomembno je poudariti, da slovenski znakovni jezik ni enak drugim znakovnim jezikom. Vsak znakovni jezik na svetu je edinstven in razlike so že znotraj iste države.
**POMEMBNO: uporaba rok, mimike obraza, oči, ustnic ter gibanja telesa, da se lahko izražajo ideje, čustva in sporočila.**

# 2 ZNAČILNOSTI DELA IN VLOGA TOLMAČA ZNAKOVNEGA JEZIKA NA TELEVIZIJI

Tolmač ZJ v Sloveniji lahko postane vsak, ki opravi NPK-certifikat za tolmače slovenskega ZJ. Od julija 2019 dalje so vrata odprta tudi za gluhe osebe, ki lahko tolmačijo slovenski ZJ. tej spremembi je pomembno prispevalo Društvo učiteljev gluhih Slovenije.[*1]

Tolmač za znakovni jezik na televiziji mora zelo dobro poznati znakovni jezik in razumeti procese načina komunikacije. Prav tako mora obvladati specifičnosti prenosa sporočil v televizijskem okolju, kjer je podajanje informacij izjemno posebno. Zagotavlja nenehno visoko kakovost tolmačenja in ohranja izjemno raven koncentracije, medtem ko posreduje sporočila na razumljiv način.

## 2.1 Ključne veščine, ki jih mora tolmač znakovnega jezika obvladati za delo na televiziji:

- Poskrbeti mora za tekoče simultano (sinhronizirano) tolmačenje, pri čemer mora hitrost tolmačenja in podajanje izrazov (čustev) biti usklajena z izrečenimi besedami.
- Izvajati mora tolmačenje s temeljitim obvladovanjem gibanja rok, prstov, oči, ustnic, dosledna uporaba gest, mimike in telesnega gibanja mora biti skladna in jasna.
- Prenašati globoke pomene in odtenke je bistvenega pomena, prenesti morajo polni pomen besedila, vključno z razumevanjem konteksta, namena govora in čustvenih nians.
- Prilagoditi se tako informativnim oddajam kot tudi zabavnim in izobraževalnim vsebinam, glede na žanr in naravo televizijske vsebine morajo prilagoditi svoj slog komunikacije.
- Delovati v skladu z etičnimi standardi, spoštovati zasebnost gledalcev ter vzdrževati profesionalen odnos do svojega dela in občinstva.

Delo tolmača je sestavljeno iz zgoraj naštetih veščin. Poudariti je treba, da tolmač ni tehnik, zato ni njegova pristojnost, ali se ga dobro vidi, ali je pravilno umeščen oziroma postavljen v kader. Njegova prvenstvena naloga je, da se pred prenosom in med njim dobro počuti, da ima stalen dovod svežega zraka in možnost, da dobi predčasen vpogled v vsebino oddaje (besedila voditeljev, besedila avtorjev skladbe, kateri gost se bo predvidoma oglasil s terena in podobno). [*2]

## 2.2 Napotki za razumevanje vloge tolmačev v televizijskem okolju

Postavitev tolmača na zaslonu mora omogočati nemoteno spremljanje tako tolmača kot tudi drugih vizualnih elementov, ki se morajo medsebojno izključevati. Upoštevati je treba optimalno razmerje med velikostjo tolmača in preostalimi vsebinami. Zelo preudarno je treba zagotoviti sodelovanje med vsemi tolmači, ki sodelujejo na televiziji, tako za slišeče kot gluhe certificirane tolmače ZJ, tudi s kamermani, svetlobnimi tehniki, tonskim tehniki, scenografom, producenti, urednikom, odgovornim za dostopnost vsebin v znakovnem jeziku, ter presojevalcem in svetovalcem za dostopnost uporabnikom znakovnega jezika. To so ključni člani ekipe, ki omogočajo kakovostno medijsko posredovanje informacij.

Velik poudarek je na izobraževanju in evalviranju opravljenega dela tolmačenja na televiziji. Ohranjanje visoke ravni strokovnosti in motivacije vključuje stalno sodelovanje tako na internih kot eksternih izobraževanjih. Priporoča se vzpostavitev uredništva za znakovni jezik, ki naj ga vodijo izkušeni strokovnjaki s področja znakovnega jezika in poznavalci gluhe skupnosti, za uvajanje znakovnega jezika za potrebe televizije.

Tolmači morajo skrbeti, da na sebi nimajo nakita, ure, visečih uhanov, vidnih motečih tetovaž, bleščečih predmetov, premočno obarvanih nohtov, podaljšane trepalnice in nohti niso zaželeni. Priporočajo se speti lasje (tolmači niso fotomodeli) in minimalistično ličenje. Zaželeni so tri četrt rokavi. Preživahne barve ali bleščice na oblačilih so prepovedane, enako velja za prekomerna vzorčasta oblačila, ki lahko motijo gledalce pri prepoznavanju znakov in gibanja tolmača. Preohlapna oblačila ovirajo delo tolmača pri gibanju in gibljivost rok ter izrazov. Oblačila z vzorci niso priporočljiva, prav tako ne globoki V-izrezi.

Pomembno je zagotoviti redno prisotnost tolmačev ZJ na televiziji, da se vzpostavi zaupanje in pričakovanje med gledalci. Za oddaje v živo se običajno uporablja slišeče tolmače, so pa tudi redke izjeme, kjer delajo tudi gluhi tolmači. Za oddaje, ki so vnaprej posnete, se priporoča, da vključijo gluhe tolmače. Pri dnevnoinformativnih oddajah naj se zagotovi desetminutna oddaja, prilagojena potrebam gluhih v znakovnem jeziku, za katero tolmačijo gluhi tolmači. Zavedati se je treba, da so gluhi in slišeči tolmači enakovredni in so drug drugemu podpora ter tim za kakovostno izvajanje storitev, še posebej na televiziji in v pretočnih spletnih vsebinah.

Svetovna zveza gluhih (WFD) piše, da so gluhi tolmači v nekaterih primerih bolj zaželeni. V Evropi in po svetu zelo podpirajo tolmačenje gluhih tolmačev, saj so izsledki njihovih raziskav pokazali, da so gluhi tolmači boljši tolmači za gluhe kot slišeči tolmači.[*3]

## 2.3 Omejitve in naloge, ki jih tolmač ZJ na televiziji ne izvaja:

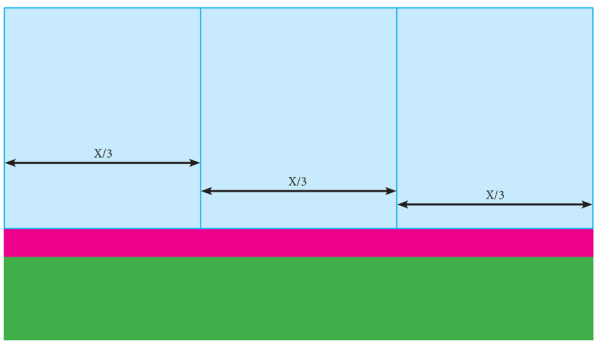
- Ne izbira vsebin, ki bodo predvajane na televiziji. Njegova naloga je tolmačenje že pripravljenih vsebin, ne pa odločanje o tem, kaj se bo predvajalo.
- Ne sodeluje pri urejanju videoposnetkov ali montaži oddaj. Njegova vloga je izključno tolmačenje med predvajanjem.
- Ne piše scenarijev za oddaje ali pripravlja vsebin za televizijo. Njegovo delo je tolmačenje in prenos že obstoječih vsebin.
- Ne nastopa v vlogah igralcev ali voditeljev. Njegova naloga je omogočiti razumevanje govorjenega jezika za gluhe in naglušne gledalce.
- Med televizijsko oddajo tolmač ne prevaja dokumentov ali pisnih grafično opremljenih besedil na zaslonu. Omejen je na tolmačenje govorjenega jezika in branje podnapisov v znakovni jezik.
- Ne izraža svojih mnenj, komentarjev ali sodb o vsebinah, ki jih tolmači. Njegova naloga je objektivno prenašanje informacij.

Pomembno je razumeti, da je delo tolmača na televiziji osredotočeno na prenos sporočil iz enega jezika v drugega, tako da se zagotovi dostopnost in razumevanje medijskih vsebin za gluhe in naglušne gledalce.

## 3 DIMENZIONIRANJE IN POZICIONIRANJE TOLMAČA ZJ NA TELEVIZIJI

Podano razumevanje znakovnega jezika in njegovih značilnosti daje vpogled, ki razkriva kompleksnost te komunikacijske oblike. Ključno je razumeti, da gledalci pred televizijskimi zasloni za celovito in razumljivo informacijo spremljajo uporabo rok, mimike obraza, oči, ustnic in gibanje telesa. S temi elementi se izražajo ideje, čustva in sporočilnost. Pri neposrednih novicah, zlasti v informativnih oddajah, je besedna vsebina zgoščena v čim krajšem času. Tolmači znakovnega jezika morajo simultano in izjemno natančno prevesti vsebino, pri čemer je pomembno, da se vsi odtenki in drobne kretnje, ki prispevajo k razumevanju sporočil, jasno vidijo in razumejo. Zmanjšanje prostora za tolmača na televiziji zmanjšuje prostor za prenos informacij, kar vpliva na kakovost razumevanja.
Pri ustrezni dimenzioniranosti tolmača znakovnega jezika je ključno, da je razmerje med njegovo velikostjo in velikostjo drugih prisotnih oseb na televiziji enako. Tako kot prikaz voditelja ali izvajalca naj bo tudi velikost tolmača znakovnega jezika enako nastavljena. Pozicioniranje tolmača na levi ali desni strani je odvisno od medijske hiše, pogosto je pozicioniranje na desni strani. Prostor za tolmača naj bo ločen in neodvisen od drugih elementov na zaslonu.

Spodnja slika ponazarja priporočeno dimenzioniranje tolmača znakovnega jezika v modrem polju. Širino prostora za tolmača se določi z razdelitvijo na tretjine, kar prispeva k optimalni vidnosti in razumevanju.

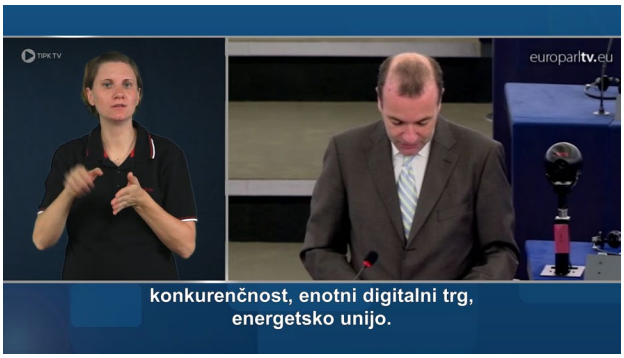



**Slika 1: Shematski/grafični prikaz razdelitve prostora pri umeščanju velikosti prostora za tolmače znakovnega jezika. Vir: osebni arhiv avtorja**

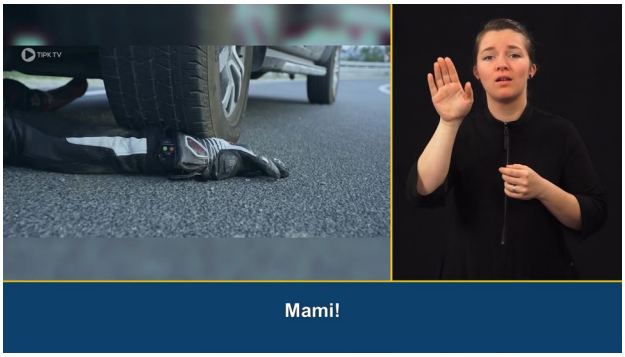
Določitev pozicije tolmača – centrirano, pustiti ob komolcu nekaj prostora (slika spodaj).

**Slika 2: Pri določanju pozicije tolmača je pomembno, da ga postavimo v centriran položaj, hkrati pa zagotovimo dovolj prostora ob komolcu.**
**Spodnji rez naj se začne nad pasom, pri tem moramo skrbno paziti, da glava ni preblizu zgornjemu robu.**
**Obe prikazani rešitvi sta ustrezni.**
**Vir: https://tipk.si/oddaje**

Slikovni prikaz pravilne umeščenosti in velikosti tolmača ZJ in njegovo pozicioniranje praktičnih primerov na klasični televiziji TIPK TV za gluhe in naglušne **Vir: https://tipk.si/oddaje**






V nadaljevanju je prikaz nekaterih različnih praks umestitve tolmača za znakovni jezik v **PRILOGI A**.

## 4 OZADJE TOLMAČA ZJ NA TELEVIZIJI

V vsaki medijski ustanovi se oblikujejo načini postavitve tolmačev ZJ pred kamero. Kljub temu se le redko pomisli, kakšno ozadje bi bilo primerno. Pomembno je, da scenografi sodelujejo s strokovnjaki za dostopnost in presojevalci, ki poznajo potrebe uporabnikov znakovnega jezika. Izbor ozadja mora biti premišljen, da bo omogočalo jasno vidnost tolmača.

Ozadje naj bo preprosto, umirjeno in nevtralno. Priporočljiv je enobarvni vzorec, ki usmerja pozornost na tolmača. Kontrast ima izjemno pomembno vlogo. Skupaj s stilisti in tolmači ZJ je treba določiti barvno paleto oblačil za določeno oddajo, kar omogoča, da roke in izrazi obraza izstopajo in so jasno vidni. Barvna ozadja naj se skladajo s celostno grafično podobo oddaje, pri tem je treba paziti na pravilno kontrastno razmerje in se izogibati motečim intenzivnim barvam.

Pravilna osvetlitev ima ključno vlogo, da se preprečijo sence in zamegljenost. Tudi manj opazni deli, na primer podbradki, morajo biti ustrezno osvetljeni. Jasna in enakomerna osvetlitev omogoča gledalcem boljšo vidnost tolmača ZJ. V ozadju ne smejo biti moteči elementi, kot so deli videa, grafični napisi, premikajoči se predmeti ali bleščeče površine. To je pogosto izraženo pri delu z zelenim ozadjem, kjer lahko tolmač ZJ prehaja med videom, kar ni priporočljivo. Položaj tolmača ZJ mora biti takšen, da ne prekriva pomembnih vizualnih elementov na zaslonu.

Velikost tolmača ZJ mora biti dovoljšna, da gledalci jasno vidijo njegove izrazne geste in mimiko, kar omogoča učinkovito spremljanje sporočil v znakovnem jeziku.

## Zaključna beseda

V svoji karieri, ki traja že več kot 25 let, sem se posvetil zagotavljanju dostopnosti za gluhe in naglušne osebe, ki uporabljajo znakovni jezik. Kljub dolgoletnemu spremljanju tega področja tako doma kot v tujini sem razočaran nad pomanjkljivostmi, ki še vedno obstajajo pri tehnični izvedbi spremljanja tolmača ZJ na televizijskem zaslonu. Vztrajno se namreč soočamo s problemi, kjer vložen trud, energija, delo tolmačev ZJ in finančna sredstva izgubijo svoj pomen zaradi pomanjkljive celostne obravnave problema.

Prvotna uvedba tolmačev na televizijskih zaslonih je razveselila in osrečila gluhe osebe. Kljub temu ne upajo izraziti zaskrbljenosti, da je bil ves trud zaman, saj obstajajo strahovi pred morebitno ukinitvijo oddaj, opremljenih z ZJ. Ko skuša skupina gluhih oseb glasno opozoriti na te težave, se pri sogovornikih pojavi »tehnični izziv«, kajti trdijo, da povečanje velikosti tolmača ZJ in zmanjšanje velikosti preostalega videa ni izvedljivo. Te tehnične omejitve so pogosto povezane z mešalnimi mizami za video, licenciranimi matričnimi postavitvami in drugimi izgovori.

Današnja tehnologija dokazuje, da je vse mogoče doseči in izpolniti tehnične ter vsebinske kriterije. Z nekaj truda in volje bi se lahko izognili tehničnim težavam, ker jih ni, in razvijali obliko v polni meri. V prispevku sem se osredotočil predvsem na velikost tolmača ZJ, ustrezno ozadje, optimalno pozicioniranje in naloge tolmača na televiziji.

Spregovoriti je treba tudi o nekaterih **ključnih področjih**, povezanih z dostopnostjo za gluhe, naglušne in uporabnike znakovnega jezika:

- tehnično urejanje podnapisov, kjer se predvajajo za televizijo, pretočne vsebine, spletne portale …;
- vsebinsko delo tolmača ZJ, evalvacija, razvoj tehnike, vrsta strategije, pristopi in načini za posamezno področje;
- urednikovanje in priprava vsebin ZJ za televizijo ter splet;
- oddaje za gluhe in informativnih vsebin, prilagojenih za gluhe, v Sloveniji na ravni RTVSLO še nimamo;
- monitoring in kontrola kakovosti dela za tolmače ZJ na vseh nivojih, še posebej na izpostavljenih mestih tolmačenja, kot so televizija, konference in javni nastopi;
- šola za tolmače za obstoječe NPK-tolmače za tiste, ki delajo (delo na televiziji, spletu – pretočne vsebine, konference, javni nastopi);
- uvedba kategorizacije in ovrednotenje dela tolmačev ZJ, pobuda za nov NPK II tolmač/tolmačica slovenskega znakovnega jezika za televizijo, konference in javne nastope (delo na televiziji, spletu – pretočne vsebine, konference, javni nastopi);
- permanentno izobraževanje je vseživljenjsko učenje za vse druge ZJ.

Vse strokovno znanje in pridobljene izkušnje tako v Sloveniji kot tudi v tujini so rezultati več kot 25-letnih izkušenj. V okviru neprofitnega Zavoda Hiša slovenskega znakovnega jezika in Zavoda za sodobno dostopnost gluhih, naglušnih in oseb s polževim vsadkom bomo v prihodnje z zgoraj naštetih področij ponujali tako individualne kot skupinske storitve. Naš skupni cilj je dvigniti kakovost storitev dostopnosti za gluhe, naglušne in uporabnike znakovnega jezika tako v Sloveniji kot tudi v tujini.

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## PRILOGA A

Prikaz nekaterih različnih praks umestitve tolmačev ZJ

# Uporaba tehnik za samodejno podnaslavljanje avdiovizualnih vsebin

Using auto-subtitle system methods in audiovisual content

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## ABSTRACT / POVZETEK

Vse več je ljudi z okvaro sluha, kar otežuje tako medsebojno sporazumevanje kot tudi razumevanje dialogov avdiovizualnih vsebin. Podnaslavljanje poveča razumljivost in zmanjša potrebni napor prizadetih pri spremljanju vsebin. Ker je ročno podnaslavljanje dolgotrajni proces in drago opravilo, ga želimo avtomatizirati s pomočjo orodij za avtomatsko razpoznavanje dialogov v zvoku in s podnaslavljanjem. Nekatera komercialna in prostodostopna orodja so že vključena v programih za video montažo. V času pandemije Covid-19 smo posneli več učnih gradiv, ki smo jih s pomočjo omenjenih orodij tudi podnaslovili. Na primeru izobraževalnega filma predstavimo postopke samodejnega podnaslavljanja video gradiv.

## KLJUČNE BESEDE

Samodejno razpoznavanje govora, podnaslavljanje, video.

## ABSTRACT

More and more people have hearing impairment, making it challenging to communicate with each other and understand dialogs of audiovisual content. Subtitling increases comprehensibility and reduces the effort required by people with disabilities to follow the content. Since manual subtitling is a time-consuming and expensive task, we want to automate it with the help of tools for automatic speech recognition and auto-subtitling. Some commercial and open-source tools are already available in video editing tools. During the Covid-19 pandemic, we recorded several educational materials and subtitled it with the help of the mentioned tools. Using the example of an educational film, we present the procedure for automatic subtitling video materials.

## KEYWORDS

Automatic speech recognition, subtitling, video.




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## 1 Uvod

Delež ljudi, ki ima težavo s sluhom se nenehno povečuje. Razlogov za slabši sluh je mnogo, nekateri so prirojeni kot posledica obolenj, ali poškodb nastalih zaradi povečane dolgotrajne ali kratkotrajne izpostavljenosti hrupu. Podaljšuje se tudi življenjska doba, s tem pa je povezana tudi starostna izguba sluha (naglušnostjo). Odmiranje čutnic za zaznavanje tonov se začne že po dvajsetem letu, v starosti pa odmirajo tudi tiste za sprejemanje nizkih frekvenc, ki so pomembne za sporazumevanje [1]. Vse bolj izrazita je izguba sluha že v najstniških letih. Vzroki za veliko število najstnikov s težavami sluha je lahko povečana izpostavljenost hrupu na zabavah, preglasnem gledanju filmov in poslušanju glasbe preko slušalk. Ko se izguba sluha enkrat pojavi, le-te ni mogoče več povrniti v prvotno stanje [1].

Osebe s slabšim sluhom imajo pri medsebojnem sporazumevanju težave, kajti to od njih zahteva dodatni psihofizični napor, posebej še v hrupnem okolju. Tudi spremljanje avdiovizualnih vsebin (AV vsebin) je težavno, pogosto pa teh niti ne razumejo. Posebej še, kadar so avdiovizualna dela slabše tonske kakovosti ali nepravilno uglašena [2]. Tudi kakovost predvajalnih naprav, neprimerna prostorska akustika in hrup iz okolja dodatno otežujejo razumevanje vsebin [2]. Avdiovizualne vsebine niso namenjena le za zabavo in sprostitev, temveč so pomembno orodje za informiranje. Uporabljamo jih pri neformalnem in formalnem izobraževanju za širše interesne skupine. Kadar je izobraževanje namenjeno osebam s slabšim sluhom, je pomembno, da so vsebine zaradi boljše razumljivosti tudi podnaslovljene.

Podnaslavljanje filmov in videa v slovenskem prostoru ni novost, saj se tujejezična dela prevajajo s pomočjo podnaslavljanja, pri tem pa originalni ton ostane nespremenjen [3]. Podnaslavljanje AV vsebin je časovno zelo zamudno opravilo, če se izvaja ročno, vendar pa današnje tehnologije s strojnim razpoznavanjem dialogov ASR (angl. Automatic Speech Recognition) že omogočajo samodejno podnaslavljanje vsebin, v ta namen so na voljo različna orodja in tehnike [4]. Za večino svetovnih jezikov so orodja ASR s funkcijo podnaslavljanja že dobro izpopolnjena. Intenzivne raziskave s področja avtomatskega razpoznavanja

potekajo tudi za slovenski jezik. Rezultat teh raziskav so orodja, ki so v okrnjeni obliki tudi dostopna za uporabo širšim uporabnikom [5]. Ker umetna inteligenca na področju strojnega razpoznavanja govora vse bolj prispeva k razvoju teh orodij, lahko v bližnji prihodnosti pričakujemo, da bodo postopki v prihodnje vsaj deloma avtomatizirani, omogočali pa tudi sprotno podnaslavljanje AV vsebin [6]. Trenutno še nimamo orodja, ki bi omogočalo celostno strojno samodejno in sprotno razpoznavanje govora v slovenskem jeziku s tvorbo samodejnega podpisovanja [5].

V prispevku predstavimo orodja za avtomatsko govorno razpoznavanje v kombinaciji s plačljivimi in prostodostopnimi orodji za urejanje videa ter izvedbo podnaslavljanja na primeru učnih videovsebin. Učne AV vsebine smo začeli intenzivno producirati v času pandemije Covid-19, ko je bil osebni stik s študenti močno okrnjen ali povsem onemogočen. Rezultati samodejnega razpoznavanja in deljenja teksta na ustrezne bralne odseke so še nepopolni in še zahtevajo ročno popravljanje, kar od urednika vsebin zahteva še dodaten čas in napor.

## 2 Video s podnapisi kot pripomoček za učenje

Video je kot pripomoček pri formalnem in neformalnem učenju pridobival veljavo vse od začetka tega stoletja, potem ko so spletne tehnologije omogočile pretočnost video vsebin preko spleta. Prvi model izobraževalnih video vsebin namenjenim gluhim in naglušnim osebam je bil v okviru Centra za študij na daljavo na UM Maribor predstavljen leta 2001. Raziskovali smo način vključevanja tolmača znakovnega jezika s tehniko slike v sliki (angl. Picture in Picture). V okviru projekta VISOCOM je bilo izdelano tutorsko orodje, za učenje gluhih uporabe sodobnih tehnologij za komunikacijo na daljavo [7]. Omenjen projekt še ni predvideval podnaslavljanja tolmača znakovnega jezika, saj bi bilo podnaslavljanje s takratno tehnologijo težko izvesti. Kasneje so avtorji s študijo ugotovili [8], da podnapisi skupaj s tolmačem znakovnega jezika bistveno prispevajo k boljšemu razumevanje vsebine učnega gradiva gluhih in naglušnih gledalcev [8]. Tudi številne druge raziskave poročajo o pozitivni uporabi podnapisov za izboljšanje besedišča in veščin razumevanja [9]. Evropska organizacija združenja gluhih in naglušnih EFHOH je z direktivo tudi zahtevala, da se vse AV vsebine v evropskem medijskem prostoru opremijo s podnapisi, da slušno prizadetim osebam omogočimo boljšo vključitev v medijski prostor in njihovo lažje razumevanje [10].

Čeprav primarno obravnavamo težave z razumevanjem AV vsebin slušno prizadete populacije oseb, pa so pogosto težave z razumevanjem tudi za starejšo populacijo in tudi pri osebah, ki sicer nimajo težav s sluhom [1]. Razlogi so lahko tudi povsem tehnični:

- hrupno okolje (sejmi, prireditve, muzeji),
- akustično neustrezen prostor,
- nekakovostna oprema za predvajanje zvoka,
- slabo uravnan in posnet zvok,
- dolg odmev zaradi lastnosti prostor.

Javna radiotelevizija Slovenija zato preko svojega spletnega portala že omogoča spremljanje več od 700 oddaj s pomočjo podnaslavljanja prek tehnologije teleteksta. Trenutno so pri javni radioteleviziji podnaslovljene le oddaje, ki so posnete vnaprej. Razvoj orodij za podnaslavljanje živih oddaj že teče, trenutno pa tehnologije za tekoče podnaslavljanje vsebin v živo še ne omogočajo. Predstavljen pilotni projekt za samodejno podnaslavljanje televizijskih programov za sprotno ustvarjanje podnapisov informativnih, kulturnih, športnih in drugih televizijskih oddaj z uporabo samodejne razpoznave slovenskega govora v realnem času je trenutno še v razvojni fazi. Razvoj orodij za razpoznavanje govora ASR iz slovenskega jezika poteka na obeh večjih slovenskih univerzah. Orodja za razpoznavo so v razvojni fazi, zato jih še ni mogoče integrirati z drugimi orodji. Zadnji rezultati kažejo na 71 % uspešnost razpoznavanja [11].

Iz zgoraj navedenih razlogov vse več ponudnikov avdiovizualnih vsebin omogoča samodejno razpoznavanje govora s podnaslavljanjem. Načinov izvedbe podnaslavljanja in umeščanja teksta v video je bilo izvedenih več raziskav [10]. Pokazale so, da klasično nameščanje teksta v spodnji srednji del slike na zaslonu ni edini možni način za podnaslavljanje, ampak da lahko namestitev teksta v okvir slike tudi dinamično prilagodimo glede na vsebino in želje uporabnika. Pomembnih elementov slike s tekstom nikakor ne želimo prekriti, saj v videu lahko vključeni tudi teksti in podnaslovi kot prevodi drugih jezikov. Prekrivanje teksta s tekstom je za gledalca moteče, zato mesto za podnaslavljanje določimo tako, da predhodno vnesenega teksta ne prekrivamo. Spletne tehnologije razen integriranega načina (angl. closed-caption) predvidevajo tudi predvajanje teksta le v primeru, kadar je predvajanje aktivirano s strani uporabnika (angl. closed-caption). Urednik vsebin lahko tekst izvozi v zunanjo datoteko in ga uporabi kot pripomoček iskalniku določenega mesta v AV vsebini s pomočjo preko ključnih besed. Pri urejanju tekstov za podnaslavljanje je treba upoštevati še vrsto smernic, kot je število znakov v vrstici in število vrstic podnapisa, razmerje med dolžino podnapisa v znakih in njegovim trajanjem, obliko in barvo črk ter vrsto podlage.

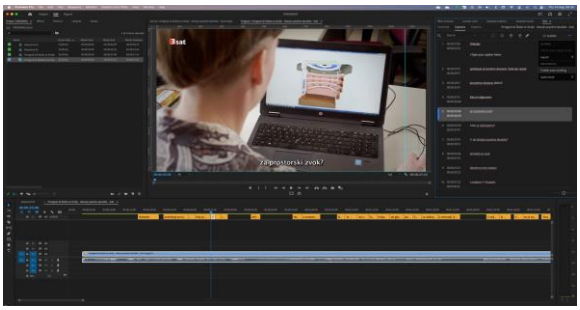
## 3 Podnaslavljanje AV vsebin

Poznamo več tehnik za podnaslavljanje AV vsebin. Pri prvem se v podnaslovljen tekst vključujejo izključno dialogi govorcev, lahko pa vključujejo tudi opisi spremnega zvoka, za opis vrste glasbe, šumov in drugega spremljajočega zvoka. Podnaslavljanje je v slovenskem prostoru že dolgo prisotno, saj so vse tujejezične AV vsebine prevedene in podnaslovljene [3]. Ker je ročno podnaslavljanje dolgotrajno in drago opravilo. Ker je AV vsebin vse več, je lahko rešitev tudi uporaba orodij za samodejno prepoznavanje govora ASR. Za dober rezultat branja mora besedilo biti dopolnjeno tudi z ločili, primerno razdvojeno, in postavljeno na ustreznih mestih [3]. Ponudniki nekaterih spletnih portalov za pretočno predvajanje AV vsebin omogočajo kreatorjem vsebin integrirana orodja ASR za samodejno podnaslavljanje. Ta uspešno prepoznajo dialog več različnih svetovnih jezikov, hkrati pa omogočajo tudi sprotni prevod besedil. Hiter razvoj na področju umetne inteligence, botruje mu

predvsem tehnološki napredek na področju velikih podatkov in uporabe akustičnih modelov globokih nevronskih mrež ima velik vpliv na razvoj orodij ASR [11]. Z umetno inteligenco je opremljeno orodje portala Vimeo, namenjeno uporabnikom za snemanje preko spletne kamere in urejanje videoposnetkov. Vgrajen ima bralnik besedil (angl. Telepromter) in funkcijo pametnega odstranjevanje neželenih vsebin, na primer besednih mašil. Orodje je namenjeno predavateljem, ki jim je neprijetno ustvarjati lastne videoposnetke. Slovenski jezik zaradi specifičnosti njegove zgradbe trenutno še ni na voljo. Avtomatsko razpoznavanje slovenskega jezika za podnaslavljanje je problematično, predvsem v primeru kratkih besed, in kadar so ob govorjeni besedi prisotni tudi drugi zvoki (šum), ali kadar je v posnetek opremljeno z glasbenim ozadjem [12]. Težave z razpoznavanjem nastanejo tudi v akustično problematičnih prostorih, to so prostori z daljšim odmevnim časom RT60 (angl. Reverb Time 60) [13].

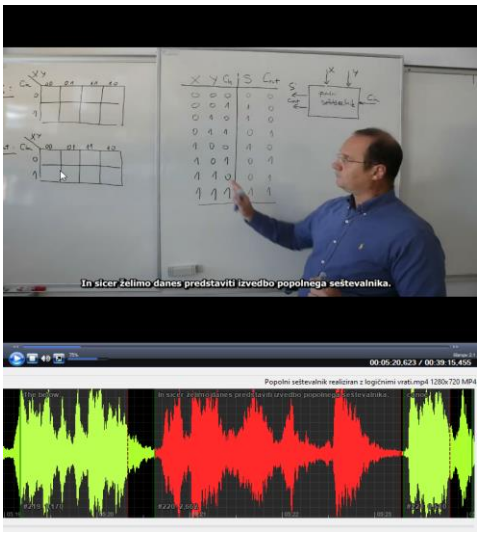
## 4 Tehnike nameščanja teksta v video

Montaža videa velja za kreativni in ustvarjalni proces, hkrati pa je časovno dolgotrajno in ponavljajoče se opravilo. Vse več video urejevalnikov že vključuje umetno inteligenco, ki delovni proces poenostavlja z avtomatizacijo dolgočasnih opravil. Raziskave so pokazale, katera pogosto izvajana opravila pri urejanju videa bodo z uvedbo umetne inteligence najbolj poenostavila proces montaže za ustvarjanje video vsebin [14]. Podnaslavljanje AV vsebin je zagotovo eno od opravil, ki ga želimo avtomatizirati. Je precej specifično delo, saj ga poleg tehničnega vidika prikazovanja podnapisov, vsebinske natančnosti in preverjenosti objavljenih podatkov pogosto spremljajo tudi kratki časovni roki. Strojno prepoznavanje dialogov montažerjem bistveno zmanjšajo obseg dela. Na Sliki 1 je prikazano okno orodja za montažo videa Adobe Premiere Pro z vgrajenim modulom za strojno razpoznavanje dialogov in možnostjo samodejnega podnaslavljanja. Čeprav z uporabo omenjenih orodij prihranimo na času, pa trenutno še veliko montažerjev ta postopek še zmeraj izvaja ročno [15].



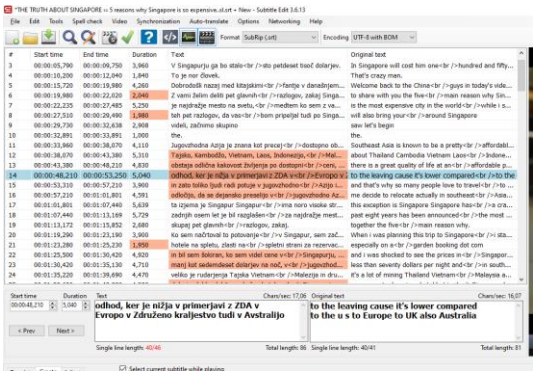
**Slika 1: Razpoznavalnik dialogov v Adobe PremirePro prepozna govor in samodejno namešča tekste po časovnici videa**

Na voljo so tudi prostodostopna orodja za strojno prepoznavanje dialogov in podnaslavljanje, na Sliki 2 je prikazan vmesnik orodja Subtitle Edit SE. Program tekst s pomočjo umetne inteligence za tekoče branje samodejno in smiselno razdeli na krajše odseke. Omogoča tudi večjezično podnaslavljanje, saj se ustvarjeni podnapisi lahko samodejno prevedejo tudi v druge jezike. Na Sliki 3 je prikazan primer za podnaslavljanje s tekstom v angleškem in slovenskem jeziku. Integracija podnapisov v video je samodejna, vendar so potrebni še ročni popravki. Največkrat gre za smiselne popravke prevodov, nastavitev trenutka začetka in konca prikaza tekstovne vrstice v časovnici, in prilagajanje trajanja posameznega podnapisa. Vgrajena je tudi funkcija za samodejno odpravljanje tipkarskih napak. Podnapise lahko v video integriramo ali izvozimo v tekstovno datoteko za predvajanje na zahtevo gledalca.



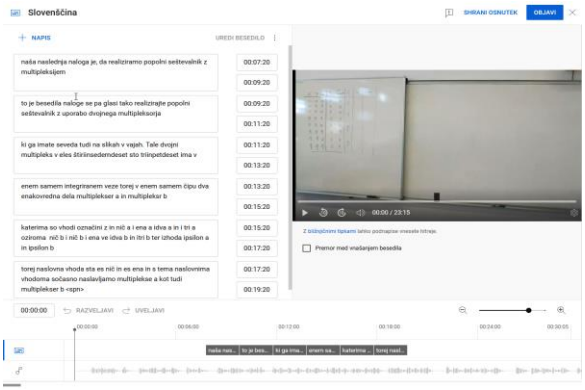

**Slika 2: Orodje za strojno prepoznavanje dialogov s funkcijo samodejnega podnaslavljanja**

V času pandemije Covid-19 smo zaradi okrnjenih osebnih stikov predavanja in vaje snemali za namen predvajanja kot video na zahtevo. Učne video vsebine so se lahko predvajale kadarkoli, v celoti ali po delih. Iz analize in statistike ogledov lahko predavatelj ugotovi, kateri del snovi je za študenta še posebej zanimiv, kajti določeni odseki v videu se lahko predvajajo pogosteje od drugih. Video vsebine so dostopne tudi po končanih omejitvah, ko se predavanja in vaje v celoti izvajajo v predavalnicah. Iz pogovora s študenti smo ugotovili, da je kombiniran način podajanja snovi dobrodošla in zaželena dopolnitev predavanjem v živo.



**Slika 2: Okno s teksti za podnaslavljanje in prevodom v drug jezik**

Video posnetke predavanj smo namestili na video strežnik v okolje Moodle in na spletni portal YouTube. Tam smo uporabili orodje Studio, namenjeno za urejanje in samodejno podnaslavljanje videa. Ker slovenskih dialogov Studio še ne prepozna, je tekst za podnaslavljanje treba vnesti ročno, kar je časovno zamudno opravilo. Postopek smo pohitrili tako, da dialog iz zvočne datoteke prepoznali z orodjem za strojno prepoznavanje jezika v spletnem portalu slovenščina.eu [5]. Ker orodje ne omogoča branja video datotek, je treba zvok pretvoriti v zvočno datoteko.




**Slika 3: Okno za urejanje podnapisov v programu Studio na spletnem portalu YouTube**

Razpoznani tekst prenesemo v okno tekstovnega urejevalnika programa Studio, prikazan na Sliki 3, ga razdelimo na ustrezne krajše razdelke in uskladimo s časovnico slike. Portal YouTube omogoča tudi večjezično strojno prevajanje, vendar so prevodi še nepopolni in potrebujejo nekaj dodatnih ročnih popravkov. Gledalec lahko v predvajalniku poljubno aktivira podnaslavljanje in izbere jezik. Učna gradiva s podnapisi zagotovo olajšajo razumevanje snovi, posebej še na delih, kjer morda govor predavatelja ni povsem razumljiv. Dialoge smo prevedli in jih za tuje študente opremili še z angleškimi podnapisi.

## 5 Zaključek

Dodajanje podnapisov v AV vsebine je pomembno za lažje in boljše razumevanja ne gluhim in naglušnim, temveč tudi širši populaciji. Dodatno se stara tudi prebivalstvo, s starostjo pa nastopijo tudi težave poslabšanega sluha. Razloge za slabše razumevanje AV vsebin lahko pripisujemo tudi neustrezni tehnični opremi pri predvajanju, akustično neurejenega prostora in visokim nivojem hrupa iz ozadja. Pomembno je tudi, da zagotovimo visoko produkcijska kakovost zvoka avdiovizualnih vsebin. Ker je pogosto ta problematična, je za lažje spremljanje pomembno, da so videoposnetki ustrezno dodatno opremljeni s podnapisi. Podnapisi v videoposnetkih vsekakor bistveno zmanjšajo napor pri spremljanju vsebin tako gluhim in naglušnim kot tudi osebam, ki sicer s sluhom nimajo težav. Javne radiotelevizije zato večino AV vsebin, bodisi so te predvajane v živo ali na zahtevo, podnaslovijo. Tudi vsebine, ki se predvajajo iz drugih virov, na primer spletnih portalov, se morajo zato podnasloviti. Podnaslavljanje AV vsebin je specializirana strokovna dejavnost in velja za zahtevno, predvsem pa časovno dolgotrajno opravilo. Ker je omenjenih vsebin vse več, je pomembno, da za podnaslavljanje uporabimo orodja, ki bi opravilo podnaslavljanje lahko kakovostno samodejno izvedla. Umetna inteligenca tehnologijam ASR danes že omogoča samodejno razpoznavanje dialogov in podnaslavljanje. Imamo orodja za urejanje videa z vgrajeno tehnologijo ASR. Dialoge nekaterih svetovnih jezikov orodja že razpoznajo z visoko zanesljivostjo in točnostjo. V podnapisih so lahko še prisotne napake, ki so posledica slabše produkcijske kakovosti posnetka ali šumov iz ozadja.

V članku smo predstavili postopke in možnosti orodij na primeru produkcije videa namenjen izobraževanju. V času pandemije Covid-19 je bil stik s študenti otežen, zato smo predavanja in vaje posneli in jih opremili s slovenskimi in angleškimi podnapisi. Samodejno razpoznavanje, deljenje teksta na ustrezne bralne odseke in podnaslavljanje z razpoložljivimi orodji je za slovenski jezik zaenkrat še težje izvedljivo, kajti orodja zahtevajo še nekaj dodatnega ročnega dela. Popolna avtomatizacija postopkov za samodejno podnaslavljanje v slovenskem jeziku bo zagotovo velika pridobitev. Umetna inteligenca na področju strojnega razpoznavanja govora vse bolj prispeva k razvoju teh orodij, zato lahko v bližnji prihodnosti pričakujemo, da bodo postopki v prihodnje ne le avtomatizirani, ampak omogočali tudi sprotno podnaslavljanje AV vsebin tudi v slovenskem jeziku.

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# Accessible Multimodal Journey Planner: Prioritizing Inclusive UI Design

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## ABSTRACT

This paper presents the planned approach for the design of a mobile application that incorporates multimodal journey planning with a strong emphasis on accessibility and user interface design (UI). The app aims to seamlessly integrate various modes of transport and focus on equal access for all users, regardless of their physical abilities. UI Design approach prioritises user-centred principles and provides an intuitive and visually appealing platform, using real-time data integration, interactive maps and multi-modal route recommendations to enhance the user experience. Accessibility is taking place at the beginning of the design planning process, ensuring that people with disabilities can navigate the platform effortlessly. Screen readers, voice control, colour contrast and inclusive design practises should be integral components. As part of the iterative process of UI design, qualitative and quantitative methods are used to measure user experience (UX) and accessibility, using feedback, surveys, usability testing, and accessibility audits. This iterative approach ensures continuous improvement and a truly inclusive transport solution.

## KEYWORDS

multi-modal route planning, accessibility, interactive map, responsive design, cross-device accessibility

## 1 INTRODUCTION

In a time when web and mobile applications have seamlessly integrated into our daily lives, their importance cannot be overstated. As these technologies advance and gain wider adoption, it becomes imperative to embrace the principles of universal design and digital accessibility. These principles ensure that products can be utilized by individuals across a wide range of abilities and in various operational contexts. The concept of digital accessibility, primarily focused on designing for individuals with disabilities, considers a wide range of impairments, spanning auditory, speech, visual, physical, cognitive, and neurological disabilities [1]. It is crucial to recognize that many of the strategies and solutions developed for accessibility directly benefit users with situational limitations, such as individuals with a broken arm or lost glasses. Additionally, the aging process brings changes in abilities for older individuals, often leading to challenges like impaired hearing and weakened vision [1][2]. Furthermore, situational limitations such as intense sunlight or noisy surroundings can also hinder interactions [2]. Embracing comprehensive accessibility measures therefore enables application designers and developers to address these various challenges and create a digital landscape that is fully accommodating.

From a business perspective, the design of accessible software offers substantial benefits to organisations [3]. These advantages encompass enhanced application usability, broader market research resulting from an improved user experience that caters to a wider range of users, mitigation of accessibility-related legal actions (especially relevant for public sector organisations), fostering a positive brand perception and providing a better environment for driving innovation [2][3]. Therefore, developing accessible applications extends beyond the ethical aspects. It is a strategic move for organisations to showcase digital inclusivity and tap into an overlooked market.

This paper discusses the initial phase of designing an accessible journey planning application, addressing relevant aspects such as application requirements and the approaches to solving various case-specific accessibility challenges.

## 2 MULTI-MODAL ROUTE PLANNING APPLICATION

In response to the growing need for efficient and user-friendly travel solutions, multimodal journey planning applications have proven to be valuable tools that simplify the organisation of trips using different modes of transport. These applications, available both on the Web and on mobile platforms, provide users with a convenient and comprehensive approach to journey planning that includes public transport, walking, cycling and other modes of transport.

At both national and international levels, the importance of robust journey planner applications is undeniable. These applications serve as key tools for effective transportation management, fostering seamless travel experience for citizens and tourists. By encouraging the use of public transport and sustainable travel methods, they help optimise transport networks as well as reduce environmental impact.

The key objectives of the presented use case presented are to redesign the existing web-based multimodal journey planner

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"AtoB" and the development of a mobile version of the journey planner for mobile devices, also taking into account accessibility of these solutions. By integrating various diverse data sources provided by different governmental and other institutions, the system will effectively plan and present trips and thus positively contribute to user-oriented journey planning experience.

Despite the existence of widely used route planning solutions like Google Maps and Apple Maps, these applications do exhibit some accessibility shortcomings [4][5]. This includes problems with focus order, keyboard navigation, colour contrast, labelling and other usability issues, which can pose challenges for users with disabilities [5][6]. Moreover, global route planning applications often lack the diverse data sources necessary for comprehensive local route planning, presenting a notable disadvantage.

## 2.1 Functional Requirements

The design of the multimodal route planning application will implement a conventional client-server architecture that enables efficient communication and data exchange between users' devices and the application's backend system. The following functional requirements, defined from a front-end and user experience perspective, describe the main features of the application.

*3.1.1 Route Planning*

The functionalities of the application extend to advanced route planning, allowing users to define start, end and intermediate points via an address, location, a point of interest or a direct map selection. In addition, preferred modes of transport (walking, cycling, rental bikes, bus, train, or boat) can be selected, along with route alternatives if available. Users should be able to set departure and arrival times or access the current departure and arrival times for convenience, underlining the app's commitment to comprehensive, adaptable journey planning. The application must allow users to view timetables for their chosen location and time, which should be available for all possible stops. Furthermore, the application must also facilitate the display of rental bike stops and provide important data on the number of bikes and parking spaces available. The design of the application should incorporate wheelchair accessibility, allowing the user to select this option when calculating the route and displaying a warning message if the route is partially or completely inaccessible. Finally, users should be able to set a maximum walking time and a slow walking pace option, which will be considered when calculating the estimated time of arrival.

*3.1.2 Interactive map*

The application must have an interactive map that allows the user to effortlessly navigate, view their current location, and select points of interest. The client recommends the use of OpenStreetMap as the underlying map data layer, chosen for its openness, wide coverage, and customisable attributes. In addition, the map should allow for the interactive display of key transport hubs, including public transport stops, bicycle, and car rentals, as well as P+R (Park + Ride) parking. Users should be provided with comprehensive information including identification, location, operating hours, rental options, booking systems, directions, accessibility features and additional services to ensure an informative navigation experience.

*3.1.3 Real-Time Location Tracking*

The application shall include real-time location tracking features to enhance the user experience during route planning, using technologies such as GPS and network-based methods for accurate data. The collection of user location data must comply with data protection regulations, with clear information and user consent for data use.

*3.1.4 Additional (Nice-to-Have) Requirements*

In addition to the basic requirements, several desirable features can be provided to further enhance the user experience of the application. These features include real-time integration of public transport information, bus and train tracking for enhanced travel visibility, real-time locations of shared vehicles, fare information and ticket purchase, as well as the ability to store and use tickets. Together, these optional features could contribute to an enhanced, user-centered travel experience.

## 2.2 Supported Platforms and Devices

The web application should be fully responsive and adhere to responsive design principles to ensure compatibility with different screen sizes. The mobile application is a crucial component that should be compatible with Android, iOS and HarmonyOS operating systems and must be accessible via Google Play, the Apple App Store, and the Huawei AppGallery. To meet these criteria, the Microsoft.NET Maui cross-platform framework will be used, ensuring efficient and consistent application deployment.

## 2.3 Variety of Content Types

The application will prominently feature textual information along with the interactive map. The map will incorporate various graphic elements, including typical map elements as well as additional lines, icons, and other visual components. The use of icons is anticipated to be substantial, contributing to visual clarity. Small animations will be used strategically to support user guidance and notifications and enhance the overall experience. Visual content will also include images, e.g. logos of transport providers and images of places. The incorporation of videos within the application is expected to be limited or non-existent.

# 3 APPROACHES TO ENSURING MULTI PLATFORM ACCESSIBILITY

In the design phase, consideration of accessibility is crucial as it lays the foundation for a product that is both inclusive and easy to use. Considering accessibility early in the design process not only reduces costs, but also prevents the need for extensive retroactive work. While a significant portion of accessibility-related efforts is expected to occur during the development phase, it's vital to thoughtfully outline necessary accessibility measures during the design phase. Therefore, while the design phase includes typical design work such as colour selection, application layout design, icon selection, etc., adherence to accessibility requirements should also be considered [7]. Addressing accessibility for this specific use case combines established best practises with unique considerations, mainly related to the interactive map functionality. The design of the

application is based on the foundation of the WCAG guidelines [8], ensuring the application is perceivable, operable, understandable, and robust. This section delves into essential accessibility implementations and challenges in designing an inclusive web and mobile application for our route planning use-case.

## 3.1 Web-Specific Challenges

In terms of web browser accessibility features, we can expect certain functions to be readily available through both the browser itself and the device's operating system. Commonly encompassed within these browser features are screen readers, high contrast options, zoom capabilities, and the ability to customise font settings, including font type, size and style [9]. However, as these features are somewhat limited and vary greatly between different browsers and devices (particularly features related to visual aspects such as different contrast modes and text adjustments), additional in-app measures need to be implemented to ensure proper cross-device accessibility of the web application.

Therefore, an accessibility menu should be integrated into the web application, which will provide users with the ability to customize the application's settings according to their preferences and needs. The accessibility menu should be readily visible, easily accessible, and offer several key options. The menu should offer settings for high contrast modes and various colour enhancements to accommodate people with visual impairments. In addition, users should be able to adjust text-related settings, such as the font type, size, style, text spacing, line height settings, and link appearances. The menu should also offer the possibility to change the size of icons and other graphical elements (including elements within the interactive map interface, such as route lines).

The interactive map, one of the most important features of the application, presents some unique challenges regarding accessibility. Keyboard-only navigation and proper focus management are particularly important for ensuring operability of the map. The order of focus must be as consistent and predictable as possible. This consistency not only promotes smooth keyboard navigation, but also ensures compatibility with screen readers, which need access to all webpage components to read essential information. Crucially, screen readers should also alert the user when important events related to the interactive map occur, such as the appearance of pop-ups or map movement [10]. Any additional elements placed on the map should have corresponding textual information for screen reader users. Accessible Rich Internet Applications (ARIA), alt, and title attributes should be added to these elements where appropriate, and they must be short and descriptive [11]. Furthermore, the interactive map should also support keyboard-only operation for navigating the map – this includes zooming, panning, and rotating the map [8][11].

In terms of the visual aspects of the interactive map, adherence to established principles of accessible map design is crucial. Key considerations when designing accessible maps include refraining from relying solely on colour to convey information, but instead using text, icons, or subtle, yet recognisable patterns to complement the colour-based information. Furthermore, it is essential to avoid excessively small or illegible labels, prevent overlapping of different elements, ensure appropriate size of graphic components, and provide intuitive icons [12].

## 3.2 Mobile-Specific Challenges

Solving accessibility challenges when designing for mobile devices will involve building upon earlier discussed measures, while also considering specific aspects of mobile applications. In general, mobile devices offer a broader and more uniform range of accessibility features for applications compared to web browsers. As a result, mobile applications often extensively rely on operating system features to provide accessibility. While these features differ slightly between operating systems, the major platforms all include core elements such as screen readers, magnification and zoom options, voice command capabilities, closed captioning, contrast and colour differentiation modes, haptic feedback through vibration, simplified gesture-based interaction, and font adjustments [13]. Thus, to make the mobile application accessible, it is first necessary to enable the effective utilization of the provided accessibility features. Furthermore, some supplementary accessibility measures need to be implemented to bridge the gaps left by the built-in functions of the operating system.

Perhaps most importantly, the application's user interface elements, including buttons, labels, and navigation, have to be coded with correct semantic information and labelling, while also arranged in an intuitive semantic order. This enables screen readers to accurately convey the content to users with visual impairments. Additionally, the application must fully support key accessibility options such as platform zoom, text resizing, providing haptic feedback instead of audio or visual feedback, and high contrast modes. Although in most cases these features are automatically available due to the built-in support of development frameworks, it remains imperative to test and validate their correct functionality.

Aside from ensuring the proper functioning of assistive technologies, additional measures should be taken to ensure accessibility. This entails adopting accessible interactive map design principles, as well as applying general design principles for accessible mobile design. It is crucial that the touch targets are sufficiently large and appropriately spaced. Since the application is expected to include various input fields, it should offer simple data entry with various input methods such as predefined drop-down lists and autocomplete functions, while also supporting voice input. Furthermore, the application should facilitate the use of key functionalities — such as navigating the interactive map — through simplified gestures instead of complex ones [14].

## 3.3 Cross-platform Development Frameworks

The development of the mobile application will be based on the cross-platform framework .NET MAUI, necessitating a thorough assessment of the potential for creating accessible user interfaces within this framework.

Development framework suppliers usually provide documentation detailing the accessibility features they offer, as is the case with Microsoft's .NET MAUI, which presents accessibility documentation and offers robust accessibility tools

[15]. Nonetheless, comprehensive testing remains imperative to ensure effective implementation of accessibility measures across all platforms and devices.

In the context of the .NET MAUI framework, the preferred method involves utilizing "semantic properties". These properties provide information about controls that need to be made accessible and text that should be read aloud to the user. Semantic properties can be added to any element, utilizing the platform's accessibility APIs. A key advantage is the ability to accommodate distinct platform-specific accessibility experiences, rather than enforcing a uniform behaviour across all platforms. UI Elements can possess properties such as description, hint, and heading level, tailoring platform-specific accessibility values for improved interaction with screen readers. Furthermore, the framework provides tools to prompt the platform's screen reader to automatically articulate specific elements. Additional "automation properties" can also be applied to elements to define how they are conveyed to the platform's accessibility framework [15][16].

Nonetheless, the behaviour of these functionalities across various platforms remains somewhat uncertain. Therefore, performing comprehensive accessibility testing on each platform is a mandatory part of the development process.

### 3.4 Accessibility testing

The evaluation of appropriately integrated accessibility features includes both automated tools and non-technical assessments. This holistic approach aims to ensure that content and functionalities are universally accessible.

Automated tools play a pivotal role in analysing application code and content, identifying accessibility issues and even providing guidance on how to resolve them. These tools streamline development by uncovering intricate code errors that may elude human evaluators [17]. However, they cannot fully understand the subtle details of context or thoroughly evaluate the quality of content [18].

Even though automated testing is necessary for accessibility, it will be reinforced by manual inspection. Manual testing entails proficient evaluators navigating the application using assistive technologies such as screen readers and keyboard-only interactions, mimicking the experiences of users with disabilities [18]. This thorough approach includes assessing content, testing keyboard-only use, and evaluating the use of screen readers and other assistive tools on various devices for both web and mobile applications. To comprehensively validate accessibility, the testing process should include a variety of mobile devices of all three required operating systems. Furthermore, the inclusion of real users with disabilities in the testing process would provide invaluable insights by uncovering additional accessibility issues and gathering feedback on user experience [18].

## 4 CONCLUSION

Diverse applications pose distinct challenges when it comes to ensuring accessibility. Throughout this paper preliminary research was conducted to identify these challenges and explore possible solutions to ensure accessibility across the entire journey planning application. The focus was on exploring specific features where accessibility integration is not particularly intuitive and not yet widespread. The focus on the interactive map and journey planning functionality revealed several potential hurdles in the design of both the mobile and web application that require a thorough application of accessibility guidelines. The use of cross-platform frameworks was also identified and explored as a potential challenge for ensuring accessibility. In addition, new ideas emerged during the research that could help improve accessibility in the next versions of the application. For example, one of these suggestions includes the implementation of an animated sign language interpreter to assist deaf or hard of hearing users.

The initial research is expected to be of great value in the design and development phase of the application, providing a solid set of design principles and enabling effective resolution of accessibility issues. Despite the additional resources dedicated to ensure accessibility, the significant business and ethical benefits of an inclusive app are likely to outweigh the initial investment. With this foundation, the stage is set for the efficient development of an accessible journey planning application.

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# Towards a Self-Assessment Tool for Enabling Inclusive Digital Education*

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## ABSTRACT

In the ever-changing field of education, facing various challenges, developing a self-evaluation tool is crucial. Striving for excellence and inclusivity demands continuous assessment, adaptability, and the development of student-friendly settings. This necessity is emphasised by tools like Self-Reflection on Effective Learning by Fostering Innovation through Educational technology (SELFIE) and the Index for Inclusion, advocating inclusive education practices and fostering collaboration among all participants. Their goal is to boost digital learning and professional growth, however, not all factors, important for inclusive digital education, are included in the existing tools. Our proposed self-evaluation tool model builds on these foundations, integrating practical insights and best practices while also addressing potential obstacles and best practices connected to digital education. It aims to deepen understanding of factors sustaining successful inclusion and enriching the educational landscape for students, educators, and institutions. Our research aims to develop a tool that will have the potential to redefine education's future.

## KEYWORDS

Inclusion, self-evaluation, supporting tools, digital education.

## 1. INTRODUCTION

Inclusive education has been defined by the United Nations Educational, Scientific and Cultural Organization (UNESCO) as "a process of addressing and responding to the diversity of needs of all learners through increasing participation in learning, cultures and communities, and reducing exclusion within and from education" [1].

Digital inclusion (DI) „is the ability of individuals and groups to access information and communication technologies (ICT)" [2]. DI in education aims to provide students with disabilities the opportunity to learn alongside their non-disabled peers and encompasses not only access to the Internet but also the availability of hardware and software, relevant content and services, and training for the digital literacy skills required for effective use of ICT.

A significant step forward in advancing DI in education was the United Nations' adoption of the Convention on the Rights of Persons with Disabilities [3]. This international commitment underscores the importance of ensuring equal access to inclusive and high-quality primary and secondary education for individuals with disabilities within their communities [4]. Today, many countries have legislation or policies that support the inclusion of students with special needs [5].

Self-evaluation of school leadership and teachers regarding the goals of inclusive digital teaching and learning is crucial for improving the quality of education and ensuring that all students have equal learning opportunities. The use of self-evaluation tools is essential for several reasons:

- Measuring progress: Self-evaluation tools allow school leadership and teachers to assess their current position in terms of inclusive digital teaching and learning. This helps them determine where they are and how they have progressed in their efforts to include all students.
- Identifying strengths and weaknesses: Self-evaluation helps identify strong points where successful practices are in place and weaknesses where improvement is needed. This enables the allocation of resources and efforts to areas where they are most needed.
- Guiding approach development: Based on the results of self-evaluation, school leadership, and teachers can develop approaches and strategies to enhance inclusive digital teaching. This contributes to better adaptation to the diverse needs of students.
- Providing evidence: With the data and analyses obtained through self-evaluation, schools and teachers can justify their approaches and decisions, including those involving school leadership, parents, and the broader community.

The goal of this study is to provide a framework for developing a tool that will help understand the specific needs of educational environments and support schools and teachers in achieving inclusive digital teaching and learning. Through the use of self-evaluation tools, we aim to achieve the following objectives: (1) *Enhancing inclusivity*: Ensure that all students, including those with special needs and different learning styles, have equal access to digital learning resources and tools; (2) *Increasing*

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*digital literacy*: Enable teachers and students to develop digital skills and competencies necessary for success in the modern world; (3) *Improving learning outcomes*: Increase students' success and their understanding of school subjects by promoting inclusive digital teaching; and (4) *Fostering Collaboration*: Encourage collaboration among teachers, school leadership, parents, and the community to achieve common goals in inclusive digital education. With self-evaluation tools, we can achieve this goal and contribute to enhancing inclusivity, digital literacy, and the quality of teaching and learning in our schools.

In the existing literature, we can find tools that enable assessing specific aspects of inclusive digital education. Most tools have been developed to evaluate the readiness to use digital technologies in primary schools or to evaluate inclusion in general schools. However, we have yet to find any studies dealing specifically with evaluating readiness to ensure effective inclusion in education based on digital technologies. There is a lack of such tools, especially in the field of tertiary education. For this reason, this work is one of the first steps towards building such a tool.

This paper is structured into four sections. Following the introduction in Section 1, Section 2 investigates the background of inclusive education. This Section focuses on digital inclusion within education, followed by an examination of accessible learning content designed to facilitate inclusive digital education. In Section 3, we explore the development of self-evaluation tools, discuss existing frameworks, and introduce a novel framework concept. Finally, Section 4 offers the conclusion and outlines future prospects for our work.

## 2. BACKGROUNDS

In the ever-changing landscape of education, the principles of inclusivity, digitalization, and accessibility have emerged as critical bases of progress. As we navigate the 21st century, the concept of inclusive education has evolved from being a noble aspiration to a fundamental necessity, emphasizing equitable opportunities for all learners, regardless of their diverse needs and backgrounds.

In this section, we embark on a comprehensive exploration of three interconnected facets: Inclusive Education, Digital Inclusion in Education, and Accessible Learning Content for Enabling Inclusive Digital Education.

### 2.1 Inclusive education

Inclusive education, as defined by UNESCO, focuses on addressing the diverse needs of all learners, fostering increased participation in learning, culture, and communities while reducing exclusion in education. This approach emphasizes the inclusion of both students with and without disabilities in the same classroom, enabling them to learn and participate together [6]. This inclusive model not only provides significant educational benefits to students with disabilities but also contributes to greater social acceptance of differences and impairments among all students [7]. Curriculum, pedagogy, assessment, student classification, and stratification are all important in determining the quality and inclusiveness of educational experiences [8].

Inclusion involves more than the placement of students with disabilities in mainstream classes and requires structural changes in organization, curriculum and teaching, and learning strategies [9]. Improving inclusivity may require substantial change not only to the teaching practices occurring inside and outside of the classroom but also within staffrooms and the school's relationships with parents, caregivers, and the community [10].

Figure 1 shows the dimensions of the Index for Inclusion, developed by Booth and Ainscow [10] that can assist schools in turning the philosophy of inclusion into inclusive educational actions. Inclusive school policy provides the foundation for enabling schools to be accessible to all students and staff. An inclusive school culture is one in which diversity is embraced, and all members are treated fairly, respectfully, and equitably. Inclusive practice means that learning and teaching activities are responsive to student diversity. Learning experiences are designed with students' individual strengths and needs in mind, and consideration is given to how all students can actively and meaningfully participate in their learning and be appropriately challenged.

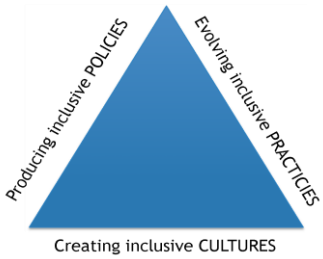


**Figure 1. Index for Inclusion – dimensions [6]**

### 2. 2 Digital inclusion in education

DI should adapt to technological progress but also aim for digital equity by actively removing barriers that perpetuate disadvantages in individuals and communities [11]. Educators are actively seeking innovative approaches to address the complexities presented by diverse modern classrooms. Universal Design for Learning (UDL) for example offers a philosophy, framework, and a set of principles that enable the creation and implementation of adaptable teaching and learning strategies, effectively catering to the diverse needs of students within the classroom environment. UDL is an educational framework based on the idea that all students can benefit from learning when they are provided with choices that are suited to their individual needs. UDL encourages educators to create flexible and adaptable learning environments in which students of all abilities and backgrounds can succeed [12][13].

At the core of the European Union's Digital Education Action Plan (2021-2027), the policy initiative offers a long-term strategic vision for high-quality, inclusive, and accessible European digital education [14]. Digital transformation goes beyond applying suitably designed digital technologies in education and involves several education system levels [14]:

- Technology Level - The development of inclusive technology should consider technology-driven approaches and the primacy of pedagogy in a balanced way. Assistive technology (AT) should be used as a compensatory means only where universally designed technology does not (yet) sufficiently satisfy all users' needs.

- Learners level - Inclusion in digital education is multi-dimensional, affected by society, technical equipment, the educational institution, the learning situation, and the individual learners. Learners' digital competencies play an important role in inclusive digital education communication, collaboration and safety, respectful and appreciative social interaction, the development of a digital person, critical reflection on digital media and self-protection against violence in digital environments, etc.
- Teachers level - Teachers need support in selecting inclusive teaching materials that present no or few barriers and are suitable for all learners. Competencies like media literacy, data literacy, and data-based decision-making are important in the context of inclusive digital teaching.
- Educational institution level - Educational organizations that embrace the digitalization process in terms of content and funding can help to reduce social exclusion. Teacher empowerment is key and must be accompanied by organizational support measures, further training, and consideration of teachers' individual needs.
- National/regional level.

## 2.3 Accessible learning content for enabling inclusive digital education

In addition to ensuring equal access for all students, content accessibility in digital education can also improve the overall quality of education. Digital content accessibility is the practice of designing digital materials to be inclusive to all individuals, regardless of their abilities. In digital education, it's vital to ensure that all students can access educational resources equitably, accommodating diverse needs, including visual, hearing or other impairments. Failing to prioritize accessibility can lead to unequal educational outcomes, as students with disabilities may struggle to fully engage in online learning, highlighting the importance of inclusive content design in the digital education landscape.

Students with different types of disabilities can face barriers when accessing digital content in the context of digital education. Students with visual impairments can have difficulty accessing digital content that is not designed with accessibility in mind. For example, images, videos, and other visual content may not be described in a way that is meaningful to individuals who are blind or have low vision. Additionally, text may be too small or too low contrast to be readable for individuals with certain types of visual impairments. Next, students with hearing impairments can face barriers when accessing digital content that includes audio content, such as lectures or videos. Without proper captions or transcripts, students who are deaf or hard of hearing may not be able to fully engage with this content. Students with cognitive disabilities can have difficulty navigating and understanding digital content that is not designed with accessibility in mind. This can include content that is overly complex or difficult to navigate, as well as content that does not provide clear instructions or feedback. Students with motor impairments may have difficulty interacting with digital content that requires precise movements, such as using a mouse or keyboard. This can make it difficult for these students to navigate websites or complete assignments that require specific types of input.

There are several solutions that can be implemented to make digital content accessible for each group of students with disabilities. To make digital content accessible for students with visual impairments, content creators can use alternative text (alt text) to describe images and graphics. This alt text should be detailed enough to convey the meaning of the image or graphic to students who cannot see it. Additionally, designers can use high-contrast colors and font sizes that are easy to read for individuals with visual impairments. To make digital content accessible for students with hearing impairments, content creators can include captions and transcripts for audio content such as videos and lectures. This will allow students who are deaf or hard of hearing to access the audio content and participate fully in the learning experience. To make digital content accessible for students with cognitive disabilities, content creators can use clear and simple language and provide clear instructions and feedback. Additionally, designers can use layout and formatting techniques that make content easy to navigate and understand, such as bullet points and headings. To make digital content accessible for students with motor impairments, content creators can design content that can be accessed using a range of input methods, such as keyboard-only navigation or voice recognition software. Additionally, designers can use a clear and consistent interface design that allows for easy navigation.

Overall, creating accessible digital content in digital education benefits all students by improving usability, enhancing the learning experience, and promoting inclusion and diversity. By making content accessible to everyone, educators and content creators can help all students reach their full potential and succeed in their education.

# 3. DEVELOPMENT OF SELF-EVALUATION TOOL

In the dynamic landscape of education, the pursuit of excellence and inclusivity is important. To achieve these goals, educators and institutions must continually assess their practices, adapt to developing trends, and foster an environment where all learners can thrive. It is within this context that the development of a self-evaluation tool becomes indispensable. In the following sections, some existing solutions are presented as well as our proposed model.

## 3.1 Existing frameworks and tools for the design of the self-evaluation tool

To promote the integration and effective use of digital technologies in schools across Europe, the European Commission's Joint Research Centre (JRC) developed a conceptual framework for Digitally-Competent Educational Organizations (DigCompOrg), which encompasses key aspects of systematically integrating digital technology in educational organisations [15]. The DigCompOrg framework consists of following seven domains: (1) Leadership & Governance Practices, (2) Teaching and Learning Practices, (3) Professional Development, (4) Assessment Practices, (5) Content and Curricula, (6) Collaboration and Networking, and (7) Infrastructure.

Based on the DigCompOrg framework, the Commission designed and implemented the self-reflection tool SELFIE (Self-

reflection on Effective Learning by Fostering Innovation through Educational Technology), which helps schools exploit the opportunities digital technologies offer [15]. SELFIE can help schools and educational institutions assess their digital readiness and competence in integrating technology for effective teaching and learning [16]. SELFIE data can be used for assessing how the utilization of digital technologies in education influences students' development of digital skills and teachers' engagement in continuous professional development. SELFIE aims to: (1) Assess digital readiness: Evaluate how well educational institutions are prepared for digital integration, (2) Encourage self-reflection: Prompt educators, administrators, and students to reflect on their digital practices, and (3) Enhance digital learning: Identify areas for improvement in technology use for better teaching and learning outcomes.

SELFIE tool supports schools to plan their digital strategies, by highlighting what is working well, where improvement is needed and what the priorities should be [17]. Key features include user-friendliness, as SELFIE provides an easy-to-use interface for all stakeholders. It is customizable, and institutions can tailor the questionnaire to their specific needs and goals. It also has data-driven insights since it generates comprehensive reports and recommendations based on responses. SELFIE also promotes professional development and helps educators identify areas for skill improvement.

SELFIE provides an extensive questionnaires that cover areas, specific to utilization of digital technologies in education, impact of the use of digital technologies in education on students' development of digital skills, teachers' engagement in continuous professional development, etc. [17]. The questionnaire defines indicators, that cover following key areas [18]: Teaching and Learning Practices; Assessment Practices; Content and Curricula; Networking and Collaboration; Professional Development; Leadership and Governance Practices; and Infrastructure. These seven areas are expanded into fifteen sub-elements and 74 descriptors. The tool provides questions that can be used for collecting data from school's leaders, teachers, and students, to assess these areas from different points of view.

The "Index for Inclusion" is another important concept that must be considered and included in the development of the tool for self-assessment of inclusive digital education. The index for inclusion was designed to support inclusive education practices within schools and educational institutions. It provides a framework for assessing, developing, and promoting inclusive practices to ensure that all students, regardless of their abilities, backgrounds, or characteristics, can access high-quality education [19]. It aims to: (1) Promote inclusive education: Encourage schools and institutions to create environments where every student can participate, learn, and thrive. (2) Evaluate and improve inclusion: Provide a structured approach for self-assessment and continuous improvement in inclusive practices. (3) Empower participants: Engage educators, students, families, and the community in collaborative efforts to enhance inclusivity. Key features include the comprehensive framework for evaluating and enhancing inclusive education practices. It is user-friendly and designed to be accessible and usable by educators, administrators, and other stakeholders. It provides practical guidance, tools, and resources for implementing inclusive practices. It also presents a collaborative approach, encouraging the involvement of all stakeholders and fostering a sense of ownership and commitment to inclusion.

## 3.2 Proposal for the model for self-evaluation tool for assessment of inclusive digital education

Self-evaluation is a process for helping schools improve autonomously, a practice that should be integrated routinely into their management systems [20]. The proposed model for self-evaluation of inclusive digital education will incorporate existing awareness of inclusion drawn from the SELFIE tool and the Index of Inclusion. However, our primary objective is to enhance this foundation with insights collected from the practical experiences of researchers, pedagogical professionals, and other experts in this field. We will integrate best practices as well as address obstacles within the existing self-evaluation tool to gain a more comprehensive understanding of their impact on successful inclusion. This approach allows to identify potential challenges and difficulties that may not have been encompassed by existing frameworks, as shown in Figure 2.

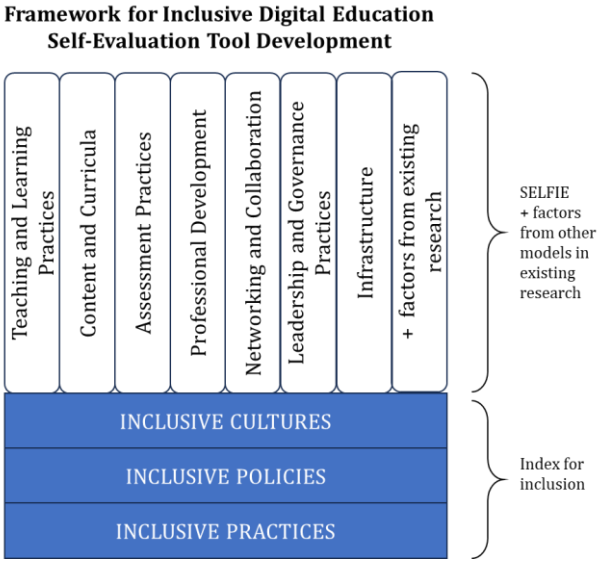


**Figure 2 Framework for integration of dimensions and factors from existing frameworks and existing research**

The following inclusion domains are planned to be addressed: leadership, collaboration and networking, infrastructure, equipment and technology, continuous professional development, resources for pedagogical activities and assessment practices, as well as student digital competence. Each domain will be subdivided into factors strongly associated with the content of that particular domain. The resulting self-evaluation tool will be designed with the assistance of a questionnaire, enabling users to assess statements related to factors within each domain using a 5-point Likert scale. The self-assessment results will be presented in the form of separate scores for each domain, representing the current state of DI within each domain. Based on the obtained assessments, recommendations will also be provided for improving DI in specific, critically assessed areas. Through this comprehensive approach, the self-evaluation tool aims to empower educational institutions not only to measure

their current state but also to chart a course for continuous improvement. Inclusive digital education is an ongoing journey, and our tool will serve as a compass, guiding institutions toward a future where every stakeholder can thrive in a digitally enhanced educational environment.

## 4. CONCLUSIONS AND FUTURE WORK

In conclusion, the development of a self-evaluation tool holds significant importance in the dynamic setting of education. Excellence and inclusivity are central goals, requiring continuous assessment, adaptation, and the creation of environments encouraging to the success of all learners. This necessity is underlined by the existence of different frameworks and tools such as SELFIE and the Index for Inclusion.

SELFIE, serves as a user-friendly, customizable, and data-driven tool for assessing digital readiness and promoting self-reflection among educational institutions. It aims to enhance digital learning and professional development by identifying areas for improvement. The Index for Inclusion, on the other hand, is a comprehensive resource that advocates for inclusive education practices. It offers an inclusive framework and encourages collaboration among stakeholders, ensuring that all students have access to quality education.

Our proposed model for a self-evaluation tool represents a step forward in this direction. By building upon the knowledge from established tools like SELFIE and the Index of Inclusion, our model strives to integrate practical insights and experiences, incorporating best practices and addressing potential obstacles. This holistic approach seeks to provide a more comprehensive understanding of the factors that influence successful inclusion, enriching the educational landscape with a tool designed to meet the evolving needs of students, educators, and institutions.

In our upcoming research activities, we plan to conduct a comprehensive literature review to survey the existing body of research conducted by scholars in this field. Furthermore, as we are interested to gather insights from individuals within the realm of higher education, we will also administer a survey among them. This approach will help us gain a well-rounded perspective and enrich our study with valuable opinions and data from relevant stakeholders.

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# Digitalna vključenost v informacijski družbi

# Digital Inclusion in Information Society

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