
> IS 2024
Informacijska družba
Zbornik 27. mednarodne multikonference
Zvezek H
Information Society
Proceedings of the 27th International Multiconference
Volume H
Digitalna vključenost v informacijski družbi
Digital Inclusion in Information Society
Urednika > Editors:
Matjaž Debevc, Ines Kožuh
9. oktober 2024 > Ljubljana, Slovenija / 9 October 2024 > Ljubljana, Slovenia

Zbornik 27. mednarodne multikonference

INFORMACIJSKA DRUŽBA – IS 2024

Zvezek H

Proceedings of the 27th International Multiconference

INFORMATION SOCIETY – IS 2024

Volume H

Digitalna vključenost v informacijski družbi
Digital Inclusion in Information Society

Urednika / Editors

Matjaž Debevc, Ines Kožuh

http://is.ijs.si

9. oktober 2024 / 9 October 2024
Ljubljana, Slovenia

Urednika:

Matjaž Debevc
Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

Ines Kožuh
Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

Založnik: Institut »Jožef Stefan«, Ljubljana
Priprava zbornika: Mitja Lasič, Vesna Lasič, Lana Zemljak
Oblikovanje naslovnice: Vesna Lasič

Dostop do e-publikacije:
http://library.ijs.si/Stacks/Proceedings/InformationSociety

Ljubljana, oktober 2024

Informacijska družba
ISSN 2630-371X

Kataložni zapis o publikaciji (CIP) pripravili v Narodni in univerzitetni knjižnici v Ljubljani
COBISS.SI-ID **214484227**
ISBN 978-961-264-306-5 (PDF)

PREDGOVOR MULTIKONFERENCI INFORMACIJSKA DRUŽBA 2024

Leto 2024 je hkrati udarno in tradicionalno. Že sedaj, še bolj pa v prihodnosti bosta računalništvo, informatika (RI) in umetna inteligenca (UI) igrali ključno vlogo pri oblikovanju napredne in trajnostne družbe. Smo na pragu nove dobe, v kateri generativna umetna inteligenca, kot je ChatGPT, in drugi inovativni pristopi utirajo pot k superinteligenci in singularnosti, ključnim elementom, ki bodo definirali razcvet človeške civilizacije. Naša konferenca je zato hkrati tradicionalna znanstvena, pa tudi povsem akademsko odprta za nove pogumne ideje, inkubator novih pogledov in idej.

Letošnja konferenca ne le da analizira področja RI, temveč prinaša tudi osrednje razprave o perečih temah današnjega časa – ohranjanje okolja, demografski izzivi, zdravstvo in preobrazba družbenih struktur. Razvoj UI ponuja rešitve za skoraj vse izzive, s katerimi se soočamo, kar poudarja pomen sodelovanja med strokovnjaki, raziskovalci in odločevalci, da bi skupaj oblikovali strategije za prihodnost. Zavedamo se, da živimo v času velikih sprememb, kjer je ključno, da s poglobljenim znanjem in inovativnimi pristopi oblikujemo informacijsko družbo, ki bo varna, vključujoča in trajnostna.

Letos smo ponosni, da smo v okviru multikonference združili dvanajst izjemnih konferenc, ki odražajo širino in globino informacijskih ved: CHATMED v zdravstvu, Demografske in družinske analize, Digitalna preobrazba zdravstvene nege, Digitalna vključenost v informacijski družbi – DIGIN 2024, Kognitivna znanost, Konferenca o zdravi dolgoživosti, Legende računalništva in informatike, Mednarodna konferenca o prenosu tehnologij, Miti in resnice o varovanju okolja, Odkrivanje znanja in podatkovna skladišča – SIKDD 2024, Slovenska konferenca o umetni inteligenci, Vzgoja in izobraževanje v RI.

Poleg referatov bodo razprave na okroglih mizah in delavnicah omogočile poglobljeno izmenjavo mnenj, ki bo oblikovala prihodnjo informacijsko družbo. “Legende računalništva in informatike” predstavljajo slovenski “Hall of Fame” za odlične posameznike s tega področja, razširjeni referati, objavljeni v reviji *Informatica* z 48-letno tradicijo odličnosti, in sodelovanje s številnimi akademskimi institucijami in združenji, kot so ACM Slovenija, SLAIS in Inženirska akademija Slovenije, bodo še naprej spodbujali razvoj informacijske družbe. Skupaj bomo gradili temelje za prihodnost, ki bo oblikovana s tehnologijami, osredotočena na človeka in njegove potrebe.

S podelitvijo nagrad, še posebej z nagrado Michie-Turing, se avtonomna RI stroka vsakoletno opredeli do najbolj izstopajočih dosežkov. Nagrado Michie-Turing za izjemen življenjski prispevek k razvoju in promociji informacijske družbe je prejel prof. dr. Borut Žalik. Priznanje za dosežek leta pripada prof. dr. Sašu Džeroskemu za izjemne raziskovalne dosežke. »Informacijsko limono« za najmanj primerno informacijsko tematiko je prejela nabava in razdeljevanjem osebnih računalnikov ministrstva, »informacijsko jagodo« kot najboljšo potezo pa so sprejeli organizatorji tekmovanja ACM Slovenija. Čestitke nagrajencem!

Naša vizija je jasna: prepoznati, izkoristiti in oblikovati priložnosti, ki jih prinaša digitalna preobrazba, ter ustvariti informacijsko družbo, ki bo koristila vsem njenim članom. Vsem sodelujočim se zahvaljujemo za njihov prispevek k tej viziji in se veselimo prihodnjih dosežkov, ki jih bo oblikovala ta konferenca.

Mojca Ciglarič, predsednica programskega odbora

Matjaž Gams, predsednik organizacijskega odbora

PREFACE TO THE MULTICONFERENCE INFORMATION SOCIETY 2024

The year 2024 is both ground-breaking and traditional. Now, and even more so in the future, computer science, informatics (CS/I), and artificial intelligence (AI) will play a crucial role in shaping an advanced and sustainable society. We are on the brink of a new era where generative artificial intelligence, such as ChatGPT, and other innovative approaches are paving the way for superintelligence and singularity—key elements that will define the flourishing of human civilization. Our conference is therefore both a traditional scientific gathering and an academically open incubator for bold new ideas and perspectives.

This year's conference analyzes key CS/I areas and brings forward central discussions on pressing contemporary issues—environmental preservation, demographic challenges, healthcare, and the transformation of social structures. AI development offers solutions to nearly all challenges we face, emphasizing the importance of collaboration between experts, researchers, and policymakers to shape future strategies collectively. We recognize that we live in times of significant change, where it is crucial to build an information society that is safe, inclusive, and sustainable, through deep knowledge and innovative approaches.

This year, we are proud to have brought together twelve exceptional conferences within the multiconference framework, reflecting the breadth and depth of information sciences:

- CHATMED in Healthcare
- Demographic and Family Analyses
- Digital Transformation of Healthcare Nursing
- Digital Inclusion in the Information Society – DIGIN 2024
- Cognitive Science
- Conference on Healthy Longevity
- Legends of Computer Science and Informatics
- International Conference on Technology Transfer
- Myths and Facts on Environmental Protection
- Data Mining and Data Warehouses – SIKDD 2024
- Slovenian Conference on Artificial Intelligence
- Education and Training in CS/IS.

In addition to papers, roundtable discussions and workshops will facilitate in-depth exchanges that will help shape the future information society. The “Legends of Computer Science and Informatics” represents Slovenia’s “Hall of Fame” for outstanding individuals in this field. At the same time, extended papers published in the Informatica journal, with over 48 years of excellence, and collaboration with numerous academic institutions and associations, such as ACM Slovenia, SLAIS, and the Slovenian Academy of Engineering, will continue to foster the development of the information society. Together, we will build the foundation for a future shaped by technology, yet focused on human needs.

The autonomous CS/IS community annually recognizes the most outstanding achievements through the awards ceremony. The Michie-Turing Award for an exceptional lifetime contribution to the development and promotion of the information society was awarded to Prof. Dr. Borut Žalik. The Achievement of the Year Award goes to Prof. Dr. Sašo Džeroski. The "Information Lemon" for the least appropriate information topic was given to the ministry's procurement and distribution of personal computers. At the same time, the "Information Strawberry" for the best initiative was awarded to the organizers of the ACM Slovenia competition. Congratulations to all the award winners!

Our vision is clear: to recognize, seize, and shape the opportunities brought by digital transformation and create an information society that benefits all its members. We thank all participants for their contributions and look forward to this conference's future achievements.

Mojca Ciglarič, Chair of the Program Committee

Matjaž Gams, Chair of the Organizing Committee

KONFERENČNI ODBORI
CONFERENCE COMMITTEES

International Programme Committee

Vladimir Bajic, South Africa
Heiner Benking, Germany
Se Woo Cheon, South Korea
Howie Firth, UK
Olga Fomichova, Russia
Vladimir Fomichov, Russia
Vesna Hljuz Dobric, Croatia
Alfred Inselberg, Israel
Jay Liebowitz, USA
Huan Liu, Singapore
Henz Martin, Germany
Marcin Paprzycki, USA
Claude Sammut, Australia
Jiri Wiedermann, Czech Republic
Xindong Wu, USA
Yiming Ye, USA
Ning Zhong, USA
Wray Buntine, Australia
Bezalel Gavish, USA
Gal A. Kaminka, Israel
Mike Bain, Australia
Michela Milano, Italy
Derong Liu, Chicago, USA
Toby Walsh, Australia
Sergio Campos-Cordobes, Spain
Shabnam Farahmand, Finland
Sergio Crovella, Italy

Organizing Committee

Matjaž Gams, chair
Mitja Luštrek
Lana Zemljak
Vesna Koricki
Mitja Lasič
Blaž Mahnič

Programme Committee

Mojca Ciglarič, chair
Bojan Orel
Franc Solina
Viljan Mahnič
Cene Bavec
Tomaž Kalin
Jozsef Györkös
Tadej Bajd
Jaroslav Berce
Mojca Bernik
Marko Bohanec
Ivan Bratko
Andrej Brodnik
Dušan Caf
Saša Divjak
Tomaž Erjavec
Bogdan Filipič
Andrej Gams
Matjaž Gams
Mitja Luštrek
Marko Grobelnik
Nikola Guid
Marjan Heričko
Borka Jerman Blažič Džonova
Gorazd Kandus
Urban Kordeš
Marjan Krisper
Andrej Kuščer
Jadran Lenarčič
Borut Likar
Janez Malačič
Olga Markič
Dunja Mladenič
Franc Novak
Vladislav Rajkovič
Grega Repovš
Ivan Rozman
Niko Schlamberger
Stanko Strmčnik
Jurij Šilc
Jurij Tasič
Denis Trček
Andrej Ule
Boštjan Vilfan
Baldomir Zajc
Blaž Zupan
Boris Žemva
Leon Žlajpah
Niko Zimic
Rok Piltaver
Toma Strle
Tine Kolenik
Franci Pivec
Uroš Rajkovič
Borut Batagelj
Tomaž Ogrin
Aleš Ude
Bojan Blažica
Matjaž Kljun
Robert Blatnik
Erik Dovgan
Špela Stres
Anton Gradišek

KAZALO / TABLE OF CONTENTS

Zbornik 27. mednarodne multikonference

INFORMACIJSKA DRUŽBA – IS 2024

Zvezek H

Proceedings of the 27th International Multiconference

INFORMATION SOCIETY – IS 2024

Volume H

Digitalna vključenost v informacijski družbi
Digital Inclusion in Information Society

Urednika / Editors

Matjaž Debevc, Ines Kožuh

http://is.ijs.si

9. oktober 2024 / 9 October 2024
Ljubljana, Slovenia

PREDGOVOR

Danes, v času hitrega razvoja digitalnih tehnologij, digitalna vključenost ostaja ključen steber naše informacijske družbe. Širjenje dostopa do tehnologij in digitalnih storitev na vedno večji del prebivalstva, vključno z osebami z različnimi oblikami oviranosti, zahteva nenehno izboljševanje dostopnosti, razumljivosti in uporabnosti digitalnih rešitev. Ob naraščajoči potrebi po prilagojenih rešitvah je naš cilj zagotoviti, da vsi posamezniki – ne glede na njihove zmožnosti – lahko v celoti sodelujejo v digitalni dobi in izkoristijo njen polni potencial.

Osrednja tematika konference "Digitalna vključenost v informacijski družbi – DIGIN 2024" je, kako lahko sodelujemo za ustvarjanje digitalno dostopnega okolja, ki omogoča enakopravno vključitev vseh. Naša druga hibridna konferenca, ki se ponovno izvaja v sodelovanju z evropskim centrom virov o dostopnosti – AccessibleEU, bo združila vodilne slovenske in mednarodne raziskovalce ter strokovnjake, ki bodo predstavili svoje rešitve, spoznanja in metode za izboljšanje digitalne vključenosti. Skupaj bomo raziskali, kako lahko s podporno tehnologijo ter prilagojenimi digitalnimi pristopi premagamo ovire, s katerimi se srečujejo osebe z različnimi oblikami oviranosti, in ustvarimo digitalni svet, ki je resnično dostopen vsem.

Prispevki, zbrani v letošnjem zborniku, predstavljajo bogat vir znanja in inspiracije za vse udeležence. Preko njih bomo bolje razumeli, kako tehnologijo uporabiti za izboljšanje kakovosti življenja in omogočiti enakopravno vključevanje v digitalno okolje. Verjamemo, da bomo skupaj s tem dogodkom pomembno prispevali k bolj vključujoči in dostopni digitalni prihodnosti.

Uredniški odbor

FOREWORD

Today, in an era of rapidly advancing digital technologies, digital inclusion remains a fundamental pillar of our information society. Expanding access to digital technologies and online services to an increasingly diverse population, including persons with disabilities, requires ongoing improvements in accessibility, clarity, and usability. As the need for tailored solutions grows, our goal is to ensure that all individuals – regardless of their abilities – can fully engage with the digital world and leverage its full potential.

The central theme of the conference "Digital Inclusion in the Information Society – DIGIN 2024" is how we can collaborate to create a digitally accessible environment that enables equal participation for all. Our second hybrid conference, organized once again in cooperation with the European Resource Centre on Accessibility – AccessibleEU, will bring together leading Slovenian and international researchers and professionals to share their solutions, insights, and methods for advancing digital inclusion. Together, we will explore how supportive technologies and adapted digital approaches can help overcome the barriers faced by persons with disabilities, thereby building a digital world that is truly accessible to everyone.

The contributions compiled in this year's proceedings provide a rich source of knowledge and inspiration for all participants. Through these insights, we will gain a deeper understanding of how technology can enhance quality of life and enable equal participation in the digital environment. We believe that, through this event, we will make a significant contribution towards a more inclusive and accessible digital future.

The Editorial Board

PROGRAMSKI SVET / STEERING COMMITTEE

Matjaž Gams (Predsdnik / Chair) – Institut Jožef Stefan

Matjaž Debevc – AccessibleEU

Zoran Ren – Univerza v Mariboru, Fakulteta za strojništvo

Marta Licardo – Univerza v Mariboru, Pedagoška fakulteta

Boštjan Šumak – Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

Damjana Kogovšek – Univerza v Ljubljani, Pedagoška fakulteta

Matevž Pogačnik – Univerza v Ljubljani, Fakulteta za elektrotehniko

Dušan Caf – Alma Mater Europaea

PROGRAMSKI ODBOR / PROGRAMME COMMITTEE

Ines Kožuh (Predsednik) – Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

Andraž Petrovčič (Podpredsednik) – Univerza v Ljubljani, Fakulteta za družbene vede

Maja Pušnik – Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

Katja Kous – Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

Darinka Verdonik – Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

Mirjam Sepesy Maučec – Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko

Patricija Sedminek – Univerza v Mariboru, Pedagoška fakulteta

Natalija Špur – Univerza v Mariboru

Narvika Bovcon – Univerza v Ljubljani, Fakulteta za računalništvo in informatiko

Jaka Čibej – Univerza v Ljubljani, Fakulteta za računalništvo in informatiko

Dejan Lavbič – Univerza v Ljubljani, Fakulteta za računalništvo in informatiko

Aleš Smrdel – Univerza v Ljubljani, Fakulteta za računalništvo in informatiko

Klemen Pečnik – Univerza v Ljubljani, Fakulteta za elektrotehniko

Žana Juvan – Univerza v Ljubljani, Fakulteta za elektrotehniko

Meta Furlan – Univerza v Ljubljani, Filozofska fakulteta

Nives Ličen – Univerza v Ljubljani, Filozofska fakulteta

Jelena Ficzko – Univerza v Ljubljani, Zdravstvena fakulteta

Anamarija Kejžar – Univerza v Ljubljani, Fakulteta za socialno delo

Jana Mali – Univerza v Ljubljani, Fakulteta za socialno delo

Simona Hvalič Touzery – Univerza v Ljubljani, Fakulteta za družbene vede

Exploring Digital Media Literacy: A Case Study of Elderly Deaf Users in Slovenia

Laura Horvat†
Faculty of Electrical Engineering and Computer Science
University of Maribor Slovenia
laura.horvat2@student.um.si

Peter Čakš
Faculty of Electrical Engineering and Computer Science
University of Maribor Slovenia
peter.caks@um.si

Irena Lovrenčič Držanič
Faculty of Electrical Engineering and Computer Science
University of Maribor Slovenia
irena.lovrencic@um.si

Ines Kožuh
Faculty of Electrical Engineering and Computer Science (University of Maribor), Faculty of Social Sciences (University of Ljubljana)
ines.kozuh@um.si,
ines.kozuh@fdv.uni-lj.si

Abstract

This study explores digital media literacy and usage patterns among elderly deaf individuals in Slovenia. Interviews with two participants revealed moderate digital literacy but limited digital media literacy, particularly in critical media consumption. The participants use social media mainly for communication and information. The findings highlight a potential relationship between digital media literacy and usage frequency, underscoring the need for tailored digital literacy training for the deaf community.

Keywords

Digital media literacy, social media literacy, deaf, social media, digital media, new media, online media platforms.

1 Introduction

In the digital age digital media play a central role in daily life, shaping how individuals access, understand and create digital content. This shift presents unique challenges for D/deaf and hard of hearing (DHH) individuals in navigating the digital landscape [1, 2]. This paper explores the digital literacy and digital media literacy of DHH individuals in Slovenia, focusing on their abilities to navigate digital media and their perceptions of digital media's accessibility. The objectives were to evaluate the level of (digital) media literacy among DHH individuals in Slovenia, and examine their experience with social media and online media platforms. By examining these aspects, the study seeks to contribute to a better understanding of how DHH individuals interact with digital media. Since the study is ongoing, this paper presents only the preliminary findings from interviews with two deaf individuals.

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

https://doi.org/10.70314/is.2024.DIGIN.1

2 Digital media literacy

2.1 Digital Media Literacy

Digital media literacy refers to the ability to access, understand and create content using digital media [3]. These skills are essential in the information age, where rapid technological advancements demand constant adaptation and learning [4]. Digital media literacy involves not only technical skills, but also includes emotional response, consumption and cultural evaluation of media content [3, 5].

With social media becoming a key source of information for many, the importance of social media literacy increased. These platforms became a popular way of spending free time, places for socialisation and communication with others in a personal or business environment [6]. Digital media usage has also shifted from desktops to mobile devices and tablets, changing the user experience, frequency and mode of use [7, 8].

2.2 Indicators of Digital Media Literacy

Digital media literacy involves four main areas: critical consuming, critical prosuming, functional consuming and functional prosuming [9]. Critical consuming includes the ability to analyse, synthesise and evaluate media content [5]. Critical prosuming involves interactive participation and critical content creation in new media environments, such as chatrooms. The individuals' critical abilities are exhibited in their understanding of social and cultural values [10, 11]. Functional consuming refers to technical skills in using media content, such as navigating the internet and using various digital devices [9, 12]. Functional prosuming includes the technical skills needed for content production and distribution, such as creating and sharing photos and videos on social media [12].

3 DHH in the digital media

3.1 Statistics on DHH Individuals

In Slovenia there are approximately 1,500 deaf people and around 50,000 hard of hearing individuals, according to the Association of the Deaf and Hard of Hearing of Slovenia [13]. The European Union of the Deaf (EUD) reports further that around 1,850 individuals in Slovenia identify as deaf, and 1,000 of them use Slovenian Sign Language [14].

3.2 Communication Habits of DHH Individuals

Communication among DHH individuals involves primarily the use of sign language, with Slovenian Sign Language being recognised officially and protected by law [15]. The right to use sign language includes access to interpreters and information through adapted techniques, ensuring inclusion in social and professional environments [16, 17]. In addition to sign language, DHH individuals use written text and visual aids to facilitate communication, particularly in digital contexts. Video calls via platforms (e.g., Skype, Teams and Zoom) have become essential, especially during the COVID-19 pandemic, enabling real-time visual communication [18].

3.3 Habits of Using Digital Media

DHH individuals use digital media increasingly for various purposes, from social interaction, information access to entertainment. Research indicates that DHH users use social media platforms frequently to connect with their community and share experiences [19, 20]. DHH users particularly value video content with subtitles, text transcriptions or sign language for improved understanding. The shift to digital media has also seen a rise in the use of mobile applications tailored to DHH needs, such as those for real-time captioning and sign language interpretation [21, 22, 23].

3.4 Challenges in Using Digital Media

Despite many benefits, DHH individuals also encounter challenges in the digital environment. Accessibility is a common issue, as many digital platforms lack subtitles or sign language features [24, 25]. This can lead to social isolation and exclusion from mainstream digital interactions and content [26, 27]. Similar constraints arise in everyday occasions, such as public speeches, often conducted without an interpreter, and official information delivered to individuals via phone calls, posing significant barriers for DHH individuals. Another significant challenge is the lack of digital literacy training tailored to the DHH community, such as those in sign language [28].

4 Methodology

4.1 Procedure

This case study examines two DHH individuals in Slovenia, who were recruited through Associations of DHH people. The inclusion criteria were (a) Identification as a DHH individual, (b) Membership in associations of DHH people, (c) Active use of at least one social media platform, (d) Use of online media platforms, e.g., dostopno.si. We collected data using semi-structured joint interviews, providing a holistic view and direct observation of the participants` interactions [36, 37]. A sign language interpreter was present to ensure accurate communication and provide additional support and information. The interview took place at the Association of the Deaf and Hard of Hearing of the Podravje, Maribor unit, and was audio-recorded to facilitate the analysis of the interpreter's translation. The data were later transcribed and analysed according to Roblek [39].

4.2 Research Questions

The study focused on two main research questions:
(1) What is digital media literacy among elderly deaf individuals?
(2) How do elderly deaf individuals use digital media?

4.3 Participants

The interviewees were two deaf individuals residing in Slovenia, who belong to the group of elderly people aged 60 years or older. They were selected randomly from a larger sample of 12 participants, to present the preliminary results of the ongoing research study. Participant 1 (P1) is a 63 year old female with a hearing loss level of 96 dB. Her educational level is lower or vocational secondary. Participant 2 (P2) is a 60 year old female with a hearing loss level of 100 dB, and has primary school education. Both participants lost their hearing early in life and their primary language is Slovenian Sign Language.

4.4 Measuring Instrument

The measuring instrument consisted of several parts. Prior to participation, the participants were questioned on their demographic data (gender, age, education level), followed by data on their hearing loss (level of hearing loss, primary language, hearing loss history). Next, the participants were questioned on their use of digital media (social media and online media platforms). This part consisted of questions on their purpose of use, content creation, frequently encountered content and frequency of use.

The next section examined digital literacy [29, 30], digital media literacy [31, 32], and literacy about social media [33]. Lastly, the participants were also asked about their perception of the accessibility of digital media for DHH, as proposed by Maiorana-Basas & Pagliaro [34] and Kožuh & Debevc [35].

5 Results

5.1 Digital Media Literacy Among Elderly Deaf Individuals (RQ1)

Both interviewees demonstrated a satisfactory level of digital literacy. P1 uses only a phone, while P2 uses a computer and tablet, with a clear preference for the phone. Both have been using digital devices for years, learning about them informally. P1 learned to use them about 10 years ago with a partner's assistance, and P2 15 years ago with her son's help, and, later, at work. Neither expressed a desire to improve their digital literacy, believing their current skills were sufficient for their needs. Both rely on others for help when encountering difficulties (e.g., suspected money fraud), with P1 turning to her partner and P2 consulting an interpreter.

Both interviewees also follow traditional media, either television or newspapers. While critical thinking skills are a crucial part of media literacy, it is concerning that neither verified the veracity of the online content. P1 typically relies on acquaintances to check veracity, and has occasionally clicked on fake news due to its attractive content, though she did not share it. She mentioned, "I can tell when it is fake news". P2 is more suspicious of online content and fears internet scams, as

indicated by her concern about the dangers of Facebook: "There are more and more of these scams". Neither participant demonstrated an understanding of media bias and political influence on media impartiality.

Social media literacy was examined in regard to the proficiency in navigating the Facebook application. P2 showed a significantly greater proficiency, as she could navigate the main features (post, comment, share) with more ease and independence, but also caution. In contrast, P1 required more time, and showed some confusion, asking P2 for help in learning to post stories. Both participants acknowledged the positive impact of social media platforms on maintaining relationships and staying informed.

5.2 Use of Digital Media by Elderly Deaf Individuals (RQ2)

Both interviewees use social media platforms frequently, mainly in the morning. Occasionally, they access them multiple times a day. They both use Facebook, Facebook Messenger and WhatsApp, while P2 also uses Instagram and Imo. They use social media to browse content, communicate and interact with posts from other users, particularly those featuring gestures in photos or videos. One example is the travelling videos from fellow deaf individuals, which P2 finds interesting, and understands due to international gestures. Their primary reasons for using social media platforms are entertainment and staying updated with current events in their hometown. P2 also uses social media platforms for direct communication and occasional posting, such as photos and videos/stories of interesting things. Contrarily, P1 does not publish her own content.

The interviewees follow Slovenian online media portals, including rtvslo.si, dostopno.si, and 24ur.com, with P1 also using zurnal24.si. P2 also follows foreign, mainly Croatian, portals displayed in her Facebook feed. They access these portals once a day, usually in the morning, and seek mainly for information, but also entertainment. Both access online media content through social media platforms rather than direct searches. The content they typically encounter is genre-specific, including news, culture, entertainment, sports and arts. When asked about the media portal dostopno.si, a portal for people with disabilities, both expressed familiarity with it and past use, as they require the presence of an interpreter to understand the content.

The interviewees were also asked about the accessibility and adaptation of the said social media platforms and online media portals for the needs of deaf people, which they both agreed were sufficient. Nevertheless, P2 has had difficulties with verbal communication, as she finds it difficult or impossible to understand speech without gestures.

We observed that neither participant understood the importance of media impartiality. They also failed to avoid fake news, often clicking on links and reading the content (for P2 there is a possibility that she would believe the content). When asked about information, neither of them checks information from different online media sources. They do ask acquaintances about the veracity, but even they cannot know for sure if a certain piece of information is really accurate. The fact that the interviewees do not seek out media content intentionally, but only access it via social media platforms, might also contribute to their lower media literacy. This leads us to conclude that the interviewees might not think critically, and we might therefore classify their digital media literacy as lower. Their lack of understanding of it does not bother them, nor do they wish to improve their digital media literacy. We believe that they may be compelled to use social media platforms (e.g., WhatsApp, Facebook Messenger) and to follow the online media portal dostopno.si, as they cannot communicate or inform themselves otherwise, no matter how well they understand digital media.

6 Discussion

To assess the interviewees' digital media literacy, we focused on answering two Research Questions. Both participants have exhibited a moderate level of digital literacy (RQ1). Despite their age and long-term hearing loss, they adapted to using digital devices and social media platforms, learning informally through family members and work experiences. However, they lacked critical thinking skills, a key component of media literacy. Neither of the interviewees verified the accuracy of online content, indicating a gap in their digital literacy abilities. It is important to note that the primary language of both interviewees is Slovene sign language, while social media platforms and most online media portals are based on text-based communication. An exception is the online media portal dostopno.si, which the interviewees know, and use mainly because the video content has an interpreter subtitling and transcripts.

Both interviewees are active users of social media platforms and digital media platforms (RQ2). They use social media platforms frequently (e.g., Facebook, WhatsApp) and mobile apps for communication (e.g., Imo). They use it for browsing content, communication, and interacting with posts, especially those that include images and videos with gestures for better understanding. There was a notable difference in content creation habits, as one participant frequently published her own content and the other avoided such behaviour.

Following these findings, the connection between the use of digital media and digital media literacy is unclear. Although both interviewees were cautious in using social media, they exhibited different levels of proficiency. P2, who shows higher digital literacy, engages more actively and confidently with digital media, creating and sharing content regularly. She is proficient in using multiple devices and platforms, indicating a higher level of digital literacy compared to P1. In contrast, P1's lower engagement and more passive consumption of digital media reflect her more limited digital literacy. Both interviewees follow various online media portals for information and entertainment, accessing content primarily through social media platforms rather than searching for it.

Based on Lin et al`s (2013) indicators of digital media literacy, both interviewees fall into the functional category. Neither can be classified as critically consuming or critically prosuming, although P1 exhibits some skepticism towards fake news. Both possess the technical skills necessary for functional consuming, with P1 proficient in using a phone, the internet and social media platforms, and P2 is also competent with a computer and tablet. P2 additionally fits into the functional prosuming category, due to her active content creation on social media platforms. Despite initial help from family members, she now

shares photos and videos independently, underscoring her functional literacy.

Apart from the small sample size, an important limitation of this study are potential misunderstandings due to the presence of an interpreter during data collection. This may result in misinterpretations of expressions between the interviewees and the interviewer.

7 Conclusions

Our study reveals that digital media literacy is crucial in using digital media effectively. The interviewees' limited digital media literacy led to less critical and cautious use of digital media. This study identified the social media platforms and online media portals they use, as well as their reasons and ways of use. The most important reasons for using them were communication, entertainment, and information. We found that higher digital media literacy may increase their presence in the digital environment, as well as enhance their understanding of digital devices and media.

Acknowledgments

We extend our sincere gratitude to the two interviewees for their insights and participation in the interview. We also thank the Association of the Deaf and Hard of Hearing of the Podravje (Društvo gluhih in naglušnih Podravja) for their invaluable support and contribution to this study.

References

[1] Julio Abascal, Simone D. J. Barbosa, Colette Nicolle and Panayiotis Zaphiris. 2016. Rethinking universal accessibility: A broader approach considering the digital gap. *Universal Access in the Information Society* 15, 2 (2016), 179–182.

[2] Nathan Shelena Soosay, Hussain Azham and Hashim Nor Laily. 2016. Studies on deaf mobile application: Need for functionalities and requirements. *Journal of Telecommunication, Electronic and Computer Engineering* 8, 8 (2016), 47–50.

[3] Sora Park. 2011. Access to digital devices and its relationship to digital media literacy. In *Proceedings of the Communications Policy and Research Forum* (Sydney, Australia, Nov. 7–8, 2011).

[4] Eric M. Meyers, Ingrid Erickson and Ruth V. Small. 2013. Digital literacy and informal learning environments: an introduction. *Learning, Media and Technology 38, 4 (2013), 355–367.*

[5] David Buckingham, Shaku Banaji, Andrew Burn, Diane Carr, Sue Cranmer and Rebekah Willett. 2005. *The media literacy of children and young people*. London, UK: Ofcom.

[6] Andrey Glukhov and Yuliya Stakhovskaya. 2021. Social media platform digital literacy.

[7] Laurel J. Felt and Michael B. Robb. 2016. *Technology addiction: Concern, controversy, and finding balance*. San Francisco, CA: Common Sense Media.

[8] Yolanda R. Chassiakos, Jenny Radesky, Dimitri Christakis, Megan A. Moreno, and Corinn Cross. 2016. Children and adolescents and digital media. *Pediatrics* 138, 5 (2016).

[9] Tzu-Bin Lin, Jen-Yi Li, Feng Deng and Ling Lee 2013. Understanding new media literacy: An explorative theoretical framework. *Journal of Educational Technology & Society* 16, 4 (2013), 160–170.

[10] Wasson Haidee. 2009. Convergence culture: Where old and new media collide. *Film Quarterly 62, 4 (2009), 84*

[11] Henry Jenkins and Mark Deuze. 2008. Convergence culture. *Convergence 14, 1 (2008), 5–12.*

[12] Der-Thanq "Victor" Chen and Jing Wu. 2011. New media literacy in the 21th century society: Key findings, gaps and recommendations. *National Association for Media Literacy Education*, Philadelphia, PA, USA.

[13] Zveza društev gluhih in naglušnih Slovenije (ZDGNS). n.d. Gluhost. Accessed on: https://zveza-gns.si/o-zvezi/o-gluhoti/

[14] Lorraine Leeson, Jemina Napier, Tobias Haug, Teresa Lynch and Haaris Sheikh. 2021. Access to justice for deaf signers: The Justisigns project. In *UNCRPD Implementation in Europe—a deaf perspective: Article 9: Access to information and communication*, 161–175. European Union of the Deaf.

[15] Zakon o uporabi slovenskega znakovnega jezika (ZUSZJ). 2002. *Uradni list RS*, 96/02. Accessed on: https://pisrs.si/pregledPredpisa?id=ZAKO1713

[16] Jasna Bauman, Veronika Ciglar, Darja Holec, Matjaž Juhart, Damjana Kogovšek, Stanislav Košir, Marjetka Kulovec, Martina Ozbič, Petra Rezar and Andreja Žele. 2009. *Stanje slovenskega znakovnega jezika: ekspertiza*. Zavod Združenje tolmačev za slovenski znakovni jezik.

[17] Laura Horvat. 2021. *Slovenski znakovni jezik in njegova uporaba na javnem radiotelevizijskem servisu v Sloveniji (RTV SLO)* Bachelor's thesis. Univerza v Mariboru, Fakulteta za elektrotehniko, računalništvo in informatiko. Accessed on: https://dk.um.si/Dokument.php?id=152687&lang=slv

[18] Maartje De Meulder and Nienke Sijm. 2024. "I feel a bit more of a conduit now": Sign language interpreters coping and adapting during the COVID-19 pandemic and beyond. *Interpreting and Society* 4, 1 (2024), 3–25.

[19] Ines Kožuh, Manfred Hintermair, Andreas Holzinger, Zala Volčič and Matjaž Debevc. 2015. Enhancing universal access: deaf and hard of hearing people on social media platforming sites. *Universal Access in the Information Society* 14 (2015), 537–545.

[20] Muhammad Ali and Anza Nasir. 2023. Investigating the Social Media Practices among Aurally Challenged Students (ACS): The challenges and issues. *Human Nature Journal of Social Sciences* 4, 1 (2023), 518–532.

[21] Ehsan Toofaninejad, Esmaeil Zaraii Zavaraki, Shane Dawson, Oleksandra Poquet and Parviz Sharifi Daramadi. 2017. Social media use for deaf and hard of hearing students in educational settings: A systematic review of literature. *Deafness & Education International* 19, 3–4 (2017), 144–161.

[22] Jess A. Cuculick. 2014. Facebook among deaf college students: *Deaf-gain and funds of knowledge*. Ph.D. Dissertation. University of Rochester.

[23] Emem P. Udofia, Daniel A. Aloysius and Victoria David Jimmy. 2017. Internet Resources And Information Literacy Of Hearing And Speech Impaired Students In Nigerian Academic Libraries. *Computing & Information Systems* 21, 1 (2017).

[24] Andrew Solomon. 2012. *Far from the Tree: Parents, Children and the Search for Identity*. Simon and Schuster. Accessed on: http://archive.wilsonquarterly.com/sites/default/files/articles/24_CBFarfromtheTree.pdf

[25] David M. Frost 2011. Social stigma and its consequences for the socially stigmatized. *Social and Personality Psychology Compass* 5, 11 (2011), 824–839.

[26] Margaret P. Brown and Andrew Cornes 2015. Mental health of deaf and hard-of-hearing adolescents: What the students say. *Journal of Deaf Studies and Deaf Education* 20, 1 (2015), 75–81.

[27] Sylvia Olsson. 2021. *Longing to belong: Deaf and hard of hearing young adults' social interaction, social relationships, and identity*. Doctoral dissertation. Mälardalen University. Accessed on: https://www.diva-portal.org/smash/get/diva2:1566410/FULLTEXT02

[28] Mary Rudner, Josefine Andin, Jerker Rönnberg, Mikael Heimann, Anders Hermansson, Keith Nelson and Tomas Tjus. 2015. Training literacy skills through sign language. *Deafness & Education International* 17, 1 (2015), 8–18.

[29] Sarah Soyeon Oh, Kyoung-A Kim, Minsu Kim, Jaeuk Oh, Sang Hui Chu and JiYeon Choi. 2021. Measurement of digital literacy among older adults: systematic review. *Journal of Medical Internet Research* 23, 2 (2021), e26145.

[30] Kristīne Mackare and Anita Jansone. 2018. Habits of Using internet and digital devices in education. In SOCIETY. INTEGRATION. EDUCATION: *Proceedings of the International Scientific Conference*, vol. 5, 348–356.

[31] Katherine N. Hayles. 2012. How we think: *Digital media and contemporary technogenesis*. University of Chicago Press.

[32] Dirk Jahn and Alessandra Kenner. 2018. Critical thinking in higher education: how to foster it using digital media. In *The Digital Turn in Higher Education: International Perspectives on Learning and Teaching in a Changing World*, 81–109.

[33] Andreas M. Kaplan and Michael Haenlein. 2010. Users of the world, unite! The challenges and opportunities of Social Media. *Business Horizons* 53, 1 (2010), 59–68.

[34] Michella Maiorana-Basas and Claudia M. Pagliaro. 2014. Technology use among adults who are deaf and hard of hearing: A national survey. *Journal of Deaf Studies and Deaf Education* 19, 4 (2014), 400–410.

[35] Ines Kožuh and Matjaž Debevc. 2018. Challenges in social media use among deaf and hard of hearing people: In *Social Media Platforms Science: Design, Implementation, Security, and Challenges: From Social Media Platforms Analysis to Social Media Platforms Intelligence*, 151–171.

[36] Graham Allan. 1980. A Note on Interviewing Spouses Together. *Journal of Marriage & Family* 42, 1 (1980).

[37] Hilary Arksey. 1996. Collecting data through joint interviews. *Social Research Update* (15).

[38] Julie Seymour, Gill Dix, and Tony Eardley. 1995. *Joint Accounts: Methodology and Practice in Research Interviews with Couples*. Social Policy Research Unit, University of York.

[39] Vasja Roblek. 2009. An Example of Performing a Text Analysis in a Qualitative Research). *Management 4, 1 (2009), 53–69.*

Innovative Technological Solutions for Cities as a Response to the Challenges of Multimodal Mobility for All Citizens

Inovativne tehnološke rešitve mest kot odgovor na izzive multimodalne mobilnosti za vse prebivalce

Jani Demšar
Cartography
Geodetic Institute of Slovenia
Jamova cesta 2
Ljubljana, Slovenia
jani.demsar@gis.si

Marina Lovrić
Spatial Management
Geodetic Institute of Slovenia
Jamova cesta 2
Ljubljana, Slovenia
marina.lovric@gis.si

Roman Rener
Cartography
Geodetic Institute of Slovenia
Jamova cesta 2
Ljubljana, Slovenia
roman.rener@gis.si

Abstract

Mobility is a fundamental right of all people, crucial for social participation, as recognized also by the UN Convention on the Rights of Persons with Disabilities. Despite this, persons with disabilities often face challenges when using public spaces and transport. This paper emphasizes the importance of physical accessibility, digital tools, and stakeholder collaboration to foster inclusivity. Using mixed-methods approach, including data cataloguing, field verification, surveys, and workshops, the study highlights the need for comprehensive data integration and accessible infrastructure to support independent mobility for persons with disabilities. It is important to approach and develop mobility solutions for people with disabilities. These include methodology implementation, standards, pilot testing, adaptation, and integration of the entire system in the country, and the knowledge transfer to all stakeholders.

Keywords

multimodal mobility, spatial data, persons with disabilities, public transport, accessibility

1 Introduction

Mobility is a fundamental aspect of human life, enabling individuals to navigate their environments and actively participate in society. This right to independent movement extends to everyone, regardless of personal circumstances. The United Nations Convention on the Rights of Persons with Disabilities guarantees this fundamental right to independent mobility for persons with disabilities (PwD) [1]. However, PwD often face significant barriers when navigating public spaces and utilizing public transportation.

Digital data play a crucial role in supporting efficient multimodal mobility, especially when it comes to understanding the entirety of the system, from standards to implementation. Real-time route planning apps that consider accessibility needs, designated accessible parking information, and integrated ticketing systems across various transportation modes facilitate independent mobility. The primary aim of this paper is to explore innovative technological solutions that can bridge the gap between current challenges and the vision of inclusive urban mobility.

Furthermore, this paper presents research based on key projects including, "Enabling Multimodal Mobility for Persons with Various Disabilities" [3], "Spatial Data Support for Public Passenger Transport Management – Persons with Disabilities in Public Passenger Transport" [4] and "Analysis of Conceptual Designs of Information and Technical System Support for Persons with Disabilities to Increase Social Inclusion" [4]. These projects provide insights into the current state of accessibility of public spaces and public transport infrastructure, addressing the specific experiences of PwD.

2 Methods

Understanding the travel needs of PwD is crucial for planning cities with effective public transport, accessible public spaces, and diverse options for multimodal mobility. We employed a mixed-methods approach in our research to address this topic. We developed various methodologies and object catalogues for data capture in the office. We developed methodologies for the four groups focused on in the project, such as persons with mobility impairments, persons with visual impairments, the deaf and those with hearing impairment, and the elderly. We have covered the elements related to the mobility and accessibility of the space for these people in the object catalogue. In the catalogue, elements are described as attributes with corresponding values. All elements are depicted in real-life scenarios with maps and photos, providing precise locations and real-world contexts. With the help of catalogues, we captured data in the office on a desktop computer with an Open-Source

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

https://doi.org/10.70314/is.2024.DIGIN.2

Geographic Information System (GIS) program tool. We used the latest orthophoto in Slovenian national coordinate system D96/TM with an accuracy of 0.25 m as the basis for captured data as background.

For this purpose, we created libraries composed of thematic characters, which we took from the object catalogues of the project. Verification of captured field data was carried out using a digital approach; with open-source mobile data capture application for Android, iOS, and macOS. Field data verification was supported by persons with mobility impairments as a participatory method. We created data capture layers that include areas for data capture, physical barriers (both permanent and temporary), routes, public facilities, parking spaces for PwD, bus stops and railway stations, as well as points of interest. Each layer contains different types of data. For example, for paths, we captured information on sidewalks, roads without sidewalks, bicycle paths, pedestrian crossings, tactile pavement elements, building edges, green spaces, fences, and stairways. Data on physical barriers includes obstacles such as steps, high curbs, hazardous objects on paths, unsuitable surfaces, traffic signs blocking sidewalks, low pegs, and movable barriers like parked cars, flower beds, advertising boards, and outdoor seating from restaurants. Temporary obstacles, such as construction sites, were also documented, including details on the duration of closures for excavation works. Additionally, we captured location data of accessible toilets for PwD, and accessibility of public transport (e.g. accessibility of bus stops and vehicles) to support route planning.

To better understand the travel habits, experiences with different modes of transport and the willingness to use the "on-call transport model among people with disabilities, we conducted a survey. The survey was conducted using the online platform - 1ka, chosen for its user-friendly interface, open-source nature, and accessibility features that cater to users with visual impairments. To ensure comprehensive data capture and increase survey participation, we employed two supplementary methods. The first method involved collecting data at social events organized by organizations for people with disabilities, allowing us to engage closely with respondents and gather opinions and information in a more informal setting. The second method involved collecting data through employment centres that cater to PwD. In both cases, respondents were given the option to complete the questionnaire either online or in person.

Finally, we conducted various workshops with persons with different types of disabilities, including those with mobility impairments, the blind and visually impaired, and the deaf and hard of hearing. These workshops were organized as focus groups, where we facilitated guided conversations through specific questions to gather as much useful information as possible. These sessions provided us with in-depth insights into how PwD navigate through different environments, how they use assistive devices, and how they prepare for travel and use public transportation. We also gained new knowledge about various technological aids and applications.

2.1 Volunteer Graphic Information for Data maintenance

For data maintenance, we used the participatory data maintenance method. We relied on similar voluntary data capture tests that have already been carried out, such as research conducted by Triglav Čekada and Radovan [6]. Participatory data maintenance is the editing and maintenance of data after the completion of data capture. Emphasis is placed on the participation of various PwD, who are often ignored in wider research or data capture. Many research projects confirm that people respond positively to changes when they are offered the opportunity to actively participate [7] in decision-making or spatial planning. The approach to data capture was based on Volunteer Geographic Information (VGI), as a new source of geospatial data. Term Volunteer Geographic Information is relatively new according to Goodchild, and it is understood as geographic data created and contributed voluntarily by individuals, often through online platforms and mobile technologies [8]. Numerous studies show that GIS, through the use of smart mobile phones, has established itself as an effective tool for ensuring participation [9][10][11][12]. This technology allows residents to actively contribute to shaping their living environment through mobile GIS applications, by capturing and sharing spatial data in real-time [13][14].

Figure 1: Demonstration of a data capture workshop.

3 Results

As highlighted in the previous chapter, we captured data for four groups of PwD included in the project. This data was then entered into the database, organized topologically, and verified for suitability in navigation applications. To visualize the captured data, we developed the Web Accessibility Viewer - a web-based GIS tool equipped with basic functionalities for displaying and defining the properties of the various layers.

Our database currently contains data for 79 municipalities, covering all groups of PwD considered in the project. The captured data includes 3,170 parking spaces designated for PwD and 5,100 physical barriers, such as dropped kerbs, inadequate ramps, unsuitable pavement surfaces, and obstructions on paths. Additionally, we have documented 1,650 accessible bus stops and 59 railway stations. In terms of public facilities, there are 4,750 identified, of which 288 have accessible toilets for PwD. For individuals with sensory impairments, 508 audible traffic signals and 921 tactile pavement elements have been captured. Furthermore, we have captured data on 712 points of interest across the municipalities.

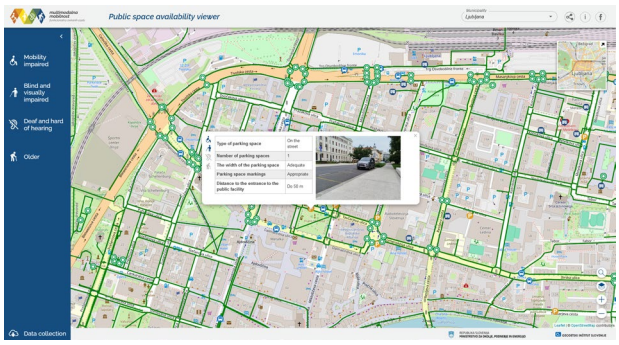

Figure 2: Web Accessibility Viewer displaying parking place from data bases.

Analysis of the survey responses highlighted current challenges in public transport, the experiences and travel habits of the respondents, as well as their actual intention to use the "on-call transport" service. A total of 921 respondents participated in the survey. The majority of respondents are from urban areas of Slovenia, more specifically Ljubljana, Maribor, Celje, Kranj, and Novo mesto.

We understand the "on-call transport" service as a service that provides transportation from the starting point to the endpoint of a journey, with both points being within the operational area of the call center. If a passenger travels outside this area, the service offers transport to the nearest accessible public transport station. This allows passengers to continue their journey using other forms of public transport, enhancing their mobility and access to a broader area. It is essential to mention that the "on-call transport" model acts as a bridge between individual transport and complements existing public transport systems.

The "on-call transport" service not only supports the independence and improves mobility of vulnerable groups but also strengthens their social inclusion and independence. Although originally designed for the transportation of PwD, the "on-call transport" service has the potential to benefit the wider community. It presents a solution that could be adapted for other vulnerable groups, such as the elderly, children, or those without private transportation in remote areas.

The majority of respondents expressed interest in using "on-call transport" if the advance notice period was 12 hours or less. A small number of respondents indicated that they would consider replacing their personal car with "on-call transport" if given the option.

Our data analysis showed that most of respondents are employed, which is probably the consequence of distributing the survey in employment centers to capture a wide range of individuals with diverse experiences and travel habits. Retirees represent the second largest group, while students and self-employed individuals constitute the smallest portion of respondents.

The analysis of field data capture, survey findings and different workshops reveals that public transport accessibility for PwD is often inadequate. Respondents cited unreliability, inaccessibility, and poor organization as some of the most significant issues, leading many to prefer using personal cars over public transport. Most stations and intercity public transport vehicles are inaccessible, as highlighted also by the Advocate of the Principle of Equality in Special Reports [15][16]. However, urban areas tend to be more accessible and the overall situation is gradually and consistently improving.

4 Discussion

As we previously established, digital data on the accessibility of public spaces and infrastructure can be captured both methodically and in a participatory way, when shared by PwD via smart mobile phones using a GIS app, thus becoming part of big data. We define big data as large-scale datasets originating from heterogeneous sources and collected in the urban environment using sensors integrated in an Internet of Things (IoT) system [17]. An IoT system combines devices such as smartphones and different sensors into a single network connected to a common server. As central elements of the IoT, sensors enable cities to collect real-time data from public transport usage and traffic flow analysis to energy consumption and weather conditions [18]. Advanced analytics tools can process and correlate this data to extract useful information to improve city planning and management decisions [19].

The importance of big data in the context of accessibility is multi-layered. These data enable the analysis and understanding of mobility patterns, use and accessibility of public spaces and infrastructure. With the help of this data, administrations or urban planning and design professionals can identify areas where improvements of accessibility are needed. Moreover, big data allows for a dynamic response to the needs of the population, as it can detect and predict changes in mobility and space use patterns. Providing accurate, real-time information on accessibility of public transport using big data improves travel planning options for PwD. This not only reduces the risk of encountering unexpected barriers, but also highlights the importance of big data in the design and planning of more accessible and inclusive public spaces. The Ljubljana Passenger Transport's Urbana mobile app is a good example of the use of big data and sensor technologies in practice, as it allows users in need of an accessible bus to order transport for a specific time and location, while the location of the bus can be monitored in real time directly through the app.

The integration of different databases which include data on accessibility and data on public passenger transport is essential for improving and enabling independent mobility of PwD. Combining data on accessible bus locations, accessible station locations, accessible sidewalks and physical barriers, and timetables allows people with different disabilities to access key information for route planning. All data are in standard format for GIS and can be converted for various application use.

To successfully implement knowledge into practice and ensure accessible public spaces, efficient public transport, and other mobility options within the context of multimodal mobility, cooperation among stakeholders at local, regional, and national levels, as well as experts in spatial planning, is essential. For digital data on accessibility of public spaces and infrastructure to be useful and effectively integrated into various systems, collaboration with urban planners, public transport operators, organizers of on-demand transport services, and representatives of PwD is necessary. This collaborative approach will help address the shortcomings and contribute to the improvement of data in the future.

5 Conclusion

In an era of rapid technological transformation, urban population growth, and ageing population, urban design faces increasing challenges to create spaces that are accessible and inclusive. The rise in the number of individuals with disabilities necessitates barrier-free access to public spaces. Over the past decade, we have witnessed a transition from traditional city concepts to the design of dynamic and adaptable urban environments. This shift is not merely physical but represents a profound change in our approach to urban design.

By centering the design process around people and leveraging innovative technological solutions, cities are becoming not only technologically advanced but also inclusive and responsive to the needs of their inhabitants. This new paradigm prioritizes accessibility and inclusiveness, ensuring that urban spaces accommodate everyone, regardless of their physical abilities. Through this approach, we are crafting cities that embody the principles of universal design, fostering environments where all individuals can thrive and participate fully in society.

The article describes the approach to the development of the entire system from methodology, standards, the use of new technologies and building a base for the purpose of mobility of persons with disabilities. It is especially worth emphasizing the involvement, sharing knowledge and collaboration between system developers and users.

In this context, technological solutions play a pivotal role in advancing multimodal mobility and enhancing urban accessibility. The integration of various transportation options such as walking, cycling, and public transit requires seamless coordination facilitated by cutting-edge technologies. Real-time data, smart infrastructure, and advanced analytics are transforming how cities manage and optimize their transportation networks.

Acknowledgments

We would like to extend our sincere thanks to the Ministry of Environment, Climate, and Energy for funding the project "Enabling Multimodal Mobility for Persons with Various Disabilities" for eight consecutive years, allowing us to improve and raise awareness about the importance of accessible environments.

We are also grateful to The National Council of Disability Organizations of Slovenia for their extensive support in implementing the project "Spatial Data Support for Public Passenger Transport Management – Persons with Disabilities in Public Passenger Transport."

The authors of the article would also like to thank the Slovenian Research and Innovation Agency (ARIS) and the Ministry of Labour, Family, Social Affairs and Equal Opportunities (MDDSZ), who financing the research project entitled "Analiza konceptualnih zasnov informacijske in tehnične sistemske podpore invalidom za povečanje socialne vključenosti" No. V2-2252, targeted research program "CRP-2022", made it possible to carry out part of the research and results of this article.

Note that there is a section break at the end of references to balance the columns (and this text is a part of the new section). If you have no space left at the end of your paper, you can delete it.

References

[1] United Nations. 2006. Convention on the Rights of Persons with Disabilities. Treaty Series, 2515, 3. Retrieve 12 Jul. 2024 from https://www.un.org/en/development/desa/population/migration/generalassembly/docs/globalcompact/A_RES_61_106.pdf

[2] Luis G. Natera Orozco, Laura Alessandretti, Meead Saberi, Michael Szell, and Federico Battiston. 2022. Multimodal Urban Mobility and Multilayer Transport Networks. *Environment and Planning B: Urban Analytics and City Science*. 50(8), 2038-2070 DOI: https://doi.org/10.1177/23998083221108190.

[3] Roman Rener, Jani Demšar, Marina Lovrić, Miran Janežič, in Helena Žnidaršič. 2022. Omogočanje multimodalne mobilnosti oseb z različnimi oviranostmi: končno poročilo. Ljubljana: Geodetski inštitut Slovenije

[4] Marina Lovrić, Maruša Vertačnik, in Roman Rener. 2023. Prostorska podatkovna podpora upravljanju javnega potniškega prometa – Invalidi v javnem potniškem prometu: končno poročilo. Ljubljana: Geodetski inštitut Slovenije.

[5] Katja Oven, Roman Rener, Dalibor Radovan, Marina Lovrić. 2022. Analiza konceptualnih zasnov informacijske in tehnične sistemske podpore invalidom za povečanje socialne vključenosti. Vmesno poročilo ciljnega raziskovalnega projekt št. V2-2252.

[6] Mihaela Triglav Čekada, Dalibor Radovan. 2019. Comparison of the volunteered geographic information usage to monitor floods and earthquakes. *Geografski vestnik*. 127-135(2). DOI: https://doi.org/10.3986/GV91207

[7] Rachael Luck. 2018: Inclusive design and making in practice: Bringing bodily experience into closer contact with making. *Design Studies*. Volume 54, 96–119. DOI: https://doi.org/10.1016/j.destud.2017.11.003

[8] Michael F. Goodchild. 2007. Citizens as sensors: the world of volunteered geography. *GeoJournal*. 69, 211–221. DOI: https://doi.org/10.1007/s10708-007-9111-y

[9] Renee Sieber. 2006. Public Participation Geographic Information Systems: A Literature Review and Framework. *Annals of the Association of American Geographers*. 96:3, 491-507, DOI: https://doi.org/10.1111/j.1467-8306.2006.00702.x

[10] Maria Antonia Brovelli, Marco Minghini, in Giorgio Zamboni. 2016. Public participation in GIS via mobile applications. *ISPRS Journal of Photogrammetry and Remote Sensing*. 114. 306-315. DOI: https://doi.org/10.1016/j.isprsjprs.2015.04.002

[11] Raquel Pérez-delHoyo, Maria Dolores Andújar Montoya, Higinio Mora and Virgilio Gilart Iglesias, 2018. Citizen Participation in Urban Planning-Management Processes - Assessing Urban Accessibility in Smart Cities. In *Proceedings of the 7th International Conference on Smart Cities and Green ICT Systems – SMARTGREENS*. 206-213. DOI: https://doi.org/10.5220/0006704202060213

[12] Katarzyna Roszewska. 2021. Geographic information systems and accessibility for persons with disabilities. *GIS Odyssey Journal*. 1(2), 21–29. DOI: https://doi.org/10.57599/gisoj.2021.1.2.21

[13] Aimi Hamraie. 2018. Mapping Access: Digital Humanities, Disability Justice, and Sociospatial Practice. American Quarterly. 70. 455-482. DOI: https://doi.org/10.1353/aq.2018.0031

[14] Sultan Kocaman and Nadire Ozdemir. 2020. Improvement of Disability Rights via Geographic Information Science. *Sustainability* 12, no. 14: 5807.DOI: https://doi.org/10.3390/su12145807

[15] The Advocate of the Principle of Equality. 2023. Inaccessibility of Public Inter-Urban Bus service for Persons with Sensory Disabilities. Retrieve 17 July 2024 from https://zagovornik.si/wp-content/uploads/2024/02/Special-Report_Inaccessibility-of-Public-Inter-Urban-Bus-Service-for-Persons-with-Sensory-Disabilities.pdf

[16] The Advocate of the Principle of Equality. 2023. Inaccessibility of Public Inter-Urban Bus service for Persons with reduces mobility. Retrieve 17 July 2024 from https://zagovornik.si/wp-content/uploads/2024/01/2023-11-23-Posebno-porocilo_Nedostopnost-javnega-medkrajevnega-avtobusnega-prevoza-za-gibalno-ovirane_EN1.pdf

[17] Elvira Nica, Gheorghe H. Popescu, Milos Poliak, Tomas Kliestik, and Oana-Matilda Sabie. 2023. Digital Twin Simulation Tools, Spatial Cognition Algorithms, and Multi-Sensor Fusion Technology in Sustainable Urban Governance Networks. *Mathematics* 11, no. 9: 1981. DOI: https://doi.org/10.3390/math11091981

[18] Amardeep Das, Sumanta Mishra Sharma, and Bikram Ratha. 2019. The New Era of Smart Cities, From the Perspective of the Internet of Things. *Smart Cities Cybersecurity and Privacy*. 1-9. DOI: 10.1016/B978-0-12-815032-0.00001-9.

[19] Michael Batty. 2016. Big Data and the City. *Built Environment*. 42. 321-337(17). DOI: https://doi.org/10.2148/benv.42.3.321.

The role of communication skills in the development of digital literacy competences using the "DigInGreen" model

Mateja Forte†
Faculty of logistics
University of Maribor
Celje, Slovenia
mateja.forte@um.si

Matevž Obrecht
Faculty of logistics
University of Maribor
Celje, Slovenia
matevz.obrecht@um.si

Bojana Slomšek Šlamberger
Faculty of logistics
University of Maribor
Celje, Slovenia
bojana.slomsek@um.si

Abstract / Povzetek

The paper deals with the field of developing communication and digital literacy with the help of the lifelong learning model "DigInGreen" for all layers of modern society, including people with special needs. The aim of the authors is a targeted search for new solutions in the field of using digital learning and communication tools for the development of digital competences in the light of "Society 5.0". We focus on a unique way of connecting paradigms, such as: inclusive society, competences, digital, special needs, literacy and lifelong learning. We want to connect the thinking about the communicative ability, an indispensable part of which is an individual's digital literacy and point out, that the circumstances of living in a modern, but still partially exclusive society, limit the development of an individual's communicative and digital literacy, due to a demonstrated special need or disability. We believe, that the activities we carry out, are a unique example of good practice, because they connect many scientific disciplines and fields into a modern concept of competence development without excluding or conditioning the end user. We combine the paradigms of logistics, informatics, statistics, social studies, linguistics and didactics. All the above and more represent the concept of "Society 5.0", which cannot exist as a scientific construct, if it does not consider the key aspect of one's own identification - social equality and the provision of equal opportunities.

Keywords / Ključne besede

communication ability, digital literacy, competences, inclusion, special needs, lifelong learning

1 Digital literacy is an exclusive component of developed communication skills

In the last few years, we have witnessed the rapid and general progress of the digitization process everywhere, including in education, which brings many opportunities, but also challenges, especially when it comes to the inclusion of people with special needs in the educational process. In the past, the field was more related to physical and intellectual challenges, but today it is increasingly focused on emotional, behavioral, psychosocial and sensory needs and the dilemmas, associated with them. One of them being the so-called digital literacy, meaning the ability of individuals to effectively use digital technologies and the internet to find, create, evaluate and communicate information. This includes understanding and using digital tools, such as computers, smartphones, applications and social networks as well as awareness of privacy, security and ethical issues in the digital environment. Digital literacy and digital tools therefore play a key role in achieving the goal of equal opportunities for all, as they can be completed by users in different periods of time, which are different for each individual and they help themselves in solving challenges with specialized learning or work tools (letter enlargement, volume, translation into another language, font transcription). In relation to the mentioned challenges, the overall aim of this paper is to connect very different research fields with the focus to find new solutions in the field of using digital learning and communication tools for the development of digital competences in the light of "Society 5.0".

1.1 Language and communication ability

We cannot talk about the concept of digital literacy without first talking about language and the communicative ability, because the latter represents the dividing line between human and other communicative codes. Language represents our means of communication, it is a code, that humans have developed, perfected, thereby enabling communication. Language is an agreed system of signs, which means, that it is a standardized communication code and leads to the realization, that language is not just an individual property, it is a social property. With this finding, ensuring the possibility of literacy development for the individual in all its forms and variations becomes a social responsibility. The latter is implemented not only in the home environment, but also in the process of education at the primary, secondary or tertiary level and in all forms of social interaction, including models of lifelong learning. When communicating, two processes always take place; encoding, creating a message and decoding or understanding and responding, to what is communicated. At the same time, we must assume, that both the communicator and the addressee have developed communication skills. These are the knowledge and abilities of both the addressee and the communicator to create any number of texts in a wide variety of speaking positions. The ability to communicate is an important part of a person's general ability, as it enables him/her to creatively adapt to new circumstances and needs. The ability to communicate therefore defines us through expression, communication with others and our social involvement. Above all, it determines our oral and written communication, both classic and digital. We can all be creators/communicators as well as addressees, but we can only cooperate with each other with

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

https://doi.org/10.70314/is.2024.DIGIN.3

developed communication skills. So, we learn the means, through which we enter the communication process.

2 Accessibility for developed communication and digital skills

Universal digitization enables adaptation of learning content and teaching methods, which can significantly improve accessibility to educational opportunities for people with special needs. We can highlight the example of online platforms and digital materials; these allow learners to access learning content in an adapted format, such as texts in larger fonts, audio recordings or video content with subtitles. In addition, interactive tools and applications can enable individual adaptation of the learning process, which increases the effectiveness of learning and the engagement of learners. The legal regulation in the field of education of people with special needs in Slovenia is based on the Act on Equalizing the Opportunities of the Disabled and the Act on the Guidance of Children with Special Needs. This legislation determines the rights and obligations of educational institutions regarding the provision of adaptations for people with special needs. In practice this means that institutions must ensure accessibility to all educational resources and services, including digital platforms and technologies, but sometimes legal commitments are a burden to institutions, as there is no guaranteed systemic funding for their implementation. With the successful implementation of education, we condition the development of competences and the latter can be applied to all final stakeholders, both people with special needs and people, who do not have demonstrated special needs. As far as we discuss the developed competences for digital literacy, of course we cannot bypass the models, that take care of the development of these competences. We have developed such a model.

3 A unique model of lifelong learning, that develops both green and digital competences

We start from the concept of a special example of good practice of lifelong education and learning of green and digital skills for all social groups. They were designed and developed at the Faculty of Logistics of the University of Maribor as part of the NOO project "DigInGreen". The acronym NOO defines the financial mechanism, namely the Recovery and Resilience Mechanism, from which operations, addressing the transition to a green, digital and resilient society are financed. As part of this project, the Faculty of Logistics of the University of Maribor has determined a research and development niche, that is aimed at the development of green and digital competences through lifelong learning and focus on various areas, which include both short-term and long-term goals for the development of social studies, information sciences and social skills. The short-term goals include training individuals to use digital literacy tools and practices, that improve the efficiency of many processes, while the long-term goals aim for the sustainable development and strengthening of digital literacy at all levels of the population, especially with an emphasis on understanding complex challenges and possible approaches for people with special needs. To ensure inclusive education, it is necessary to adapt teaching materials and methods, that enable equal access to knowledge and skills. For example, courses and workshops can include adapted digital interfaces, that are also accessible to people with visual or hearing impairments and tools, that enable easier management of digital content. We also know about the implementation of individual distance educations, that enable less mobile individuals to participate and do it more easily. Good practices include collaboration with various stakeholders, including non-governmental organizations, that liaise with people with special needs and developers of digital technologies to ensure comprehensive support and adaptations of learning content. In addition, it is important to promote lifelong learning and ensure constant updating of competences, which contributes to greater employability and inclusion of everyone, including people with special needs in the labor market. Digitization and the development of green and digital competences through lifelong learning are important steps towards ensuring equal opportunities for all, including people with special needs. With legal frameworks and good practices we can create an inclusive environment, that promotes sustainable development and digital literacy for everyone. But for this it would be necessary to actively increase financial resources and educate personnel about new approaches, advantages and tools for increasing an inclusive educational environment.

4 Acquired competences are the basis for developed communication skills with an emphasis on digital literacy

Digitization represents a major challenge, as the appropriate knowledge of users, including people with special needs, represents an essential pool of skills for the efficient operation of many processes. At the Faculty of Logistics of the University of Maribor, we prepare, develop and implement short workshops, that cover a wide variety of topics, such as: research into the management of sustainability and resilience in supply chains, digitization, interdisciplinary and applied knowledge. The use of skills in the field of digitization enables efficient data collection and analysis, as well as high-quality tracking and optimization of various processes. With the appropriate knowledge for all users, we want to get closer to up-to-date and reliable information. In lifelong education and learning within the "DigInGreen" model, we focus on offering all interested participants educational workshops in the field of digitization, such as: planning and implementation of digitization, use of simulation tools as decision support, information and computer security, use of artificial intelligence tools, information and digital literacy, methods of communication, creation of video content. We enable participants to study selected topics in depth and participate in concrete tasks and practical examples. This type of method of implementing the lifelong learning model has proven to be very successful in imparting and acquiring new knowledge and skills. As an educational institution, we see the development of lifelong learning according to the "DigInGreen" model in using digital tools with the end user in mind, including users with special needs.

4.1 Model implementation

Our most effective and also the most innovative form of work or activity is the framework of the workshops, that we offer as part of the project. All of them are innovative in terms of content, as they all address topics, that are strongly related to “Society 5.0”. The main ideas are: digital, sustainable and resilient. All workshops are interconnected and together provide a comprehensive insight into the topic of sustainable and digitalized future for all walks of society. Their innovation lies in the method of imparting knowledge, as it is not a lecture.

These are experiential workshops, that encourage participants to come to certain insights on their own. Former concepts of learning and teaching have been abandoned and learners need experiential learning to quickly assimilate the elements, that then make up the so-called “micro education”.

4.2 Following the principles of an egalitarian society – “Society 5.0”

The “DigInGreen” lifelong learning model is defined by the principles of the “Society 5.0”, therefore an egalitarian society in its entirety. We follow: equal opportunities; all stakeholders of our project - participants in the planning of activities, implementation of workshops, participation in workshops - have the same opportunities to participate. Our basic criteria are the demonstrated area competence of the individual and potential gaps in knowledge. We offer all interested parties’ equal opportunities to participate in the project. Non-discrimination; we treat individuals equally. Individuals are not compared to someone else because of gender, nationality, race or ethnic origin, religion or belief, disability, age, sexual orientation or other personal circumstance. Accessibility for the disabled and people with special needs; for all participants in the activities of the “DigInGreen” lifelong learning model we provide suitable materials, that contribute to the development of their digital and communication skills, using appropriate teaching methods and ensuring the correct guidance.

4.3 Model performance analysis

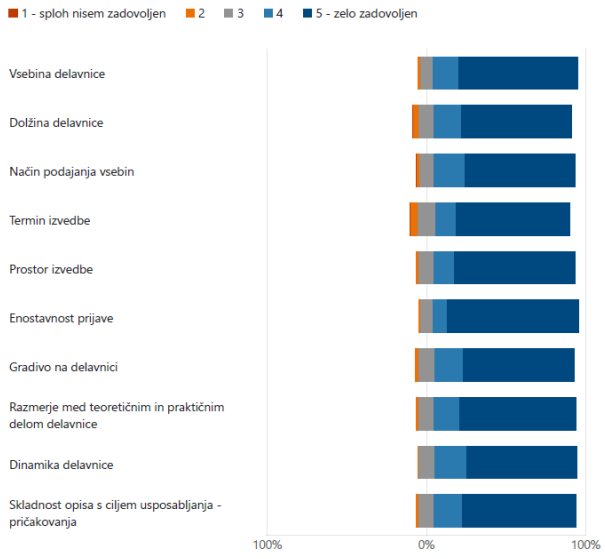

Figure 1: Model performance analysis

In order to determine the effectiveness of the proposed model of lifelong learning and education to improve sustainable and digital literacy within different social groups, we conducted an analysis of satisfaction at the level of the participant. In the sample, we analyzed the following parameters: content of the workshop, length of the workshop, method of delivering content, place of performance and its accessibility, ease of registration, accessibility of material, relationship between theoretical and practical elements, dynamics and compliance with individual expectations. 66 % of the participants expressed their intention to deepen and upgrade the knowledge they acquired at the workshop. 95 % of them will also recommend participation in the workshop to their colleagues, acquaintances and business partners. Most of the participants pointed out that at the attended workshop they upgraded their existing or acquired new knowledge to improve their digital and sustainable skills.

Acknowledgments / Zahvala

The article is funded from the European Union – Next Generation EU and the Ministry of higher education, science and innovation, Slovenia. The research was carried out within the project, entitled: »Establishing an environment for green and digital logistics and supply chain education«.

References / Literatura

[1] Mateja Forte. 2015. *Slovene language infrastructure for blind/impaired students in regular primary school conceptual design of a primary school textbook of the Slovene language for the inclusion program*. University of Primorska, Koper

[2] Maria Golden. 2001. *About language and linguistics*. Department of Comparative and General Linguistics, Faculty of Arts, University of Ljubljana, Ljubljana

[3] Olga Kunst Gnamuš. 1994. *Theory of Communication*. Center for Discursive Studies, Ljubljana

[4] Matevž Obrecht, Tina Cvahte Ojsteršek, Mateja Čuček, Martin Fale, Milena Kajba, Polona Vičič, Bojana Slomšek Šlamberger, Lazar Pavić. 2024. *Knowledge supply chains - Guidelines for green and digital transition*, (1st. ed.), University of Maribor, University Press, Maribor

[5] Bojana Slomšek Šlamberger. 2024. ESG – Environment, company, management no. 188, DigInGreen – an innovative concept of lifelong education

The Moore's Law for Education and the Need for Inclusion

Marius M. Balas*, Valentina Balas*, Dana Rad†, Gavril Rad† and Sérgio D. Correia‡
*Engineering Faculty, Aurel Vlaicu University of Arad, Arad, Romania
†Center of Research Development and Innovation in Psychology, Faculty of Educational Sciences Psychology and Social Work, Aurel Vlaicu University of Arad, Arad, Romania
‡Portalegre Polytechnic University, Portalegre, Portugal
Correspondance: {marius, balas, dana}@drbalas.ro, radgavrilarad@gmail.com, scorreia@ipportalegre.pt

***Abstract*—From within the electronics industry, Gordon Moore observed an exponential rate of development of technology. Over time, the same pace of development has been observed for most human activities, resulting in an exponential growth in the volume of accumulated knowledge. This phenomenon also has adverse consequences, especially the increasing difficulty of the educational process, mainly in the scientific and engineering fields, which ultimately results in an increase in school dropout. To cope, we will have to initiate the inclusion of students in the new context, through measures that will support for long term a Moore's law for education. To begin with, we propose several measures, such as increasing the share of visual representations of knowledge or applying the recommendations of the Bologna Process more rigorously.**

***Index Terms*—Moore's Law, Visual Representation of Knowledge, Bologna Process, Inclusive Education, System Engineering**

I. The Moore's Laws and Education

In 1965, Gordon Moore, Intel CEO & Co-founder, made a perspicacious empirical observation: *the number of transistors in integrated circuits doubles every two years*. This observation became the well-known First Moore's Law. In the following decades, and until today, the law has been verified and even knowingly applied in the management of the electronics industry. Moreover, the exponential development pattern noticed by G. Moore has been observed in many more areas of human activity: (1) Moore's Second Law (Arthur Rock's Law): the cost of a semi-conductor chip fabrication plant doubles every four years; (2) More than Moore: the Moore's law is now beginning to be revalued in the sense of performance indexes per chip instead of sheer number of transistors per chip; (3) Moore's Law for Knowledge: the general human knowledge doubles every year [1]; and (4) Moore's Law for Everything: addresses our entire society as a whole [2].

An undesirable consequence of the Moore's Law for Knowledge appears in education: *young students face more and more difficulty the increased volume and complexity of the knowledge they have to assimilate*. Therefore, we are witnessing an alarming increase in school dropouts. In 2001 G. Moore complained: "*It's hard to come up with ways to increase productivity in education*" [3]. Eventually one can observe that Moore's Law is beginning to make its presence felt in education too [3].

We believe that the current situation requires a new fundamental approach, capable to sustain in the long term a proper Moore's Law for Education, helping students to include into the Moore's Law for Knowledge era. For this, we must increase the efficiency of learning, so that it keeps pace with the increase in the volume of knowledge. This approach is encouraged by the statement according to which learning resources are practically unlimited [4].

II. Psychological Theories Explaining the Phenomenon

A. Cognitive Load Theory

Cognitive load theory (CLT), developed by John Sweller, provides a valuable framework for addressing the challenges posed by exponential growth in knowledge and its implications for education. CLT posits that working memory has a limited capacity for processing information. As the volume and complexity of educational content increase, the cognitive load on students also rises. This escalation in cognitive load can lead to cognitive overload, where students struggle to process or retain information effectively, ultimately resulting in reduced learning efficiency and increased dropout rates [5], [6]. To counteract these issues, strategies that manage cognitive load, such as simplifying complex information and utilizing multimedia tools to present knowledge visually, are essential. These strategies help accommodate the rapid advancements described by Moore's Law in education, thereby supporting more effective learning experiences.

Van Merrienboer and Sweller emphasize that recent developments in CLT highlight the importance of designing instructional methods that manage cognitive load effectively, especially when dealing with complex learning scenarios [7]. By integrating these principles into educational practice, educators can better support students in handling the growing complexity of their studies.

B. Self-Determination Theory

Self-determination theory (SDT), developed by Deci and Ryan, emphasizes the essential psychological needs for autonomy, competence, and relatedness as central to motivation and learning [8]. The exponential growth of knowledge, as highlighted by Moore's Law, may challenge students' sense of

competence and autonomy, especially when the pace of learning feels overwhelming or unmanageable. This can adversely impact their motivation and academic performance. According to SDT, when students perceive their learning environment as supportive of their need for autonomy, they are more likely to experience intrinsic motivation and engage more deeply with the material. Similarly, providing constructive feedback and fostering meaningful interactions with peers and educators can enhance students' sense of competence and relatedness, which are crucial for maintaining motivation and engagement [9].

Research supports the idea that educational practices aligning with SDT principles can lead to more effective learning outcomes. For instance, Guay, Ratelle, and Chanal argue that optimal learning environments, which cater to students' psychological needs, contribute to better educational outcomes [10]. They found that when students experience a high degree of self-determination within their learning contexts, they are more likely to engage actively and perform well academically.

In light of these insights, incorporating measures that support the psychological needs identified by SDT - such as providing opportunities for self-directed learning, ensuring frequent and constructive feedback, and facilitating collaborative and supportive peer interactions - can help mitigate the negative effects of rapid knowledge expansion. This approach not only addresses the challenges posed by Moore's Law for education but also promotes more inclusive and effective educational practices that cater to diverse student needs.

C. Information Processing Theory

Information processing theory, as developed by Atkinson and Shiffrin, provides a framework for understanding how information is encoded, stored, and retrieved [11]. This theory becomes increasingly relevant as the volume of information grows exponentially, presenting challenges for processing and organizing vast amounts of data effectively. According to the theory, cognitive strategies such as chunking and rehearsal are crucial for managing large data sets, which can help students process and retain information more efficiently.

Chunking involves breaking down complex information into smaller, manageable units, making it easier to encode and recall [12]. Rehearsal, which includes techniques like repetition and active engagement with the material, also plays a significant role in strengthening memory retention. Integrating these cognitive strategies into educational practices can aid students in navigating the challenges associated with the rapid expansion of knowledge. For example, employing visual aids, interactive tools, and other multimedia resources can enhance students' ability to process and retain information by presenting it in more digestible formats [13].

Incorporating information processing techniques into teaching methodologies supports increased inclusion and provides effective support mechanisms for students facing the complexities of modern education. By applying these strategies, educators can help students manage cognitive load more effectively, fostering an environment where learners are better equipped to handle the demands of rapid knowledge growth.

D. Complex Adaptive Systems Theory

Complex adaptive systems theory (CAST) provides a contemporary cognitive psychological perspective that integrates concepts from Systems Engineering. CAST focuses on how systems, including educational systems, adapt and evolve in response to environmental changes [14]. This theory emphasizes the dynamic interactions among various components of a system and the necessity for flexibility in adapting to rapid changes.

In the context of Moore's Law for education, CAST posits that educational systems must be designed to be adaptable and resilient to the exponential growth in knowledge. As knowledge expands at an accelerating rate, educational environments must continuously evolve to meet diverse learning needs and integrate new technologies and methodologies. This adaptability involves creating learning systems that can effectively incorporate feedback and undergo iterative improvements to refine educational practices [15].

CAST also highlights the importance of feedback loops and iterative processes in educational settings. By applying CAST principles, educators can develop more responsive and inclusive educational systems. For instance, leveraging iterative feedback mechanisms and promoting flexibility in teaching approaches can help address the challenges associated with rapid knowledge expansion, ultimately supporting long-term student success [16].

By implementing CAST, educational institutions may create settings that are more suited to managing the complexity of modern education and responding to the needs of fast knowledge expansion, as outlined by Moore's Law.

Understanding the psychological underpinnings of educational challenges in the context of rapid knowledge expansion provides valuable insights into how to support students effectively. By applying theories such as cognitive load theory, self-determination theory, information processing theory and complex adaptive systems theory, educators can develop strategies to enhance learning outcomes and address the needs of a diverse student population. In addition to supporting the inclusion of all students in a changing educational environment, these strategies aid in managing the growing body of information.

III. Concrete Inclusion Measures

A. Improving the Bologna Process Application

School dropout is all the more expensive the more advanced the student is on a higher level of preparation and the larger the target group. That is why we will focus with priority on students in the undergraduate stage.

The Bologna Declaration (19 June 1999) proposed a higher educational system with two main cycles, undergraduate and graduate, leading to the master and/or doctorate degree (Fig. 1). Access to the second cycle requires successful completion of first cycle of minimum three years. The first cycle degree (Bachelor) is already relevant to the European labour market as an appropriate level of qualification.

A key issue is the balance between mass and elite higher education [17]. This balance is perfectly designed, but our

observations (direct, empirical, and at a restricted scale) point out that many professors apply elite standards for the mass level, leading to scholar dropout. Besides personal attitudes, this might also be caused by a possible lack of attention paid to the mass level compared to the elite one. There are important differences between mainstream and elite education. The inclusiveness of mass education is meant to be broad, but its depth remains shallow, as does its specialization and rigor. On the other hand, elite education is supposed to be deep, rigorous, and specialized, thus losing out on inclusiveness. That is why the next measures will point to possible technical solutions leading to effectiveness, notably in mass education.

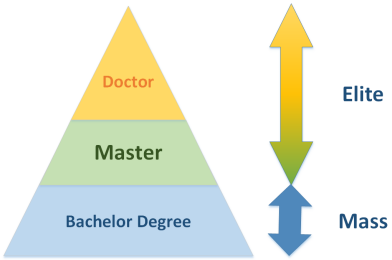

Fig. 1. The higher education structure (Bologna Process)

B. Visual Representation of Knowledge

Homo Sapiens is a diurnal species, essentially relying on sight [18]: 90% of information transmitted to the brain is visual; 50% of the brain's surface is used for the vision; and visual information gets to brain 60.000 times faster than text.

These facts lead us to the conclusion that we should look to favorize the visual representation of knowledge, especially when addressed to the undergraduate students [19]. Figure 2 illustrates how visual adds enhance texts' understanding [18].

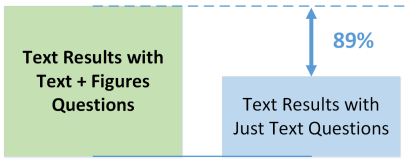

Fig. 2. Better formulated questions lead to better results

Visuals can break down complex concepts into more digestible parts, making it easier for students to grasp intricate ideas. Diagrams, flowcharts, and mind maps can illustrate the relationships between different concepts, helping students understand how they interconnect. Moreover, visuals are often more memorable than text alone. The dual-coding theory suggests that information presented both visually and verbally is more likely to be remembered, as visual representations can reinforce learning by providing multiple ways to process and recall information. When considering student motivation, visuals can make learning more engaging and interesting, potentially increasing student motivation and participation. Visual tools like graphs and charts encourage students to analyze data and identify patterns, trends, and outliers, and they help visualize problems and brainstorm solutions, fostering critical thinking skills.

As previously mentioned, in fields like science, technology, engineering, and mathematics, visualizations such as graphs, models, and simulations are crucial for understanding abstract and complex concepts. Visual tools can illustrate historical timelines, sociological theories, and literary analyses, making these subjects more accessible and engaging. To give an example, we mention that visual reasoning is beginning to be adopted even in areas where formal mathematical approaches seemed immutable, such as automation. These approaches are specific to Artificial Intelligence methods, which, let's not forget, seek to emulate human reasoning. In the broadest sense, in automation, one can observe a revaluation of methods based on quantitative or even qualitative time analysis, such as the analysis of the phase trajectory of the control error, which has appeared since the nineteenth century, comparing to methods based on the precise frequency analysis (transfer functions, pole placement, etc.). More specifically, we can mention: (1) The sliding mode [20]; (2) The qualitative analysis [21]; (3) The self-adaptive fuzzy-interpolative controllers [22]; and (4) Sculpting the state space [23].

Systems engineering (SE) is an increasingly significant scientific field that successfully manages multidisciplinary and very complex systems (including educational ones). SE applications are based almost entirely on visual software packages: UML (Unified Modeling Language), IDEF (Integration Definition), QFD (Quality Function Deployment), etc.

C. The Top-Down Approach

SE is proposing another way to increase education's efficiency, which is derived from its holistic feature: embracing the Top-Down approach [24]. The top-down approach means essentially fewer details and more comprehension.

Bottom-Up teaching starts with small details and broadens the scope of the lessons step by step as students master the skills. This way is rigorous, yet instruction-driven, cumbersome, and time-consuming, eventually suited for elite education and company specific training.

The strategy of top-down teaching begins with the big, abstract concept and works down to the specific details, according to the available time. This motivates students to learn through direct interaction and their own experience and is fast and suited to mass education. The Top-Down Approach in education provides a structured and motivating way to learn, promoting a deeper and more integrated understanding of subjects while aligning well with real-world problem-solving and diverse learning styles. It is structured and linear, ideal for subjects where a foundational understanding is crucial, aiming for a comprehensive understanding by building from general to specific. Students gain an overall understanding of the subject, helping them see how individual parts fit into the bigger picture. This broad perspective can enhance comprehension and retention of detailed information. By understanding the ultimate goals and applications of what they're learning, students can be more motivated to engage with and master the detailed content. Knowing the relevance and end goals of their studies can make the learning process more meaningful and interesting. Moreover, starting with general

concepts allows students to quickly grasp the subject's scope and identify areas that need more focus. This can make the learning process more efficient, as students can prioritize their efforts on more challenging aspects once they understand the overall framework.

Given the current complexity of education, illustrated in section 2, a mechanical application of any of the methods proposed above is virtually impossible. Hybrid solutions have the highest chance of success. Let's give an example from digital electronics: the Hardware Description Languages (HDL). HDLs admit two types of descriptions for the same circuit: Behavioral and architectural, which are interchangeable according to needs (Fig. 3). The behavioral description is top-down functional, while the architectural is bottom-up structural.

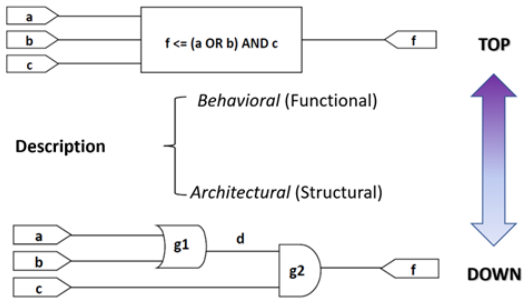

Fig. 3. The HDL descriptions

IV. Conclusion

The paper discusses the ever-widening gap between the volume of general knowledge, which obeys Moore's law of exponential knowledge development, and the effectiveness of education, which cannot keep up. The effect of this gap is critical for young people, especially for undergraduates, who have a high dropout rate. This is a peculiar case of inclusion, because it is addressing a wide group of perfect valid persons: virtually any student. In order to promote their inclusion in the context of Moore's law for knowledge, several fundamental measures are proposed in order to give education a greater dynamic: the more rigorous application of the Bologna Process system, the prioritization of visual methods of representation and manipulation of knowledge and the broader application in education of methods derived from Systems Engineering, such as the top-down approach.

Incorporating visual representation of knowledge in higher education not only caters to diverse learning styles but also enhances comprehension, retention, engagement, and critical thinking. By leveraging the power of visuals, educators can create a more effective and enriching learning environment that prepares students for both academic and real-world challenges. The application of such a set of measures is a large, lasting action and will require the involvement of all teachers, whose task is difficult because they will have to start by changing themselves.

References

[1] R. B. Fuller, *Critical path*. St. Martin's Press, 1981, (ISBN: 9780312174910).

[2] . Sam Altman · March 16, "Moore's law for everything." [Online]. Available: https://moores.samaltman.com/

[3] G. Anders, "Moore's law touches education at last – to techies' delight," Apr 2014. [Online]. Available: https://www.forbes.com/sites/georgeanders/2014/04/16/moores-law-touches-education-at-last-to-techies-delight/

[4] J. W. Botkin, M. Elmandjra, and M. Malitza, *No limits to learning bridging the human gap; a report to the club of Rome James W. Botkin; Mahdi Elmandjra; Mircea Malitza*. Pergamon Press, 1979, (ISBN: 0-08-024705-9).

[5] J. Sweller, J. Plass, R. Moreno, and R. Brunken, "Cognitive load theory: Recent theoretical advances," *Cambridge Univerisity Press*, p. 29–47, 2010.

[6] F. Paas, A. Renkl, and J. Sweller, "Cognitive load theory and instructional design: Recent developments," *Educational psychologist*, vol. 38, no. 1, pp. 1–4, 2003.

[7] J. J. G. Van Merrienboer and J. Sweller, "Cognitive load theory and complex learning: Recent developments and future directions," *Educational psychology review*, vol. 17, pp. 147–177, 2005.

[8] E. L. Deci and R. M. Ryan, "Self-determination theory," *Handbook of theories of social psychology*, vol. 1, no. 20, pp. 416–436, 2012.

[9] J. Reeve, "A self-determination theory perspective on student engagement," in *Handbook of research on student engagement*. Springer, 2012, pp. 149–172.

[10] F. Guay, C. F. Ratelle, and J. Chanal, "Optimal learning in optimal contexts: The role of self-determination in education." *Canadian Psychology / Psychologie Canadienne*, vol. 49, no. 3, p. 233, 2008.

[11] R. C. Atkinson and R. M. Shiffrin, "Human memory: A proposed system and its control processes," in *Psychology of learning and motivation*. Elsevier, 1968, vol. 2, pp. 89–195.

[12] J. T. Wixted, "Atkinson and shiffrin's (1968) influential model overshadowed their contemporary theory of human memory," *Journal of Memory and Language*, vol. 136, p. 104471, 2024.

[13] G. Sucharitha, A. Matta, K. Dwarakamai, and B. Tannmayee, "Theory and implications of information processing," *Emotion and Information Processing: A Practical approach*, pp. 39–54, 2020.

[14] T. Fidan and A. Balcı, "Managing schools as complex adaptive systems: A strategic perspective," *International Electronic Journal of Elementary Education*, vol. 10, no. 1, pp. 11–26, 2017.

[15] P. McMillan and M. Jess, "Embracing complex adaptive practice: the potential of lesson study," in *Non-Linear Perspectives on Teacher Development*. Routledge, 2023, pp. 77–92.

[16] J. K. Garner and A. Kaplan, "A complex dynamic systems approach to the design and evaluation of teacher professional development," in *Non-Linear Perspectives on Teacher Development*. Routledge, 2023, pp. 93–118.

[17] K. Miklavič, "Elite vs. mass higher education - a reflection on the purpose of higher education," in *The GAPS Think Piece*. GAPS - Global Access to Postsecondary Education, 2016, no. 14, pp. 1–8.

[18] E. McCoy, "How our brains are hardwired for visual content," *Killer Visual Strategies*, 2019.

[19] M. Chein, M.-L. Mugnier, and M. Croitoru, "Visual reasoning with graph-based mechanisms: the good, the better and the best," *The knowledge engineering review*, vol. 28, no. 3, pp. 249–271, 2013.

[20] K. D. Young, V. I. Utkin, and U. Ozguner, "A control engineer's guide to sliding mode control," *IEEE transactions on control systems technology*, vol. 7, no. 3, pp. 328–342, 1999.

[21] W. F. Clocksin and A. J. Morgan, "Qualitative control," *In Proceedings of the Seventh European Conference on Artificial Intelligence*, vol. 350, no. 6, 1986.

[22] M. M. Balas, "The fuzzy-interpolative methodology," *Soft Computing Based Modeling in Intelligent Systems*, pp. 145–167, 2009.

[23] J. M. Mendel, "Comparing the performance potentials of interval and general type-2 rule-based fuzzy systems in terms of sculpting the state space," *IEEE Transactions on Fuzzy Systems*, vol. 27, no. 1, pp. 58–71, 2018.

[24] S. Blakeley, "Bottom up & top down teaching strategies." [Online]. Available: https://study.com/academy/lesson/bottom-up-top-down-teaching-strategies.html

Multimedia Based Sign Language Dictionaries: How are Potential Users Involved?

Žana Juvan*
zana.juvan@fe.uni-lj.si
Faculty of Electrical Engineering
University of Ljubljana
Ljubljana, Slovenia

Klemen Pečnik†
klemen.pecnik@fe.uni-lj.si
Faculty of Electrical Engineering
University of Ljubljana
Ljubljana, Slovenia

Abstract

Sign languages are rich visual-gestural languages that serve as the primary means of communication for the d/Deaf community. Despite their complexity and cultural significance, sign language dictionaries face challenges in terms of documentation, accessibility, and usability. Despite their linguistic richness, the development of comprehensive and user-friendly sign language dictionaries remains limited, especially in terms of adequate user testing, leading to a gap between technological advances and user satisfaction.

This paper examines the history and evolution of sign language dictionaries, from the early printed versions to interactive digital formats. It highlights their key features and technological advances and discusses the benefits of integrating modern technologies such as motion capture and artificial intelligence into sign language dictionaries to improve the accuracy and accessibility of sign language resources. The paper emphasizes user-centered design and calls for a thorough evaluation involving diverse target groups, including d/Deaf, hard of hearing, and hearing users. By addressing the current lack of empirical testing, this paper proposes a hybrid approach to the development of sign language dictionaries that are accessible, effective, and culturally sensitive, ensuring equal access to communication and information for all.

Keywords

online dictionary, sign language, sign language dictionary, user testing, evaluation

1 Introduction

The natural language of the d/Deaf, where "deaf" refers to a physiological state, while "Deaf" refers to a member of the Deaf community [1], is sign language, characterised by its unique visual-gestural modality, with each sign functioning as a lexical unit within a comprehensive grammatical system. These languages are fully-fledged and serve as important means of communication for people with varying degrees of deafness, whether prelingual or postlingual.

Despite their richness, sign languages face significant challenges in terms of documentation and supporting materials, like textbooks, grammar books and dictionaries [2]. High-quality sign language dictionaries are rare, and those that exist often suffer from poor accessibility and usability. Modern multimedia technologies offer a promising solution for a better representation of the spatio-temporal content. These technologies can be used to create more accessible and effective dictionaries that meet the target users' needs [3]. Yet, there is a notable lack of testing and evaluation of these dictionaries with all target audience groups [4]. This gap highlights a critical problem where effectiveness and practicality of these resources are often assumed rather than empirically tested.

This paper explores the development and key features of multimedia Sign Language Dictionaries (SLD), focusing on appropriate empirical testing with target groups. This could improve accessibility and usability, as well as better meet the needs of the Deaf community, their relatives, friends, and anyone who wishes to communicate in sign language.

2 Technical Aspects of Sign Language Dictionaries

In the interconnected world, access to information in one's natural language is a fundamental right that is essential for equal participation and involvement in society. Language is a carrier of culture, identity and knowledge. When people have access to information in their natural language, they can better engage and break down the barriers that exclude people from important conversations and opportunities. If information is only available in a few languages, most people become marginalised and their voices go unheard.

Conventional methods of information dissemination fall short when it comes to sign languages. General dictionaries rely on words, phonetics, pronunciation, and text-based explanations that are inadequate for sign languages. Sign languages are visual and spatial, and include hand and body movements as well as facial expressions which can modify sign meaning. To accurately represent these elements, SLDs must use additional means of communication such as videos, or other alternatives like animations, 3D animations, 360 videos, spatial videos and in addition, specialised notations [5].

Developing effective SLDs requires a hybrid approach that combines features of both learner's and explanatory dictionaries. Learner's dictionaries simplify definitions and provide clear examples to help beginners. Explanatory dictionaries provide detailed descriptions and a broader vocabulary for advanced users [6]. An ideal SLD would include a learner's section with videos demonstrating basic signs, accompanied by 3D animations and text descriptions, with the goal to focus on fundamental vocabulary and common phrases, making it accessible to beginners. The explanatory part would cover complex signs with multiple examples in different contexts. This hybrid model would ensure that SLDs are versatile resources for all users, promoting equal access to information and supporting the development of sign language skills. By creating advanced hybrid SLDs that embrace

*ORCID: 0000-0001-8859-180X
†ORCID: 0009-0004-1430-8054

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

https://doi.org/10.70314/is.2024.DIGIN.5

the visual and dynamic nature of sign languages, inclusion and equality would be promoted in the best possible way.

2.1 History and Development

The history and development of SLDs reflect the evolving understanding and appreciation of sign languages. The first sign language dictionaries were created in the 20th century [7] providing a valuable resource for both the Deaf and hearing communities. These dictionaries were printed works that used static images, line drawings of signs and textual explanations to depict the signs, which helped to somewhat bridge the gap in communication. These early dictionaries, while pioneering, had significant limitations when it came to accurately capturing the dynamic and spatial nature of sign languages. The static nature of used images often failed to convey the fluid and expressive aspects of sign languages, often making it very hard for people to understand and learn the signs correctly [3, 4].

A significant advancement in the representation of sign language was achieved with the introduction of notation systems. The first notation system was developed in 1960 by Stokoe, which was closely followed by SignWriting (1974) and HamNoSys (1985) notation systems. They use pictures and abstract symbols to describe the elements of each sign, which makes analysis of sign language structure possible. To describe a sign accurately, five parameters are needed: movement, handshape, location, palm orientation and non-manual signals [4, 8]. Printed SLDs used four of the five parameters to describe included signs, which allowed for easier categorisation as well as more efficient searching, since it was possible to organise signs by their characteristics instead of alphabetically [7].

Video technology made a revolutionary advance for SLDs. Early video dictionaries which began appearing in the late 20th century and used 2D video to demonstrate the signs [9, 10]. These video dictionaries provide a more accurate representation of signs compared to static images, as they show body movements and facial expressions. However, 2D video still lacks spatial information, which is crucial for fully capturing the three-dimensional nature of sign languages [11].

The development of 3D avatar dictionaries has addressed some of the limitations of 2D videos by incorporating spatial information. These systems use computer-generated avatars to perform signs, offering users to depict signs from multiple viewing angles, which facilitates better understanding and learning. Despite these advances, 3D avatars often struggle to adequately reproduce natural facial expressions and body movements, which are integral parts of signing, causing the Deaf community to not yet fully accept 3D avatars [12].

The most advanced SLDs today are exploring the use of sophisticated interactive systems to improve inclusion and interaction. Researchers are utilising technologies like motion capture, augmented reality and artificial intelligence to create more natural and accurate representations of signs. These systems aim to capture the full complexity of sign languages, including accurate facial expressions and subtle body movements [13, 14]. E.g. interactive platforms may allow users to view signs from different angles, slow down movements to study them in detail, and even converse with virtual assistants in sign language in real time.

Scientific publications have documented these advances and highlighted the associated technical and social challenges. Studies have examined the effectiveness of various technologies and their acceptance in the Deaf community, emphasising the importance of cultural sensitivity and user-centred design in the development of these aids [15, 16].

2.2 Advantages

Sign language dictionaries offer numerous advantages that significantly support the learning process and enhance communication and inclusion. They provide a standardised way of showing and understanding signs, which helps to standardise their meanings for different users and contexts. This promotes the recognition and use of the sign language, raises awareness and increases the participation of the d/Deaf in society. In addition, these dictionaries enable anyone to learn new signs or refresh their knowledge, ensuring accurate and effective communication, regardless of skill level - whether beginner or certified sign language interpreter. As a comprehensive resource, sign language dictionaries play a crucial role in promoting inclusion and bridging communication gaps between d/Deaf and hearing people [3, 11].

2.3 Key Features

SLDs have evolved from simple printed resources to sophisticated, interactive tools that are essential for learning, communication and inclusion. Initially, these dictionaries were based on static images and textual explanations, which were basic but limited in their ability to capture the full nature and details of sign language.

Modern SLDs [3, 6, 11, 17, 18, 19] have evolved considerably, incorporating a robust entry structure that typically includes the lemma, a video demonstration, and a detailed explanation. Each entry can also provide usage examples and information on frequency of use, along with grammatical details, synonyms, antonyms and collocations. Visual aids and notation systems such as Stokoe, HamNoSys, SignWriting further break down the components of each sign, improving understanding and learning.

The search function in these dictionaries is versatile and allows users to find signs by entering a word or phrase, search by sign components, or by thematic groups. The search results are listed by relevance, ensuring the most accurate match.

Interactivity is a key feature of modern SLDs. Video content offers controls to play, pause, change playback speed and jump to specific sections. Some dictionaries offer multiple synchronised 2D videos filmed from different viewing angles for better understanding, or even 3D avatars with 360-degree views, giving users the ability to freely change rotation or perspective.

As up-to-date and unlimited resources, online SLDs continually add new information, avoiding the limitations of printed versions. This approach mitigates the pressure of deciding which entries to include and allows for quick updates, keeping the dictionary current and comprehensive.

Additional features of modern SLDs increase their usefulness and educational value. Instructions on how to use the dictionary effectively, information on the history and context of sign language, and up-to-date information on the latest developments keep users informed and engaged. Features such as the "word of the day" encourage regular learning and exploration of new signs. These interactive features lead to better learning outcomes. More advanced SLDs incorporate additional features, allowing users to participate in quizzes and games, practise with structured exercises, and save and print customised vocabulary lists. In addition, SLDs can also support language rehabilitation by providing tools for continuous practise and improvement.

3 User Centered Design and Evaluations

The development of SLDs has mainly focused on its features, programming processes, and design. Numerous articles and papers meticulously describe the intricacies of these aspects, often emphasising the technical and linguistic challenges. However, there is a glaring absence in the literature when it comes to user evaluation of these dictionaries with the users. Since SLDs are used by deaf, hard of hearing and hearing users, these solutions should be tested and evaluated by all target groups with comparable tools.

User testing is crucial to the development of any effective educational resource, which is especially true for SLDs. Many studies have shown that involving end users in the testing phase is crucial to ensure effectiveness, efficiency and user satisfaction. One of the most widely used methods for this purpose is User Centered Design (UCD) [2]. This methodology emphasises effectiveness, efficiency and user satisfaction. Effectiveness ensures that the tools or services fulfil the intended purpose, efficiency minimises the effort and time required for users to achieve their goals, while user satisfaction creates a positive and engaging user experience. UCD focuses on improving usability and aims to develop tools that are intuitive and user-friendly. Ideally, SLD design should follow all UCD steps, including thorough user testing and evaluation. Unfortunately, in practise, many SLD development projects tend to skip the crucial fourth step of UCD — evaluation with actual users.

This omission leads to a gap between the theoretical benefits of SLDs and their practical usability. Without empirical evaluation, developers miss out on important feedback that could lead to improvements and adjustments. As a result, SLDs may not fully meet the needs and preferences of the d/Deaf and hard of hearing communities and hearing users, limiting their effectiveness as a learning or helping tool.

3.1 Target Users

The users of SLDs are diverse and they use these tools for various reasons, e.g. to learn a sign language, to interpret, to prepare for specific interpretations or to test their knowledge. Understanding these different user groups is essential for the creation of effective and accessible dictionaries.

Users can be categorised according to their purpose: Sign language learners who are seeking to expand their vocabulary, interpreters who need accurate signs for communication, teachers who use SLDs as teaching tools, and developers who are creating or improving sign language resources. Another categorisation is by hearing status: d/Deaf people for whom sign language is a primary form of communication and hearing people who use SLDs for learning, interpreting or teaching.

Sign language competence also defines user categories: Beginners who are just starting to learn, advanced beginners with basic proficiency, proficient users who engage in complex interactions, proficient users who often work in a professional context, and experts, including native signers and experienced certified interpreters or educators. It is important to understand all different user groups through user studies. They provide insight into how the different groups interact with SLDs, their specific needs, challenges and preferences. This knowledge is invaluable when it comes to customising features, increasing usability and improving accuracy to ensure SLDs are effective and user-friendly for all experience levels within the sign language community [2, 3, 20].

3.2 Evaluation Studies

The evaluation of SLDs can focus on both technical criteria and user experience. Categorising features of SLDs and determining what should be evaluated are crucial steps in this process.

From a technical perspective, the evaluations often look at how well the dictionary code or service works. However, this type of evaluation is insufficient, if the user experience is not taken into account. An effective evaluation should also include an assessment of functionality and usability, ideally involving the target audience. For example, the evaluation of an Electronic Malaysian Sign Language Dictionary [21] was conducted with actual users and provided valuable insights into its effectiveness. In contrast, most SLD evaluations often involve non-target groups of users, typically in very small numbers, which limits the relevance of the obtained feedback.

Unfortunately, many SLD projects do not report on user testing at all. Instead, they rely on simple functional testing or use metrics such as Google Analytics as a substitute for evaluation. This approach overlooks important aspects of user interaction and satisfaction.

A few articles emphasise the importance of thorough user evaluation and show how user feedback can lead to improvements. A study on the users of an online dictionary of sign languages titled "Proposing an instrument for evaluation of online dictionaries of sign languages" [4] provides a proposed framework for conducting comprehensive evaluations and further illustrates the benefits of involving users in the testing process.

3.3 Guidelines and Importance

The evaluation of sign language dictionaries is crucial to ensure that they are effective, user-friendly, and meet the needs of their diverse users. Key aspects of evaluation must include testing specific features, assessing usage and usability, ensuring ease of use and reviewing the quality of videos and content. Feedback and ideas from the community are invaluable for further development and improvement of any dictionary.

An evaluation of SLD should include all target user groups, including the d/Deaf and hard of hearing people, as well as professional interpreters, teachers and other hearing learners, in order to gain comprehensive insights. Methods that include interviews are preferable to written surveys to obtain more in-depth, nuanced feedback [22]. In a separate ongoing study, we were able to demonstrate that it is important to use tools translated into sign language for all users whose natural language is sign language, in addition to semi-structured interviews with participants. To summarise, it is important to tailor the evaluation methods to the specific user group and allocate sufficient time for thorough testing and feedback collection. Although there are some differences between countries in terms of certified interpreters and legal obligations, each method should consider all possible options to reduce the pressure on users by providing them with a comfortable environment and relaxed user testing to minimise the negative impact of testing methods on the final results.

The importance of these evaluations cannot be overemphasised as they lead to a better end product or service. Systematic evaluations improve functionality, usability, and overall quality, and ensure that the SLD or any other product or service actually serves the target audience for which it is intended. This iterative process ensures that the final product truly meets the needs and expectations of its users, resulting in a more effective and user-friendly sign language dictionary.

4 Conclusions

The evolution of sign language dictionaries from printed images to advanced interactive systems reflects significant technological and linguistic advancements. While early efforts provided basic resources, modern approaches strive to capture the complexity and richness of sign languages. As research and technology advance, the goal is to develop inclusive, accurate, and widely accepted resources that empower the Deaf community and improve communication for all. Sign language dictionaries have thus become indispensable, continually updated resources that support learning, foster inclusivity, and bridge communication gaps between deaf and hearing individuals.

To bridge this gap, it is essential that future SLD development incorporates comprehensive user testing into their methodologies. By doing so, developers can ensure that their dictionaries are not only linguistically and technically sound, but also genuinely useful and accessible for their intended users.

In conclusion, for SLDs to be truly effective, evaluations must extend beyond technical functionality and include thorough user testing. This involves categorising features appropriately, assessing content accuracy, and involving all targeted user groups to ensure the dictionaries meet the actual needs of the Deaf and Hard of hearing communities, as well as all other user groups who are using SLDs.

Finally, our research on SLDs and user testing methods has identified some exemplary approaches [20, 21, 22] that integrate users into the design, development, and evaluation stages. On the other hand, however, we could not find a suitable tool for user testing that was adapted to or created in sign language. This highlights a significant area for improvement, particularly in ensuring that solutions meet user needs without assuming that every solution and current evaluation methods are good enough.

Acknowledgements

This research was in part supported by Slovenian Research and Innovation Agency (ARIS), P2-0425: Decentralized solutions for the digitalisation of industry and smart cities and communities. The results of the research were partially produced within the framework of the research project titled "Analysis of Conceptual Designs for Information and Technical System Support for the Disabled to Increase Social Inclusion" No. V2-2252, as part of the Target Research Program "CRP-2022," co-financed by the Slovenian Research and Innovation Agency (ARIS) and the Ministry of Labour, Family, Social Affairs, and Equal Opportunities (MDDSZ).

References

[1] Gary Morgan and Bencie Woll. 2002. *Directions in Sign Language Acquisition*. John Benjamins Publishing, (June 2002). ISBN: 9789027297242. Retrieved Aug. 1, 2024 from https://api.semanticscholar.org/CorpusID:57766071.

[2] Tania Di Mascio and Rosella Gennari. 2008. An Intelligent Visual Dictionary for Italian Sign Language. *Journal of Web Engineering*, 7, (Jan. 2008), 318–338. Retrieved July 10, 2024 from https://journals.riverpublishers.com/index.php/JWE/article/view/4081.

[3] Rachel Locker McKee and David McKee. 2013. Making an Online Dictionary of New Zealand Sign Language. *Lexikos*, 23, (Dec. 2013), 500–531. Retrieved July 6, 2024 from https://lexikos.journals.ac.za/pub/article/view/1227.

[4] Klara Majetić and Petra Bago. 2017. Proposing an Instrument for Evaluation of Online Dictionaries of Sign Languages. In *INFuture2017: Integrating ICT in Society*. Department of Information, Communication Sciences, Faculty of Humanities, and Social Sciences, University of Zagreb, Croatia, (Jan. 2017), 189–203. Retrieved July 10, 2024 from https://infoz.ffzg.hr/infuture/2017/images/papers/INFuture2017.pdf.

[5] Ahmed H. Aliwy and Ahmed A. Alethary. 2021. Development of arabic sign language dictionary using 3D avatar technologies. *Indonesian Journal of Electrical Engineering and Computer Science*, 21, (Jan. 2021), 609–616. Retrieved May 17, 2024 from https://ijeecs.iaescore.com/index.php/IJEECS/article/view/22518.

[6] Pavel Campr, Marek Hrúz, Jiří Langer, Jakub Kanis, Miloš Železný, and Luděk Müller. 2010. Towards Czech on-line sign language dictionary - technological overview and data collection. In *Proceedings of the LREC2010 4th Workshop on the Representation and Processing of Sign Languages: Corpora and Sign Language Technologies*. European Language Resources Association (ELRA), (May 2010), 41–44. ISBN: 2-9517408-6-7. Retrieved May 19, 2024 from https://www.sign-lang.uni-hamburg.de/lrec/pub/10043.html.

[7] William C. Stokoe, Dorothy C. Casterline, and Carl G. Croneberg. 1976. *A Dictionary of American Sign Language on Linguistic Principles*. Linstok Press. ISBN: 9780932130013. Retrieved July 31, 2024 from https://books.google.si/books?id=WjAFAQAAIAAJ.

[8] Joe Martin. 2000. A Linguistic Comparison: Two Notation Systems for Signed Languages – Stokoe Notation and Sutton SignWriting, 1–33. DOI: 10.1145/1188913.1188915.

[9] Martin L. A. Sternberg. 1994. *American Sign Language Dictionary on Cd-Rom*. Harpercollins Interactive. ISBN: 978-0-06-279016-3. Retrieved July 31, 2024 from https://search.library.wisc.edu/catalog/999897039602121.

[10] Aleš Jaklič, Dora Vodopivec, and Vito Komac. 1995. Learning Sign Language through Multimedia. In *Proceedings of the International Conference on Multimedia Computing and Systems*. IEEE, (May 1995), 282–285. ISBN: 978-0-8186-7105-0. Retrieved July 31, 2024 from http://ieeexplore.ieee.org/document/484935/.

[11] Luka Cempre, Aleksander Bešir, and Franc Solina. 2013. Dictionary of the Slovenian Sign Language on the WWW. In *Human Factors in Computing and Informatics*. Springer Berlin, Heidelberg, (July 2013), 240–259. ISBN: 978-3-642-39061-6. Retrieved May 17, 2024 from http://eprints.fri.uni-lj.si/2099/.

[12] Lorna Quandt, Athena Willis, Melody Schwenk, Kaitlyn Weeks, and Ruthie Ferster. 2022. Attitudes Toward Signing Avatars Vary Depending on Hearing Status, Age of Signed Language Acquisition, and Avatar Type. *Frontiers in Psychology*, 13, (Feb. 2022), 1–14. Retrieved May 19, 2024 from https://pubmed.ncbi.nlm.nih.gov/35222173/.

[13] 2020. *Recent Advances in 3D Imaging, Modeling, and Reconstruction*. IGI Global, (Jan. 2020), 50–78. ISBN: 9781522552956. Retrieved July 31, 2024 from https://www.mdpi.com/journal/applsci/special_issues/MCV6B6MQRX.

[14] Ilias Papastratis, Christos Chatzikonstantinou, Dimitrios Konstantinidis, Kosmas Dimitropoulos, and Petros Daras. 2021. Artificial Intelligence Technologies for Sign Language. *Sensors*, 21, (Jan. 2021), 5843–5868. Retrieved July 31, 2024 from https://www.mdpi.com/1424-8220/21/17/5843.

[15] Vaishnavi Upadrasta, Astrid Oehme, and Sandra Böhm. 2020. User-Centred Design for Accessibility in Media Content – Sign Language and Virtual Signer. In *HCI International 2020 – Late Breaking Papers: Universal Access and Inclusive Design*. Springer International Publishing, (Sept. 2020), 126–143. ISBN: 978-3-030-60148-5. Retrieved July 30, 2024 from https://link.springer.com/chapter/10.1007/978-3-030-60149-2_11.

[16] Gregor Burger, Katja Oven, and Matevž Pogačnik. 2021. Uporabnost pametnih telefonov in mobilnih aplikacij kot pripomočkov za osebe z invalidnostjo. In *Proceedings of the 30th International Electrotechnical and Computer Science Conference ERK 2021*. ERK 2021, (Sept. 2021), 105–108. Retrieved Aug. 1, 2024 from https://erk.fe.uni-lj.si/2021/erk21.pdf.

[17] Ines Kožuh, Primož Kosec, and Matjaž Debevc. 2016. Evaluating User Experience of the Online Dictionary of the Slovenian Sign Language. In *Proceedings of the LREC2016 7th Workshop on the Representation and Processing of Sign Languages: Corpus Mining*. European Language Resources Association (ELRA), (May 2016), 129–132. Retrieved July 10, 2024 from http://www.lrec-conf.org/proceedings/lrec2016/index.html.

[18] Jette Hedegaard Kristoffersen and Thomas Troelsgård. 2010. The Danish Sign Language Dictionary. In *Proceedings of the XIV Euralex International Congres*. Fryske Academy, (July 2010), 1549–1554. ISBN: 978-90-6273-850-3. Retrieved July 6, 2024 from http://euralex.fryske-akademy.eu/.

[19] Chiara Vettori and Mauro Felice. 2008. E-LIS: Electronic Bilingual Dictionary Italian Sign Language-Italian. In *Proceedings of the 13th EURALEX International Congress*. Institut Universitari de Linguistica Aplicada, Universitat Pompeu Fabra, (July 2008), 791–796. ISBN: 978-84-96742-67-3. Retrieved July 6, 2024 from https://euralex.org/publications/e-lis-electronic-bilingual-dictionary-italian-sign-language-italian/.

[20] Mireille Vale. 2015. A Study of the Users of an Online Sign Language Dictionary. In *Electronic Lexicography in the 21st Century*. Trojina, Institute for Applied Slovene Studies, (Aug. 2015), 281–303. ISBN: 978-961-93594-3-3. Retrieved July 16, 2024 from https://api.semanticscholar.org/CorpusID:218358484.

[21] Siew Ow. 2009. User Evaluation of an Electronic Malaysian Sign Language Dictionary: e-Sign Dictionary. *Computer and Information Science*, 2, (Apr. 2009), 34–52. DOI: 10.5539/cis.v2n2p34.

[22] Amelie Unger, Dieter P. Wallach, and Nicole Jochems. 2021. Lost in Translation: Challenges and Barriers to Sign Language-Accessible User Research. In *Proceedings of the 23rd International ACM SIGACCESS Conference on Computers and Accessibility*. Association for Computing Machinery, (Oct. 2021), 1–5. ISBN: 978-1-4503-8306-6. Retrieved July 31, 2024 from https://dl.acm.org/doi/10.1145/3441852.3476473.

(In)Accessibility of Slovenian E-commerce the Year Before the European Accessibility Act

Bogdan Cerovac†
Institute for Digital Accessibility
A11Y.si
Ljubljana, Slovenia
Bogdan.Cerovac@gmail.com

Abstract

The European Accessibility Act (EAA, Directive (EU) 2019/882) aims to harmonize accessibility requirements, with a significant focus on e-commerce services due to their socio-economic impact. This study manually assessed 26 key EN 301 549 requirements, aligned with WCAG 2.1 success criteria at levels A and AA, to provide more relevant results for future accessibility trend comparisons and to advocate for necessary awareness and education initiatives. We examined 20 major and original, Slovenian e-commerce platforms expected to fall within the EAA's scope. None of the websites were fully accessible; each failed at least 13 out of the 26 selected requirements, with an average of 17.1 criteria unmet per website. Our findings highlight the urgent need for improved accessibility to ensure digital inclusivity in Slovenia and identify specific accessibility and usability issues that must be addressed to achieve compliance and bridge existing digital barriers.

Keywords

Accessibility, E-commerce, European Accessibility Act, WCAG, EN 301 549, Design for all, EN 17161, Accessibility culture

1 Introduction

With the increased digitalization of e-commerce and beyond, it is crucial that digital solutions are inclusive and accessible to everyone, including individuals with permanent, temporary, or situational disabilities. International studies show that 95.9% of the top one million home pages had detected WCAG 2 failures [1].

Recent studies in Europe reveal that 94% of European websites fail to meet accessibility requirements [2]; however, these large-scale studies primarily rely on automated accessibility testing due to its speed, convenience, and low effort.

† ORCID: 0009-0007-2254-2459

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

https://doi.org/10.70314/is.2024.DIGIN.6

Unfortunately, automated accessibility testing is quite limited and cannot cover all success criteria and accessibility requirements [10]. Furthermore, it can never definitively determine conformance [3].

Such tests are unable to address context-based accessibility requirements, which can only be evaluated by a human. As a result, they often fall short in detecting real accessibility issues [4].

Testing the accessibility of websites and native mobile applications using automated tools can therefore only provide a superficial impression of the state of accessibility [5].

The main objective of the European Accessibility Act (EAA) is to harmonize accessibility requirements for a wide range of essential services and products, including e-commerce services, starting from 28 June 2025. The EAA does not specify a particular accessibility standard to be used. Instead, it emphasizes that accessibility should be achieved by systematically removing and preventing barriers, preferably through a universal design or "design for all" approach. [6].

Studies using manual testing for accessibility are sparse due to the significant time investment and specialized knowledge required. Our intention with this study was to manually audit the accessibility of 20 representative Slovenian e-commerce websites, present an overview of our findings, highlight the most significant barriers for people with disabilities, and briefly suggest ways to prevent or address these accessibility issues.

Based on our experience from other audits, we expected to find that all these websites would be inaccessible.

2 Methods

Since the EAA does not define a specific technical standard, we used selected parts of EN 301 549 accessibility requirements to evaluate functional performance statements.

These requirements are mandated by the Web Accessibility Directive (Directive (EU) 2016/2102) [7], which applies to the public sector in the European Union.

Our study focused on a selection of 26 relevant accessibility requirements from section 9 (check table 1) of the EN 301 549 (version 3.2.1) [8] standard during our manual evaluation, supported by different tools (contrast checker, static code

validators (HTML, CSS and ARIA) and developer tools built in browsers).

The selection of websites was based on three criteria:

1. The company has at least 10 employees.
2. The company has an annual turnover of at least 2 million euros.
3. The website is original Slovenian e-commerce, rather than being a translation of content from international companies.

The sampling of webpages was conducted based on the following essential end-user digital journeys:

- Home page and navigation mechanisms.
- Product search, filtering, comparison.
- Add to cart procedure.
- Registration and login mechanisms.
- Contact and customer support functions.

The manual accessibility audits were conducted from April to May of 2024, by four auditors: two senior auditors with multiple years of experience, one auditor with a couple of years of experience, and one junior auditor. The results were coordinated and verified to ensure the highest possible quality and reliability.

To ensure the integrity of our findings and maintain confidentiality, we anonymized the e-commerce platforms under study. This approach allowed us to objectively highlight the barriers identified, aiming to raise awareness and mitigate potential biases.

3 Results

All websites failed to conform to the EN 301 549 and WCAG 2.1 standards at both A and AA levels.

On average, each website had 17.1 accessibility issues out of 26 selected criteria. The two worst-performing websites failed 20 out of 26 criteria, while the best-performing website failed 13 out of 26 criteria.

The specific accessibility requirements that all websites failed include:

- 9.1.2.2 Captions (pre-recorded) – 10 sites of 20 used videos and all the videos were without captions of any kind.
- 9.1.1.1 Non-text content – mainly missing or wrong alternative text on images and functional icons.
- 9.1.3.1 Info and relationships – mainly wrong or missing semantics of HTML code.
- 9.1.4.3 Contrast (minimum) – mainly text contrasts that were below 4.5:1 for normal size texts.
- 9.4.1.3 Status messages – mainly for features like add to cart, filter/search result changes and some form validations.

Table 1: Accessibility failures detected with manual accessibility testing of selected EN 301 549 requirements of 20 e-commerce sites

EN 301 549 Requirement	Failed sites	% of failed sites
9.1.2.2 Captions (pre-recorded)	10/10 *	100%
9.1.1.1 Text alternatives	20/20	100%
9.1.3.1 Info and relationships	20/20	100%
9.1.4.3 Contrast (minimum)	20/20	100%
9.4.1.3 Status messages	20/20	100%
9.2.4.1 Bypass blocks	18/20	90%
9.2.4.4 Link purpose (in Context)	18/20	90%
9.2.4.7 Focus visible	18/20	90%
9.3.3.2 Labels or instructions	17/20	85%
9.1.4.5 Images of text	16/20	80%
9.2.2.2 Pause, stop, hide	16/20	80%
9.2.4.6 Headings and labels	15/20	75%
9.2.4.3 Focus order	15/20	75%
9.3.3.3 Error suggestion	15/20	75%
9.2.1.1 Keyboard	15/20	75%
9.1.4.11 Non-text contrast	15/20	75%
9.1.3.5 Identify input purpose	14/20	70%
9.1.4.1 Use of colour	12/20	60%
9.3.3.1 Error identification	11/20	55%
9.3.1.1 Language of page	9/20	45%
9.1.4.10 Reflow	8/20	40%
9.2.4.2 Page titled	8/20	40%
9.1.4.4 Resize text	5/20	25%
9.2.4.5 Multiple ways	4/20	20%
9.2.1.2 No keyboard trap	2/20	10%
9.1.3.4 Orientation	1/20	5%

* 9.1.2.2 Captions (pre-recorded) was only tested on 10 sites as the other 10 did not have any videos.

The secondary goal of manual accessibility testing was to document specific issues that can be used for further research. We are only briefly reporting them here:

- Use of **CAPTCHA** was often conducted with inaccessible solutions that were totally blocking blind people relying on screen readers.
- Modal implementations, especially **cookie consent** modal windows, were often inaccessible for multiple groups of users, especially blind screen reader users and keyboard only (or assistive technologies based on keyboard). This also has further legal implications for data collection consent management.
- Unstoppable, auto-playable **carousels** loaded with information that is unusable for all people.
- Pages **coded as English with Slovene texts** and components that use English alternative texts for screen readers on pages with Slovene language.
- Inaccessible **mobile ("hamburger") menu** buttons, often totally unusable for keyboard-based assistive technologies, screen readers and voice input.

- **260 tab presses needed to bypass** site navigation and get to the content of the page.
- **Background images** coded as decoration including important information.
- When pages are zoomed in or in landscape mode on mobile devices, the site framework like navigation, footer, and sticky buttons cover almost 90% of the screen, thus making content practically invisible.

Results of manual accessibility testing of the selected EN 301 549 requirements / WCAG success criteria, show that even if all 20 sites were to pass various types of automatic accessibility testing (which they did not), they would not conform to accessibility requirements and would be inaccessible to certain groups of users, especially screen reader users, keyboard-only (and similar assistive technologies) users, users with visual impairments and deaf users or users with hearing impairments.

4 Discussion

The study confirmed our expectation that all websites audited were inaccessible to groups of users, especially people with disabilities. The pervasive neglect of web accessibility in Slovenian e-commerce not only excludes users with disabilities but also represents a missed opportunity for businesses to reach a broader audience.

A year before the new accessibility legislation is enforced, we would like to see better results – less inaccessibility, highlighting the need for increased awareness and education among stakeholders, project managers, web developers and designers, content providers, and everyone else involved in the planning, production, maintenance, and implementation of e-commerce.

Besides people with permanent disabilities, we also need to consider situational and temporary disabilities that are often left out of demographics and statistics. It is important to be aware of the negative implications of inaccessibility on society as well as its negative impact on the business sector.

Automatic accessibility testing alone can never be enough to test for conformance to accessibility standards, but it is nevertheless a useful complementary tool, helping to make manual auditing slightly faster and more efficient. There are numerous automatic accessibility testing tools that also have issues with false positives (reporting accessibility issues falsely) [10] and human interpretation will always be vital for quality of the end results.

We would like to point out that it is obvious that there is ample evidence that accessibility needs to be integrated into organizations from top to bottom, and it is also evident that standards such as Design for All (EN 17161:2019) [9] and EN 301 549 get insufficient attention. We encourage stakeholders and all interested persons to study, implement, and share knowledge to raise awareness, improve accessibility at scale, and with that enable more people to use their services for common benefits.

We are aware of multiple limitations of this study, but would like especially to point out the following:

- We scaled down the scope of testing with the full EN 301 549 set of requirements to expedite testing. Testing a full list of requirements would most likely produce even worse results, but our selection was based on the relevance of requirements for e-commerce.
- Keeping the selected 20 e-commerce websites intentionally undisclosed makes comparison of trends of the same websites impossible, but we still believe that they are a well-chosen and relevant representative sample for high-level inaccessibility situation indication and may be compared with similar websites on a requirement basis.
- Our scope was limited to a set of the most vital parts of the user journey, and testing beyond that would most probably find more failures, but we wanted to focus on the most important parts from an end-user perspective instead of mapping the situation of the technically wider but less realistic scenarios.
- We would like to involve people with different disabilities to support the study with parallel usability testing, using their own ways and assistive technology, but that was not possible due to limited resources.

5 Conclusion

This study's findings highlight the pervasive inaccessibility of Slovenian e-commerce websites, with none of the 20 audited sites fully conforming to EN 301 549 and WCAG 2.1 standards. Each e-commerce website failed an average of 17.1 out of 26 selected criteria, with issues ranging from missing captions and alternative texts to inadequate contrast and problematic navigation mechanisms. These shortcomings exclude users with disabilities and represent missed opportunities for businesses to engage a broader audience.

As the European Accessibility Act's implementation approaches, it is imperative to raise awareness and educate stakeholders, including project managers, web developers, designers, and content providers. Improving accessibility is not only a legal obligation and financial repercussion prevention, but also a moral and business imperative. Automatic testing tools, while useful, cannot replace the nuanced insights gained from manual audits.

Therefore, a combination of both methods, with a focus on manual evaluation, is essential for meaningful progress toward digital inclusivity. When baseline conformance is guaranteed and there are no obvious barriers, we highly recommend the involvement of people with disabilities, to further improve the usability aspects beyond technical guidelines and standards.

Addressing accessibility issues benefits everyone, including those with temporary or situational disabilities, and enhances the overall user experience. The study underscores the need for ongoing efforts to bridge digital barriers and ensure that e-commerce platforms are accessible to all users, thereby fostering an inclusive digital environment in Slovenia.

Acknowledgments

I would like to express my gratitude to the following individuals, members of the Institute for Digital Accessibility A11Y.si, Slovenia, who made this research possible by auditing and reviewing the audit results (listed alphabetically):

- Andreja Bevc MSc,
- Grega Fajdiga
- Tilen Škraba

References

[1] WebAIM (Web Accessibility In Mind). The WebAIM Million. 2023. Retrieved from https://webaim.org/projects/million/#wcag

[2] Craftzing.com and Wieni.com. Digital Trust Index. digitaltrustindex.eu. 2024. Retrieved from https://www.digitaltrustindex.eu/#summary

[3] The ACT Task Force of the W3C Accessibility Guidelines Working Group (AG WG). W3C Web Accessibility Initiative (WAI). 2024. Retrieved from https://www.w3.org/WAI/standards-guidelines/act/rules/about/#act-rules-are-partial-checks

[4] Adrian Roselli. Comparing Manual and Free Automated WCAG Reviews. 2024. Retrieved from https://adrianroselli.com/2023/01/comparing-manual-and-free-automated-wcag-reviews.html#Highlights

[5] Kollotzek, G., Zimmermann, G., Ableitner, T., & Nebe, A. M.. 2021. Comparison of Manual Evaluation Methods for Assessing the Accessibility of Websites based on EN 301 549. In CHIRA (pp. 24-35). https://doi.org/10.5220/0010647000003060

[6] Official Journal of the European Union. 2019. Directive (EU) 2019/882 of the European Parliament and of the Council of 17 April 2019 on the accessibility requirements for products and services (Text with EEA relevance). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L0882

[7] Official Journal of the European Union. 2016. Directive (EU) 2016/2102 of the European Parliament and of the Council of 26 October 2016 on the accessibility of the websites and mobile applications of public sector bodies (Text with EEA relevance). Retrieved from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32016L2102

[8] European Telecommunications Standards Institute. 2021. EN 301 549 V3.2.1: Accessibility Requirements for ICT Products and Services. CEN/CENELEC/ETSI Joint Technical Body. 2024. Retrieved from https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf

[9] European Committee for Standardization. EN 17161:2019 Design for All - Accessibility following a Design for All approach in products, goods and services - Extending the range of users. 2019. Retrieved from https://standards.cencenelec.eu/dyn/www/f?p=CEN:110:0::::FSP_PROJECT,FSP_ORG_ID:62323,2301962&cs=1AECBCDFF18BED2C84BA2E5FA7AF6E955

[10] Markel Vigo, Justin Brown, and Vivienne Conway. 2013. Benchmarking web accessibility evaluation tools: measuring the harm of sole reliance on automated tests. In Proceedings of the 10th International Cross-Disciplinary Conference on Web Accessibility (W4A '13). Association for Computing Machinery, New York, NY, USA, Article 1, 1–10. https://doi.org/10.1145/2461121.2461124

Digital Inclusion of Children with Special Needs in Extracurricular Sports Activities

Nuša Maver†
Pedagoška fakulteta
Univerza v Mariboru
Maribor, Slovenia
nusa.maver@gmail.com

Matjaž Debevc
AccessibleEU
Maribor, Slovenia
matjaz.debevc@guest.um.si

Katja Košir
Filozofska fakulteta
University of Maribor
Maribor, Slovenia
katja.kosir@um.si

Abstract

This article explores the inclusion of children with special needs in extracurricular sports activities, focusing on necessary adaptations for their full participation. It analyzes the current state of sports offerings in the Maribor region and identifies challenges faced by sports clubs. Key recommendations include specific coach training, systematic program adjustments, and the use of digital tools to enhance engagement and track progress. A handbook for coaches is presented, offering strategies and adaptations for various groups of children with special needs. The aim is to ensure accessible sports activities for all children, promoting their social, emotional, and physical development.

Keywords

Children with special needs, inclusion, sport clubs, inclusive sport activities, assistive technologies

1 Introduction

The inclusion process is based on the mindset that children have diverse abilities, expectations, and needs, but can learn and develop together in a suitably designed environment. In a positive school climate, where diversity is valued, every child can realize their potential [3]. The Slovenian »Placement of Children with Special Needs Act« facilitates the inclusion of children with special needs into regular educational programs with adapted implementation and additional professional assistance [6]. For effective work and active involvement of all participants, teachers must understand the characteristics of the children and the necessary adjustments concerning content, tools, environment, and other factors.

Inclusion extends beyond education to other areas of life, such as work, cultural life, leisure, recreation, and sports, although it is rarely organized in these fields. This article focuses on sports, which play a significant role in the lives of individuals by maintaining physical and mental health, boosting self-esteem, fostering friendships, and integrating into the broader social environment [1]. Organized sports activities should be accessible to all, as they offer numerous benefits to everyone [2]. Including children with special needs in sports activities requires properly trained staff, suitable equipment and tools, and environmental and content adjustments. For successful inclusive sports training, it is crucial that coaches and other professionals in sports understand the specific needs of different groups of children with special needs, implement necessary adjustments during the training process, and remain open to exploring new possibilities and solutions [5].

In recent years, digital tools have become essential in adapting sports activities for children with special needs. Modern technologies, such as exercise tracking apps, virtual reality, and interactive training programs, enable adaptations that facilitate inclusion in sports activities [7]. These tools not only ease the implementation of training but also increase children's motivation, allow monitoring of progress, and adapt activities to their needs and capabilities.

Through a review and analysis of the current situation, conducted via survey research, we investigated the possibilities for including children with special needs in organized sports activities in the Maribor area and the surrounding regions, and the knowledge of this field among the leaders of sports clubs and associations. Special emphasis was also placed on the use of digital tools, which can significantly contribute to improving the quality of sports programs for children with special needs.

Based on the analyzed research results, which will be described in the following sections, and the review of documented good practices from abroad, we have developed a handbook [4] providing guidelines for successfully implementing an inclusive training process. This handbook aims to enable coaches to effectively work with children with special needs within regular sports programs.

2 Empirical research

2.1 Problem definition and purpose

The issue of including children with special needs in organized extracurricular sports activities is critical, as we observe in practice that this group of children has limited opportunities to participate in mainstream programs of sports clubs and associations.

The purpose of the research was to analyze the existing situation and identify barriers preventing the inclusion of these children in sports activities. By doing so, we aimed to contribute to a better understanding of the issue and develop guidelines for working with each group of children with special needs in sports.

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

https://doi.org/10.70314/is.2024.DIGIN.7

2.2 Objective of the empirical research

The primary objectives of the empirical research were:

- To determine the opportunities available for children with special needs to participate in extracurricular sports activities in the Maribor area and its surroundings.
- To identify the barriers and reasons why sports clubs/associations reject children with special needs.
- To propose solutions and formulate guidelines to improve the inclusion of children with special needs in sports activities.
- To examine the role of digital tools in adapting sports activities for children with special needs.

2.3 Methodology

The research was conducted in three parts. Initially, we performed a local environmental scan by contacting 13 disability organizations via telephone to gather data on the availability of sports programs for children with special needs and the possibilities for their inclusion. In the second part of the research, we employed a survey method to collect data on the existing practices and challenges faced by sports clubs/associations in including children with special needs in their regular sports programs.

The survey questionnaire, answered by the leaders of the sports clubs/associations, consisted of ten closed-ended and two open-ended questions. A total of 48 local sports clubs and associations, covering 18 different sports disciplines, participated in the research.

Regarding the use of digital tools in sports activities, we conducted interviews and a brief review of studies published in journals. The handbook written following the research is based on the conceptual framework of foreign sports organizations that exemplarily implement inclusion in sports practice. To deepen our understanding of the inclusive paradigm, we attended online courses organized by their umbrella organizations, studied the methods and principles essential for achieving inclusion in sports, and supplemented these insights with our own experiences.

3 Analysis of the sports offer by disability organizations

The analysis of the sports offerings by disability organizations in in Slovenia (town Maribor area and its surroundings) revealed that while the range of sports activities is extensive, no association allows participation by children, only by their adult users.

From the analysis of the second part of the research, in which the leaders of sports clubs/associations reported on their experiences and challenges in including children with special needs in their regular programs, we found that most leaders first inquire about the child's disability, impediment, or deficiency and implement certain adjustments in their work. Data on the number of children with special needs included in regular sports programs was not provided by most sports clubs/associations. Those that did provide information reported having only one to six children with special needs in their sports clubs/associations.

The main reasons cited for non-inclusion were the lack of trained personnel capable of making appropriate adjustments, hindrance to the progress of other participants, and fear of responsibility.

The analysis of the inclusion of children with special needs in sports clubs and associations showed a highly varied situation. Key findings from the analysis can be linked to foreign practices, identifying the main reasons for the non-inclusion of children with special needs in additional sports activities as follows:

Social environment:

1. Negative societal attitudes towards individuals with special needs.
2. Low level of trainer qualifications: sports clubs and associations reported that their trainers have limited knowledge and experience working with children with special needs. Most surveyed trainers expressed a need for additional education and training.
3. Inappropriate attitudes and communication towards children with special needs.
4. High costs: the groups with children with special needs are significantly smaller in number compared to others, as a higher degree of individualization is necessary for the safe conduct of training. It is also necessary to provide more coaches.

Physical environment:

1. Access issues and inadequate equipment (facilities, devices, tools).
2. Lack of programs that enable children with special needs to engage in organized sports.
3. Unadapted existing programs: although some clubs implement adjustments to their sports programs, these are often not systematic or specific enough for individual groups of children with special needs. The most common adjustments include changes in the intensity of training and individually tailored tasks.

Personal reasons:

1. Lack of confidence among trainers in their abilities.
2. Lack of confidence among parents in the abilities of trainers.
3. Time constraints for parents.
4. Financial constraints for parents.
5. Lack of parental knowledge about the importance of sports activities for their child's quality of life, available sports programs, and possible adaptive equipment and tools that would enable their child to safely engage in chosen sports activities.

Use of digital tools:

1. Digital tools, such as exercise tracking apps, virtual reality, and interactive training programs, are rarely used. However, the clubs that have introduced them reported positive effects, including increased motivation among children, better progress tracking, and more tailored training programs.

Based on these findings, we have written a handbook that formulates guidelines for improving the inclusion of children with special needs in sports activities.

4 Handbook for inclusive coaches

The handbook, developed based on the findings of our research, aims to empower coaches to successfully implement inclusive sports activities [4]. It includes guidelines and recommendations for working with children with special needs, with an emphasis on adaptations that enable these children to fully participate in organized sports activities.

The first part of the handbook defines and describes the inclusive paradigm, addressing the knowledge gaps among sports professionals on how to approach, communicate, and establish successful relationships with children with special needs.

A successful inclusive coach must possess specific knowledge and skills for working with children with special needs and create an encouraging environment where all participants can actively engage and realize their potential.

The inclusive approach of a coach is based on empathy, understanding, and respect. This requires careful planning of sports activities and adapting methods, the environment, equipment, tools, and content. Using respectful and positive language is crucial for successful communication. Coaches must develop skills to adapt the training process, be innovative in creating a motivational environment, and be adept and understanding in resolving conflicts.

The handbook describes the so-called inclusive spectrum, which includes various methods and approaches to integrate children with special needs into sports activities. Based on foreign practices, we derived inclusion models (TREE, STEP, and CHANGE IT), which are practical tools designed to support coaches in adapting and modifying sports activities.

Additionally, the handbook outlines an important friendship system that promotes peer cooperation and creates a supportive network for children with special needs.

The second part of the handbook provides detailed guidelines for adapting sports training for each group of children with special needs.

By following these recommendations and guidelines, coaches can contribute to a more inclusive environment where every child feels accepted and valued.

5 Proposed adaptations for implementing inclusive sports training

When implementing inclusive sports training, it is crucial to understand the specific needs of each child, the limitations they face, and the specific adaptations required to enable safe participation in sports activities, along with the appropriate digital tools. Each child has unique characteristics that affect their abilities and needs during training.

The following summarize key adaptations for each group to ensure full participation and optimal development of every child.

5.1 Children with Intellectual Disabilities

Adaptations for children with intellectual disabilities include using simple and clear instructions. Significant time should be dedicated to reinforcement, and it is essential to strive for a predictable and structured training environment. Coaches should encourage positive interactions and praise achievements, thereby increasing the child's motivation and self-esteem.

Relevant digital tools include applications for visualizing exercises (as videos or pictures), which help children understand and follow instructions. Additionally, coaches can use apps to create structured training schedules, allowing children to better plan and execute activities.

5.2 Blind and Visually Impaired Children

For blind and visually impaired children, it is crucial to adapt the training environment to be safe and accessible. The use of auditory signals, tactile markers, and verbal descriptions of exercises can significantly enhance understanding and safety. Coaches must pay attention to the orientation and mobility of these children, ensuring they feel safe and accepted.

Digital tools include auditory applications that guide children through exercises and devices for auditory orientation. These tools can help children navigate the space and participate in training without additional barriers. Additionally, the use of braille displays for presenting information about exercises is beneficial.

5.3 Deaf and Hard-of-Hearing Children

Adaptations for deaf and hard-of-hearing children include using visual signals, gestures, and clear facial expressions. Coaches must ensure that all visual representations of tasks are clear and visible. Communication should be adapted so that children can follow instructions and participate in the training process without difficulty.

Digital tools include speech-to-text applications and video instructions with subtitles. Coaches can also use video calls with sign language interpreters to facilitate communication.

5.4 Children with Speech and Language Disorders

When working with children with speech and language disorders, it is important to use short and simple instructions and visual aids. Coaches should encourage communication in various ways, including gestures, picture cards, and other visual tools to facilitate understanding and participation.

Digital tools include visual communication apps and interactive storytelling apps that assist in learning and communication. Applications for creating picture communication boards are also useful, enabling children to express their needs and desires more easily.

5.5 Children with Motor Disabilities

Adaptations for children with physical disabilities involve adjusting exercises according to their physical abilities and using specific equipment, such as wheelchairs or orthopedic aids. Coaches need to be creative in designing exercises that allow participation from all children, regardless of their physical limitations.

Digital tools include motion control applications that aid in rehabilitation and virtual reality for simulating various sports activities. Movement tracking devices can also be used to monitor progress and adjust exercises based on capabilities.

5.6 Children with Long-term Illness

For chronically ill children, it is crucial to consider their health limitations and adjust the intensity of the training. Coaches must be aware of the children's health conditions and any contraindications for specific physical activities. Training should be tailored to enhance the health and well-being of the children.

Digital tools include health and fitness tracking apps that allow for adjusting training programs based on health conditions. Apps for recording symptoms and medications are also useful, enabling children to monitor their health status and adjust their activities as needed.

5.7 Children with Learning Disabilities

Adaptations for children with learning disabilities involve using multisensory approaches and offering various learning methods. Coaches should use a combination of visual, auditory, and kinesthetic methods, providing additional support and time for understanding instructions.

Digital tools include interactive learning and brain training apps that help improve cognitive functions and motor skills. Applications for creating visual schedules and monitoring progress during training are also beneficial.

5.8 Children with Autism Spectrum Disorders

Adaptations for children with autism spectrum disorders include creating a structured and predictable environment and using visual schedules and clear rules. It is important to reduce (or increase) sensory stimuli and adapt the training to allow focus and sustained attention.

Digital tools include apps for creating visual schedules and social stories that help understand and adapt to changes. Sensory integration apps are also useful, helping children manage sensory stimuli during training.

5.9 Children with Emotional and Behavioral Disorders

For children with emotional and behavioral disorders, it is important to create a supportive and stable training environment. Coaches should use positive reinforcements, set clear boundaries and rules, and be consistent in their training approach. Adaptations should enable children to manage their emotional and behavioral challenges and participate in sports activities.

Digital tools include apps for meditation and emotional regulation that help children manage stress and anxiety. Apps for recording and monitoring emotional states are also useful, enabling children and coaches to recognize behavior patterns and adjust training accordingly.

6 Conclusions

The inclusion of children with special needs in organized sports activities is crucial for their social, emotional, and physical well-being. This article presents various adaptations necessary for the successful integration of this group of children into sports activities. We found that adaptations depend on the specific needs of each group of children, making it essential for coaches to understand and recognize these characteristics and needs, maintain a positive attitude, be open to adjusting the training process, and seek innovative solutions.

Adaptations for individual groups of children with special needs are essential for the effective implementation of inclusive sports training. With the right approach and the use of digital tools, coaches can create an inclusive environment where each child feels accepted and valued, contributing to their optimal development and full participation in sports activities.

The use of digital tools is fundamental in facilitating these adaptations and enabling the full participation of children with special needs in sports. Applications for visualizing exercises, auditory and visual signals, interactive stories, motion control, and health monitoring are just some of the tools that can significantly improve the quality of training and increase children's motivation.

It is also important to emphasize the need for continuous education and training for coaches working with children with special needs. Only with appropriate knowledge and skills can they create an inclusive and supportive environment.

Future efforts should focus on continuing research and developing new approaches and technologies to support inclusion in sports. This will ensure that sports are accessible to all children, regardless of their abilities or special needs, providing them with equal opportunities for holistic development.

Acknowledgments

The research was co-funded by the European Commission, in the framework of the project European Accessibility Resource Centre - AccessibleEU (VT/2022/027).

References

[1] Herman Berčič. 2001. Športna rekreacija v funkciji kakovosti življenja prebivalcev Slovenije. V H. Berčič (ur.), *Zbornik 2. Slovenskega kongresa športne rekreacije* (9–20). Športna unija Slovenije.

[2] Anita Goltnik Urnaut. 2007. *Šolske športne dejavnosti in samopodoba mladostnikov z ovirami v gibanju*. [Doktorska disertacija, Univerza v Ljubljani, Pedagoška fakulteta].

[3] Kefallinou Anthoula, Simoni Symeonidou and Cor JW Meijer. 2020. Understanding the value of inclusive education and its implementation: A review of the literature. *PROSPECTS, 49*(3–4), 135–152.

[4] Nuša Maver. 2024. *Vključevanje otrok s posebnimi potrebami v izvenšolske športne dejavnosti.* [Magistrsko delo, Univerza v Mariboru, Pedagoška fakulteta].

[5] Rajko Vute. 1999. *Izziv drugačnosti v športu.* Narodna in univerzitetna knjižnica v Ljubljani.

[6] Zakon o usmerjanju otrok s posebnimi potrebami (ZUOPP-1). 2011. Uradni list RS, št. 58/11, 40/12 – ZUJF, 90/12 in 41/17 –ZOPOPP. Accessed on: http://pisrs.si/Pis.web/pregledPredpisa?id=ZAKO5896#

[7] Isabel Cristinna do Nascimento da Silva and Ana Cristina de Jesus Alves. 2020. Identification of assistive technologies in paralympic sports: contributions and barriers. *Cadernos Brasileiros de Terapia Ocupacional*, *28*, 917-930.

A micro-Learning Units Package for Improving Inclusive Digital Education in HEI

Sérgio D. Correia
Lusófona University
Lisbon, Portugal
Portalegre Polytechnic University
Portalegre, Portugal
sergio.correia@ulusofona.pt
scorreia@ipportalegre.pt

Ana Cunha
Lusófona University
Lisbon, Portugal
ana.cunha@ulusofona.pt

Maja Pušnik
Boštjan Šumak
maja.pusnik@um.si
bostjan.sumak@um.si
University of Maribor
Maribor, Slovenia

Abstract

In Higher Education Institutions (HEIs), digital inclusion plays a crucial role in providing equitable and just access to educational materials for every student, irrespective of their varied origins, capacities, or impairments. To leverage HEIs and their ability to implement an inclusive educational system, this work considers identifying the factors that impact e-inclusion in HEIs to create a new content package of micro-learning units. These will cover categories such as leadership techniques, teamwork and networking, infrastructure needs, professional development, pedagogical support systems, classroom implementation, assessment procedures, and digital competency. The structured pedagogical content is supplied to the user through a recommendation model that constitutes an online self-evaluation tool.

Keywords

Inclusion, Learning Unit, Higher Education Institutions, Education, Educational Content

1 Introduction

Digital technologies have revolutionized the landscape of Higher Education Institutions (HEIs), enhancing accessibility and facilitating innovative teaching and learning methods. However, this digital transformation also underscores the imperative for digital inclusion, ensuring that all students have equitable access to educational resources regardless of their diverse backgrounds and abilities. Digital inclusion in HEIs is not merely about providing access to digital tools but involves a comprehensive strategy that encompasses leadership, infrastructure, professional development, and pedagogical innovations [6, 2].

Micro-learning units are small, self-contained learning modules designed to deliver targeted educational content in a flexible and accessible manner. These units can be particularly effective in promoting digital inclusion by allowing students, teachers, and HEI staff to engage with material at their own pace and according to their individual learning needs. Recent studies have shown that micro-learning can enhance engagement and retention by breaking down complex subjects into manageable segments [1, 3]. To create a comprehensive package of micro-learning units aimed at improving inclusive digital education, it is essential to identify the key factors that impact e-inclusion in HEIs. These factors include leadership techniques, teamwork and networking, infrastructure needs, professional development, pedagogical support systems, classroom implementation, assessment procedures, and digital competency. By addressing these areas, the learning units can be tailored to provide practical and actionable insights that support educators and administrators in fostering an inclusive digital environment [4, 5].

This paper presents the development of a *micro-Learning Units Package* designed to enhance inclusive digital education in HEIs. By incorporating the identified factors that impact e-inclusion, this package aims to provide a structured and flexible pedagogical content delivery system. The micro-learning units will cover various essential categories and will be supplied to users through a recommendation model that includes an online self-evaluation tool. This approach ensures that the learning experience is personalized, responsive to individual needs, and conducive to fostering a more inclusive digital education environment.

The remaining paper is organized as follows. Section 2 addresses the key factors previously identified as enablers for digital inclusive education, and Section 3 describes the Learning package, its structure and content. Finally, Section 4 concludes the paper.

2 Factors for Inclusive Digital Education as Building Blocks

Identifying the factors that affect digital accessibility is here considered a previous starting point for constructing educational content. Policymakers, educators, and institutions can create plans and initiatives to support e-inclusion in HEI by recognizing these elements and how they interact. In this case, a set of micro-learning units was produced, making educational content available that relays and is organized based on the structure of the identified factors [4, 5].

The overall methodology consisted of four different stages. Firstly, a theoretical framework of inclusive digital education was developed, considering technology, pedagogy, content, management aspects, and different e-learning settings and modes. From this analysis, factors and indicators were obtained. Secondly, online workshops for refinement and validation of the variables and indicators were conducted in five countries (Italy, Portugal, Slovenia, Spain, and Turkey). In the workshops, the audience discussed and evaluated the framework, the factors, and the indicators). With the framework, the micro-learning package was created, consisting of a wide range of units as e-learning materials that cover all the factors and indicators previously identified. Thirdly, a second set of workshops was conducted to refine and validate the e-learning materials produced. Finally, a piloting stage was implemented in five European Universities, where management

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

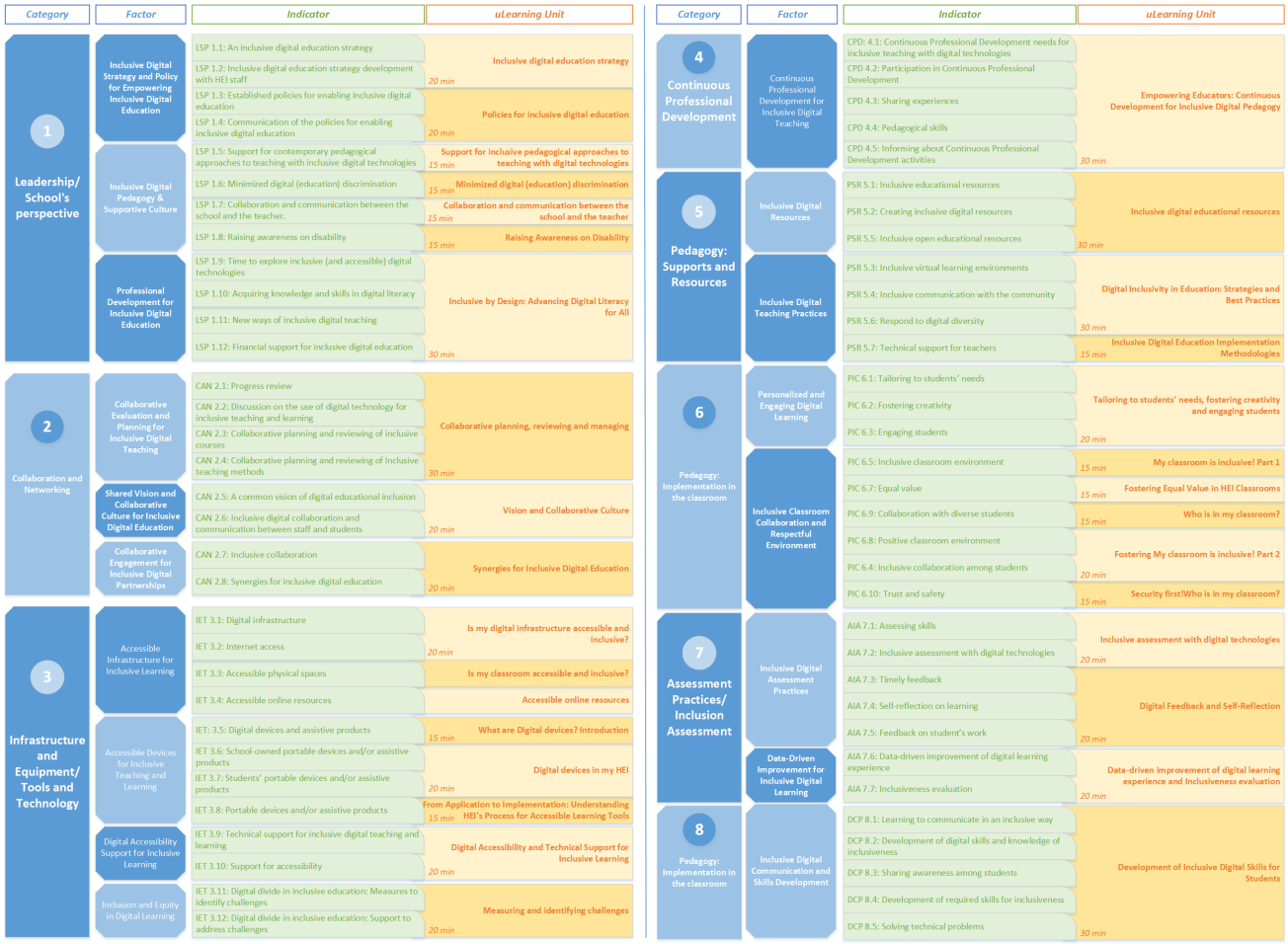

Figure 1: Micro-Learning Units Mapping with Categories, Factors, Indicators, and Estimated Duration

and teachers were invited to test the entire pipeline and evaluate its performance.

The model of factors enabling inclusive digital education was categorized into 8 categories: (1) Leadership/ School's perspective; (2) Collaboration and Networking; (3) Infrastructure and Equipment/ Tools and Technology; (4) Continuous Professional Development; (5) Pedagogy: Supports and Resources; (6) Pedagogy: Implementation in the classroom; (7) Assessment Practices/ Inclusion Assessment; and (8) Student Digital Competence/ Student's Perspective, where each category embraces 1 to 4 factors. Besides each category, the theoretical model that identifies the factors is operationalized by considering a set of indicators. By tracking these indicators, stakeholders can gain insights into the effectiveness of digital inclusive education initiatives and identify areas needing improvement. In the context of digital inclusive education, an indicator is a specific measure or metric that provides information about the extent to which digital education resources and opportunities are accessible, equitable, and effective for all learners. These indicators help assess and monitor various factors such as access to technology, digital literacy, inclusivity, engagement, policy support, and educational outcomes, allowing educators, policymakers, and stakeholders to identify strengths, gaps, and areas needing improvement in implementing digital inclusive education.

For the first category, Leadership/School's perspective, three factors are considered: (1.1) Inclusive Digital Strategy and Policy for Empowering Inclusive Digital Education: This factor reflects the importance of an inclusive digital strategy, collaboration with leaders and teachers, and the establishment of enabling policies to reduce barriers to learning and participation; (1.2) Inclusive Digital Pedagogy & Supportive Culture: This factor encompasses supporting contemporary pedagogical approaches with inclusive digital technologies, minimizing digital discrimination, and fostering collaboration and communication between HEI staff and the organization; (1.3) Professional Development for Inclusive Digital Education where scheduled time for staff to explore inclusive digital technologies and supporting their acquisition of digital literacy knowledge and skills are considered.

When considering the second category, Collaboration and Networking, a set of three factor are considered: (2.1) Collaborative Evaluation and Planning for Inclusive Digital Teaching: highlighting the importance of reviewing progress in teaching and learning with inclusive digital technologies, discussing the advantages and disadvantages of inclusive teaching, and engaging in collaborative planning for inclusive courses and teaching methods; (2.2) Shared Vision and Collaborative Culture for Inclusive Digital Education: This factor emphasizes the importance of promoting a common vision of digital educational inclusion

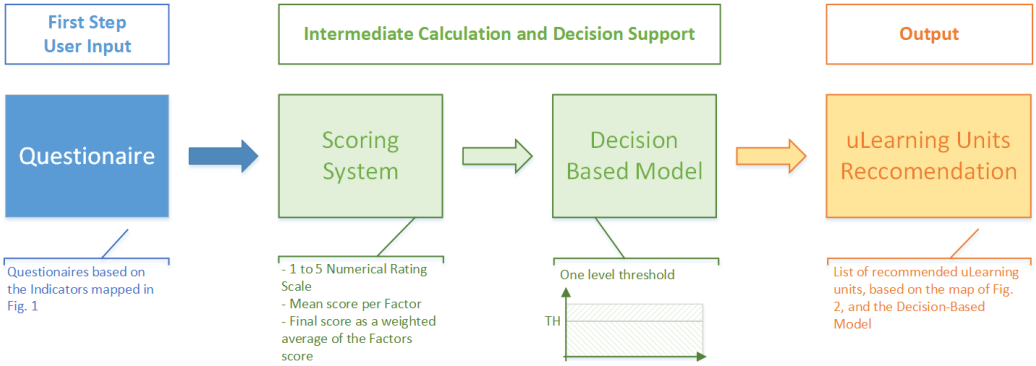

Figure 2: Recommendation Tool Model

among the main actors in the institution (management, pedagogical staff, students, and parents), as well as fostering inclusive digital collaboration and communication between staff and students; and (2.3) Collaborative Engagement for Inclusive Digital Partnerships: This factor highlights the importance of enabling inclusive collaboration with local communities, caregivers, and parents through digital technologies, as well as actively collaborating with other HEIs or organizations to support the use of inclusive digital technology.

Regarding Infrastructure and Equipment/ Tools and Technology, the third category, four factors are considered: (3.1) Accessible Infrastructure for Inclusive Learning: This factor highlights the importance of both digital and physical infrastructure in creating an inclusive learning environment; (3.2) Accessible Devices for Inclusive Teaching and Learning: This factor emphasizes the importance of providing accessible digital devices and assistive products for inclusive teaching in HEI; (3.3) Digital Accessibility Support for Inclusive Learning: This factor emphasizes the importance of HEI providing support for digital accessibility in order to facilitate inclusive learning; and (3.4) Inclusion and Equity in Digital Learning: This factor emphasizes the importance of HEI's efforts to identify and address the digital divide and challenges related to students' learning needs and socio-economic backgrounds in the context of digital learning.

Only one factor is identified for the fourth category, Continuous Professional Development: (4.1) Continuous Professional Development for Inclusive Digital Teaching. This factor emphasizes the importance of HEI leaders discussing and addressing continuing professional development needs for inclusive teaching with digital technologies. It also highlights the importance of providing staff with opportunities to participate in CPD and fostering the sharing of experiences within the school community.

Concerning the fifth category, Pedagogy: Supports and Resources, two factors are considered: (5.1) Inclusive Digital Teaching Practices: This factor emphasizes the importance of HEI teachers using virtual learning environments and digital technologies in an inclusive way, as well as being trained and instructed on how to address student diversity; and (5.2) Inclusive Digital Resources: This factor emphasizes the importance of HEI staff searching for inclusive digital educational resources, creating digital resources to support inclusive teaching, using inclusive open educational resources, and developing and updating resources that support inclusive learning and participation.

The sixth category, Pedagogy: Implementation in the classroom, involves three factors: (6.1) Personalized and Engaging Digital Learning: This factor emphasizes the importance of HEI staff using digital technologies to personalize and tailor their teaching to student's individual needs, incorporating digital learning activities that foster creativity, and setting inclusive digital learning activities that actively engage and motivate all students; (6.2) Inclusive Classroom Collaboration and Respectful Environment: This factor focuses on promoting inclusive collaboration and creating a respectful classroom environment using digital technologies; and (6.3) Enhanced Pedagogical Digital Inclusiveness: This factor emphasizes the focus on enhancing digital inclusiveness among pedagogical staff.

The seventh category, Assessment Practices/ Inclusion Assessment, embraces three factors: (7.1) Inclusive Digital Assessment Practices: This factor emphasizes the importance of HEI staff using inclusive and accessible digital technologies for assessing students' skills; (7.2) Digital Feedback and Self-Reflection: This factor emphasizes the importance of HEI staff using inclusive digital technologies to provide timely feedback to students, enable students to self-reflect on their own learning and facilitate peer feedback on other student's work, and (7.3) Data-Driven Improvement for Inclusive Digital Learning: This factor highlights the focus on leveraging digital data analysis and evaluation metrics to identify students' needs and improve their inclusive digital learning experience.

Finally, the last category, Student Digital Competence/ Student's Perspective, is considered with one factor: (8.1) Inclusive Digital Communication and Skills Development: This factor emphasizes the importance of HEI ensuring that students learn to communicate in an inclusive way using digital technologies and that they develop their digital skills and knowledge on inclusiveness across subjects. The factor reflects the focus on promoting inclusive communication practices and fostering the development of digital skills in relation to inclusivity.

3 The Micro-Learning Units Package

Based on the factors previously identified and described in Section 2, a newly package of micro-learning units was created. A micro-learning unit is a small, focused segment of educational content designed to teach a specific skill or concept in a brief period. These units are typically short, ranging from a few minutes to about 15 minutes, and are meant to be easily digestible and accessible. To organize the micro-learning units and to guarantee

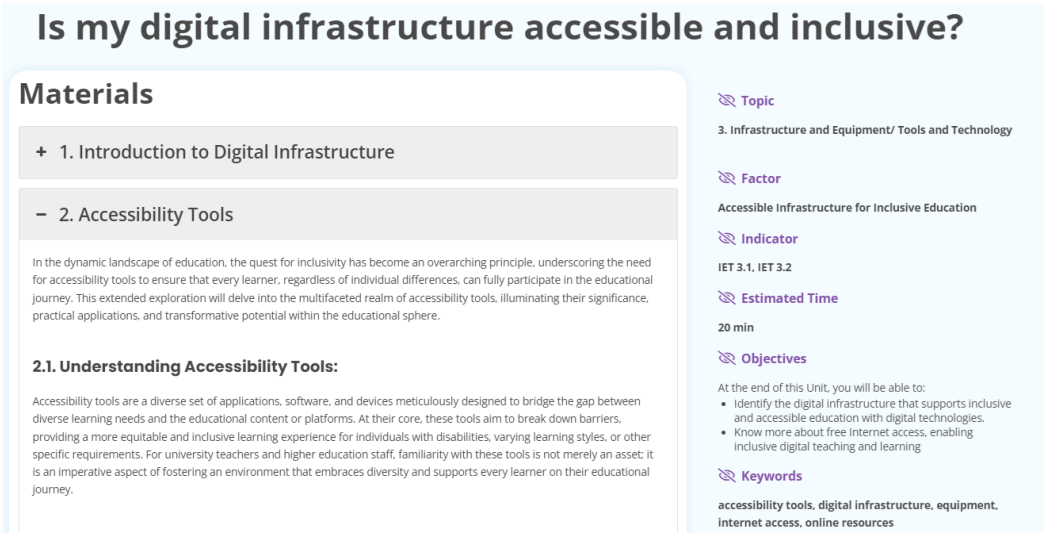

Figure 3: Example of a Micro-Learning Unit Content

their integrity, the units are correlated to the indicators associated with each factor, also allowing directing the reader with the help of a self-evaluation tool as described in Fig. 2. The figure presents a comprehensive framework for the micro-Learning Units Package aimed at improving inclusive digital education in Higher Education Institutions (HEIs). It is organized into several categories, each addressing specific factors contributing to digital inclusion. Each category is further divided into factors, indicators, and corresponding micro-learning units with specified durations.

The user is first invited to answer a questionnaire that relies on the indicators. From this point, a scoring system evaluates the user's perception of each factor, and globally, in its aptitude in relation to digital and inclusive education. Then, a decision-based model advises the user on which micro-learning units it should be involved in. The estimated time frame for each unit varies from 15 to 30 minutes, depending on how many indicators it covers, since some indicators are cross-correlated and are thus blended into one micro unit. A total of 32 micro-learning units constitute the overall package, totaling seven hours, although the purpose of the tool is for the user to only study the units related to the topics they least mastered. Besides, the tool can be used cyclically, meaning it can be used several times until the overall score obtained from the self-evaluation reaches a satisfactory value, allowing the user to manage the learning path. Both the self-evaluation tool and the micro-Learning unit contents are allocated online at www.set4inclusion.eu. Figure 3 exemplifies how the unit *"Is my digital infrastructure accessible and inclusive?"*, related to indicators *"IET 3.1: Digital infrastructure"*, and *"IET 3.2: Internet access"*, associated to the factor *"Accessible Infrastructure for Inclusive Learning"*, under the category *"Infrastructure and Equipment/Tools and Technology"* is presented to the user.

When considering the presented micro-Learning package, wider content is broken down into small, manageable pieces, making it easier for learners to consume and understand, where each unit targets a single, specific learning objective, ensuring that learners can quickly grasp the intended concept or skill. Designed to be accessed on-demand through the self-evaluation tool, it allows learners to engage with the material at their own pace and on their own schedule. Also, the concise and focused nature of micro-learning units can improve retention by minimizing cognitive overload and reinforcing key points through repetition and varied presentation. Although the micro-Learning units are integrated into a larger educational framework, they are also effective as standalone lessons.

4 Conclusion

Using a self-evaluation tool, a set of micro-learning units previously mapped using factors and indicators of inclusive digital education is made available to a user through a recommendation model.

The global set of micro-training units covers a broad set of skills, considered based on the factors that involve inclusive digital education. With this procedure, the personnel involved in higher education institutions, teachers or staff, acquire the necessary skills to provide truly inclusive digital education in their institution.

Acknowledgments

This research was conducted within the activities of the Self-Evaluation Tools for e-Inclusion in HEI (SET4Inclusion) project (2022-1-SI01-KA220-HED000088368), co-funded by the Erasmus+ Programme of the European Union.

References

[1] Mary Jo Dolasinski and Joel Reynolds. 2020. Microlearning: a new learning model. *Journal of Hospitality & Tourism Research*, 44, 3, 551–561.

[2] Paulo Ricardo dos Santos, Débora NF Barbosa, Eduardo G Azevedo Neto, Jorge LV Barbosa, Sérgio D Correia, and Valderi RQ Leithardt. 2021. Learning and well-being in educational practices with children and adolescents undergoing cancer treatment. *Education Sciences*, 11, 8, 442.

[3] Karen Mossberger, Caroline J Tolbert, and Ramona S McNeal. 2007. *Digital citizenship: The Internet, society, and participation*. MIt Press.

[4] Maja Pušnik, Katja Kous, Tatjana Welzer Družovec, and Boštjan Šumak. 2024. Identification and analysis of factors impacting e-inclusion in higher education. In *Information Modelling and Knowledge Bases XXXV*. IOS Press, 308–317.

[5] Boštjan Šumak, Sergio Duarte Correia, Ana Cunha, Tuncer Can, Irfan Simsek, Katja Kous, and Maja Pušnik. 2024. Identification of factors that impact e-inclusion in hei. In *2024 47th MIPRO ICT and Electronics Convention (MIPRO)*, 478–483. DOI: 10.1109/MIPRO60963.2024.10569746.

[6] UNESCO. 2020. *Global Education Monitoring Report 2020: Inclusion and education: All means all*. UNESCO, Paris. https://unesdoc.unesco.org/ark:/48223/pf0000373718.

Segmentation of students with special needs at UL

Andrej Košir*
Janez Zaletelj*
andrej.kosir@fe.uni-lj.si
janez.zaletelj@fe.uni-lj.si
Fakulteta za elektrotehniko, Univerza v Ljubljani
Ljubljana, Slovenia

Janja Košir
Pedagoška Fakulteta, Univerza v Ljubljani
Ljubljana, Slovenia
janja.kosir@pef.uni-lj.si

ABSTRACT

This paper deals with the identification and interpretation of segments of students with disabilities at the University of Ljubljana. The data on which this segmentation is based are the students' responses to a dedicated questionnaire created through an operationalization process according to the selected aspects and objectives of the segmentation.

The segmentation aimed to identify homogeneous groups of students with disabilities in order to 1. improve the understanding of students' needs, 2. prepare reliable data for the selection of technological support for students and 3. create the basis for a subsequent project on ICT-based support for special needs students.

Through the operationalization process, we identified five areas (aspects), namely 1. Technology and overcoming study barriers, 2. Technology and study outcomes, 3. ICT and Study Obligations, 4. ICT and Study Skills, and 5. Opportunities to use ICT technology. Based on student responses, we identified segments for the first three areas, with all three areas well covered by three segments each. We identified three segments in each area: 1. Technology Enthusiasts (accept everything), 2. Skeptical Users (reject everything but the exceptions), and 3. Picky Users (accept almost everything but the exceptions). From the second and third segments, we extracted the main characteristics by technology and by activity. The results are applicable for the next steps in technology support for students with special needs.

KEYWORDS

user segmentation, special needs students, segmentation algorithm

1 INTRODUCTION

Effective technological support for students with special needs is crucial for modern teaching and learning at universities. Over the last decade, the landscape of teaching and learning has changed rapidly [17].On the other hand, the rapid development of information and communication technologies [6] and studies on technological support for students [4] has added a variety of new support options. There is no effective technological support without prior knowledge of the needs of the users - in our case, the specific needs of our students.

In this paper, we present the operationalization of the segmentation instrument (aspects and questions) and the results of the segmentation of students with disabilities at the University of Ljubljana (UL). The initial goal of segmentation is to plan and implement effective and needs-based support for students with disabilities at UL.

We have concluded that this study does not require ethical review. The study is fully consistent with the purpose of collecting data from students with disabilities and its results will be used for the direct benefit of the population.

1.1 Aims of the student segmentation

The main aim of the segmentation is to learn about the main groups of students with disabilities in relation to the opportunities for technological support for their studies provided by the university. The sub-objectives are:

(1) Identify the groups of students with disabilities at UL along with their basic characteristics.
(2) Identify meaningful groups of active students with disabilities.

To achieve the goal ad 1. we designed a questionnaire. The design of the questionnaire resulted in 12 questions, with 5 main sub-questions and a larger number of sub-questions.

To achieve objectives ad 2, we conducted an extensive data analysis (see Sec. 4) and consulted domain experts.

2 STATE OF THE ART

2.1 User segmentation

User segmentation is the process of dividing users into different groups or segments based on common characteristics. It was developed in the field of business and management. An organization can segment users by language preference, product version, geographic region or user personality [1]. A similar segmentation has been successfully applied to other areas, e.g. to the users of ICT and also to the area of ICT in special education [6].

Data mining techniques entered the field quite early on [21]. Machine learning-based techniques are the most important approach to user segmentation today [2].

Successful segmentation methods lead to homogeneous subgroups of users. A necessary next step is to understand these segments, i.e. to define and understand their typical representatives. Such a representative is called a persona, and to clearly understand the part of their behavior that is relevant to them, they are described as a living person [20]. A persona is therefore a fictional character whose characteristics and goals best fit the segment.

2.2 Operacionalisation

Operationalization is a process of 1. selecting relevant aspects of the designed instrument (set of questions) and 2. selecting an initial set of questions representing the selected aspects. There is a long history of research on this approach [16]. It is based

*Both authors contributed equally to this research.

Information Society 2024, 10–14 October 2022, Ljubljana, Slovenia

https://doi.org/https://doi.org/10.70314/is.2024.DIGIN.9

on human expert judgment. The aim of operationalization is to construct a measurement instrument that is used in data collection [12]. The validity and reliability of the resulting instruments are of central importance and the research community has developed strict guidelines on how to achieve and ensure this [3]. In our case, we have focused on relevant aspects of technological support for students with special needs.

2.3 Unsupervised clustering for user segmentation

User segmentation is a subfield of the highly developed field of customer segmentation. Machine learning techniques found their way into customer segmentation decades ago [19]. From various data mining approaches [21], the focus shifted to neural networks [18] and deep learning [15].

Unsupervised clustering with visualization of the cluster hierarchy is a necessary step in customer segmentation [11]. In the case of this study, understanding the user segments obtained is very important. The technique of explainable customer segmentation is discussed in [14].

3 MATERIALS AND METHODS

3.1 Operacionalisation and existing instruments

The operationalization procedure of this research focused on the existing support for students with special needs at our and other universities. Theoretical knowledge and practical experiences in supporting students with special needs were also taken into account. This is crucial to achieve good validity and reliability of the resulting instrument in fewer iterations.

To incorporate existing measurement instruments related to the use and benefit of assistive technologies, we also examined available measurement instruments. As early as 1996, the authors of [7] developed a scale "Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST)". The instrument contains 18 items and two dimensions. The construct was later reviewed in [8], where 12 items were further selected.

A scale called the Psychosocial Impact of Assistive Devices Scale (PIADS) was developed by the authors of [13]. The PIADS is a 26-item self-report questionnaire to assess the impact of an assistive device on functional independence, well-being and quality of life. The construct is three-dimensional and includes 1. competence (measures feelings of competence and effectiveness), 2. adaptability (indicates willingness to try new things and take risks) and 3. self-esteem (indicates feelings of emotional health and happiness).

The authors Dijcks et. al developed a scale (one-dimensional construct) to assess the quality of service delivery in the provision of assistive technology (KWAZO) [9]. It aims to assess the quality of the provision of assistive devices from the customer's perspective. The instrument consists of seven questions relating to accessibility, knowledge, coordination, efficiency, flexibility and user influence. The reliability of the scale is rated as very good.

As a result of all considerations, we decided to include the following aspects:

(1) Technology and overcoming study barriers
(2) Technology and study outcomes
(3) ICT and Study Obligations
(4) ICT and Study Skills
(5) Opportunities to use ICT technology

To cover these five aspects, we also constructed, selected and modified questions that led to the final instrument (not listed here for space reasons).

3.2 Participants and data collection

The selected population is all UL students with disabilities. Given the estimated number of 700 to 800 such students, the entire population was included in the sample.

The data collection was carried out by the University of Ljubljana (UL) administration services. They provided us with a list of all students with special needs at ULat UL. We then manually screened this list with the baseline descriptions and selected 723 respondents.

The inclusion criteria for selection were self-selected categories of special needs selected by the students at the time of enrolment. They covered general special needs, and deficits from disabilities (hearing, vision, speech, physical, emotional, mental health). There were no exclusion criteria for selection into the sample.

3.3 Unsuprvised clustering for user segment determination

We applied the unsupervised clustering technique K-Means with dendrogram visualization [5]. The feature space was a space of participant responses, no dimensionality reduction or location-dependent transformation [10] or similar was used. The Euclidean distance is used for K-means clustering. Other distances lead to similar clusters. Since all responses were on the same Likert scale, no prior scaling was performed. We used elbow curves to determine the optimal number of segments and basic statistics to determine the most important characteristics of the selected segments. The initial number of clusters was set to $k = 12$.

4 EXPERIMENTAL RESULTS

4.1 Student data

The sampling method chosen was to send emails to the e-mail addresses provided by the students with disabilities at the time they obtained their special education student status. The inclusion and exclusion criteria were specified in subsection 3.2. The questionnaire was administered via the web-based system 1ka (https://www.1ka.si/d/sl) and the questionnaire with response categories is available on request. Invitees received an email with explanations and instructions.

The invitations were sent out in three phases

(1) First invitation: by e-mail from the university e-mail address;
(2) Second invitation: via the Disability representatives at the faculties and academies;
(3) Third invitation: via the Association of Students with Disabilities

The invitation was sent to 733 people. A total of 18 (3.4%) responses to the first invitation were received within one week, next 7 to the second invitation and next 18 to the third invitation, altogether 43 (5.9%). At the time of study design, we estimated that the response rate of respondents would be around 10%. We did not formally identify the reasons for this low response rate, but we did gather some opinions. These can be grouped as follows:

(1) There is enough freely available technology that I can use myself and I do not need any special support from the university;
(2) In the responders' mind, the university does not have enough technical support to help individuals;

We present the results of the segmentation according to the criteria specified in Subsec. 3.1 identified aspects.

4.2 Basic statistics

The breakdown of the 43 respondents by gender can be found in Fig. 1 (top left), where NA indicates those who did not wish to state their gender.

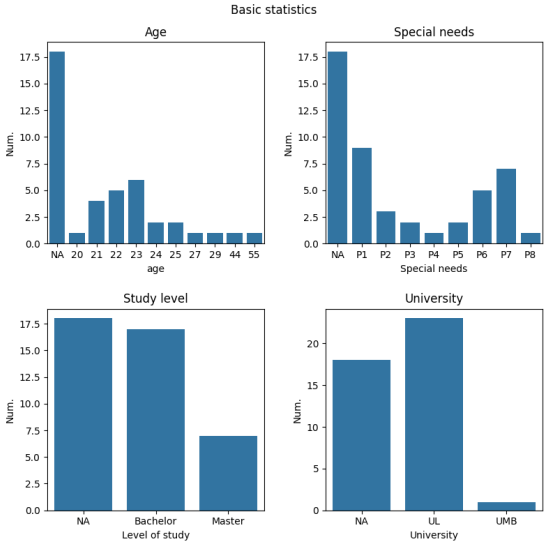

Figure 1: Response of participants: by gender (top left), age (second row left), special needs (second row right), study style (third row left) and university (third row right), where UL stands for the University of Ljubljana and UMB for the University of Maribor

The histogram by age is shown in Fig. 1 (center left), where NA denotes those who did not want to reveal their age. Respondents aged 44 and 55 were excluded from the analysis. The responses by special needs are shown in figure 1 (middle right), where the meanings of the special needs are as follows:

P1: 'Deficits in certain areas of learning (dyslexia, dysgraphia, dyscalculia ...)',
P2: 'Physical disability',
P3: 'Partial or total hearing loss',
P4: 'Partial or total loss of vision',
P5: 'Speech-language difficulties',
P6: 'Emotional and behavioral disorders',
P7: 'Long-term or chronic illness',
P8: 'Autism spectrum disorder',

In terms of university, one student was from the University of Maribor and 18 students did not specify their university. We assume that most of the students were from the University of Ljubljana.

As there are not enough complete responses for aspects Q4 and Q5 (less than 15) to draw more reliable conclusions, we only report the results for the first three aspects Q1: Technology and overcoming study barriers, Q2: Technology and study outcomes and Q3: ICT and Study Obligations.

The interpretation of the identified segments is based on manual inspection of identified clusters' specifics such as frequency of answers etc. Due to lack of space, we cannot reproduce these figures here.

4.3 Aspect Q1: Technology and overcoming study barriers

The main question was: "Please indicate how important each of the ICT assistive technologies listed is to you in overcoming the challenges you face in your studies due to your own specific needs."

Seg.	Q1a	Q1b	Q1c	Q1d	Q1e	Q1f
1	4.3	4.0	5.6	6.2	5.9	6.2
2	4.4	3.9	2.9	2.5	2.3	2.9
3	4.1	3.6	5.0	5.2	4.8	6.2
	Q1g	Q1h	Q1i	Q1j	Q1k	Q1l
1	5.9	4.1	6.1	5.5	4.9	6.0
2	2.2	3.5	4.0	3.6	3.2	3.4
3	5.3	3.6	3.5	3.8	3.9	5.3

Table 1: Aspect Q1: Averages of answers per segment.

According to the inertia curve and the dendrogram of the development of the segments, the number of identified segments can be set to 3 or 5. In line with the segment structure, we have opted for three segments.

The observed characteristics by segment are:

Seg. 1: The answers to all questions are the highest, i.e. all technologies are rated as very important. These are **technology enthusiasts**.
Seg. 2: Most questions are answered with low values. These are **technology sceptics**. Little importance is attached to most technologies, with the exception of e-materials, e-environments and multimedia content. This segment therefore scores well for e-materials, but not for content conversion tools, etc.
Seg. 3: Importance varies considerably on average. These are those who believe in and use some technologies but not others. They rate most technologies well, with the exception of visual and design customization tools.

4.4 Aspect Q2: Technology and study outcomes

The guiding question was: "Please indicate how important each of the ICT support services listed is to you in overcoming the challenges you face in your studies due to your own specific needs."

The number of segments was determined by combining the dendrogram and the "inertia" curve". We decided on 3 segments.

The observed characteristics by segment are:

Seg. 1: Technologies are of varying importance. These are **critical users**. They rate most technologies well, with the exception of audio-to-sketch, dictation, e-interpreting and audio-to-text tools.
seg. 2: They rate all technologies as very important. This is **technology Enthusiasts**, the first segment from a segmentation into two segments.

Seg.	Q2a	Q2b	Q2c	Q2d	Q2e	Q2f
1	3.4	3.0	3.4	2.6	3.1	4.3
2	4.4	6.0	4.9	6.2	6.3	5.8
3	1.5	1.5	1.0	1.0	1.0	1.0
	Q2g	Q2h	Q2i	Q2j	Q2k	
1	4.1	3.9	4.3	3.0	6.3	
2	5.0	5.0	5.3	5.7	6.2	
3	2.5	1.5	1.5	2.5	2.0	

Table 2: Aspect Q2: Averages of answers per segment.

Seg. 3: All technologies are classified as unimportant. These are **technology sceptics**. They classify most technologies as unimportant, with the exception of electronic communication and customized hardware.

4.5 Q3: ICT and Study Obligations

The guiding question was: "Please indicate to what extent you consider the use of ICT support important to fulfil the study requirements listed below."

Seg.	Q3a	Q3b	Q3c	Q3d	Q3e	Q3f	Q3g
1	4.2	3.6	2.4	2.2	4.4	2.2	5.4
2	4.2	4.5	5.0	4.9	5.0	4.9	5.9
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0

Table 3: Aspect Q3: Averages of answers per segment.

The number of segments was determined by combining the dendrogram and the "inertia" curve". We estimate that a reasonable number of segments is again 3.

The observed characteristics by segment are:

Seg. 1: The technologies are characterized by different applicability. These are **Critical Users**, which are Segment 1 of a two-segment segmentation. All technologies are classified as useful, with the exception of ICT to support independent work, to support group work and to support examination requirements.

Seg. 2: In this segment, all technologies are rated as very useful. This is **Technology Enthusiasts**, which is virtually identical to segment 2 of the two-segment segmentation.

Seg. 3: Here, the majority of respondents consider the technologies to be of little use. These are technology . They describe all technologies as not very useful, with the exception of support for direct distance learning.

5 CONCLUSIONS AND DISCUSSIONS

The student response rate was relatively low (5.8%, total $N = 43$). For the first three aspects listed in subsection 3.1, we found meaningful segmentations (for the last two aspects, there was not enough data to create segments). We did not find any common segments between the aspects. Obtained segments were expected and it was confirmed a useful grouping of students is doable. Further investigation of the segments would require at least 10 new responses in the first three aspects. In the near future, we will study the usage patterns of these students based on carefully designed case studies.

ACKNOWLEDGMENTS

This research was supported by the project P2-0246 ICT4QoL - Information and Communications Technologies for Quality of Life.

REFERENCES

[1] Miguel Alves Gomes and Tobias Meisen. 2023. A review on customer segmentation methods for personalized customer targeting in e-commerce use cases. en. *Information Systems and e-Business Management*, 21, 3, (Sept. 2023), 527–570. DOI: 10.1007/s10257-023-00640-4.

[2] R Amutha and Aazmaan Ahmed Khan. 2023. Customer Segmentation using Machine Learning Techniques. en. 44, 3.

[3] APA. 2020. APA Guidelines for Psychological Assessment and Evaluation. en. Institution: American Psychological Association. (2020). DOI: 10.1037/e510142020-001.

[4] Shu-Chen Cheng and Chiu-Lin Lai. 2020. Facilitating learning for students with special needs: a review of technology-supported special education studies. en. *Journal of Computers in Education*, 7, 2, (June 2020), 131–153. DOI: 10.1007/s40692-019-00150-8.

[5] Parag Dange et al. 2023. EXPLORING CUSTOMER SEGMENTATION WITH K-MEANS CLUSTERING ALGORITHM. en. 11, 4.

[6] Rabi Das. 2023. ICTs In Special Education: A Review. en. 11, 8.

[7] Louise Demers, Rhoda Weiss-Lambrou, and Bernadette Ska. 1996. Development of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). en. *Assistive Technology*, 8, 1, (June 1996), 3–13. DOI: 10.1080/10400435.1996.10132268.

[8] Louise Demers, Rhoda Weiss-Lambrou, and Bernadette Ska. 2000. Item Analysis of the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST). en. *Assistive Technology*, 12, 2, (Dec. 2000), 96–105. DOI: 10.1080/10400435.2000.10132015.

[9] Béatrice P. J. Dijcks, Roelof D. Wessels, Suzanne L. M. De Vlieger, and Marcel W. M. Post. 2006. KWAZO, a new instrument to assess the quality of service delivery in assistive technology provision. en. *Disability and Rehabilitation*, 28, 15, (Jan. 2006), 909–914. DOI: 10.1080/09638280500301527.

[10] Xiaofei He and Partha Niyogi. 2003. Locality preserving projections. In *Proceedings of the 16th International Conference on Neural Information Processing Systems* (NIPS'03). MIT Press, Whistler, British Columbia, Canada, 153–160.

[11] Nouri Hicham and Sabri Karim. 2022. Analysis of Unsupervised Machine Learning Techniques for an Efficient Customer Segmentation using Clustering Ensemble and Spectral Clustering. en. *International Journal of Advanced Computer Science and Applications*, 13, 10. DOI: 10.14569/IJACSA.2022.0131016.

[12] Louise Norman Jespersen, Susan Ishøy Michelsen, Bjørn Evald Holstein, Tine Tjørnhøj-Thomsen, and Pernille Due. 2018. Conceptualization, operationalization, and content validity of the EQOL-questionnaire measuring quality of life and participation for persons with disabilities. en. *Health and Quality of Life Outcomes*, 16, 1, (Dec. 2018), 199. DOI: 10.1186/s12955-018-1024-6.

[13] Jeffrey Jutai and Hy Day. 2002. Psychosocial Impact of Assistive Devices Scale (PIADS). en. *Technology and Disability*, 14, 3, (Sept. 2002), 107–111. Gert Jan Gelderblom and Luc P. De Witte, editors. DOI: 10.3233/TAD-2002-14305.

[14] Riyo Hayat Khan, Dibyo Fabian Dofadar, and Md. Golam Rabiul Alam. 2021. Explainable Customer Segmentation Using K-means Clustering. en. In *2021 IEEE 12th Annual Ubiquitous Computing, Electronics & Mobile Communication Conference (UEMCON)*. IEEE, New York, NY, USA, (Dec. 2021), 0639–0643. ISBN: 978-1-66540-690-1. DOI: 10.1109/UEMCON53757.2021.9666609.

[15] Dr Chitralekha Navneet Kumar, Dr Ramchandra Vasant Mahadik, Dr Sangeeta Paliwal, Dr Pallavi, and Chaitali B Kasar. 2024. Leveraging Deep Learning for Customer Segmentation: Patterns and Preferences Unveiled. en. *International Journal of Intelligent Systems and Applications in Engineering*.

[16] Theodoros A. Kyriazos and Anastasios Stalikas. 2018. Applied Psychometrics: The Steps of Scale Development and Standardization Process. en. *Psychology*, 09, 11, 2531–2560. DOI: 10.4236/psych.2018.911145.

[17] 2018. *Learning and teaching in the European higher education area*. en. OCLC: 1142675866. European University Association asbl, Brussels ; Geneva. ISBN: 978-90-78997-65-8.

[18] Sukru Ozan and Leonardo O. Iheme. 2019. Artificial Neural Networks in Customer Segmentation. en. In *2019 27th Signal Processing and Communications Applications Conference (SIU)*. IEEE, Sivas, Turkey, (Apr. 2019), 1–4. ISBN: 978-1-72811-904-5. DOI: 10.1109/SIU.2019.8806558.

[19] Rakeshkumar Umanath Upadhyay and Prof. Nilesh Choudhary. 2023. A Review of Customer Segmentation Methods. en. *International Journal of Advanced Research in Science, Communication and Technology*, (Mar. 2023), 684–692. DOI: 10.48175/IJARSCT-8904.

[20] David A. Siegel. 2010. The mystique of numbers: belief in quantitative approaches to segmentation and persona development. en. In *CHI '10 Extended Abstracts on Human Factors in Computing Systems*. ACM, Atlanta Georgia USA, (Apr. 2010), 4721–4732. ISBN: 978-1-60558-930-5. DOI: 10.1145/1753846.1754221.

[21] Hasan Ziafat and Majid Shakeri. 2014. Using Data Mining Techniques in Customer Segmentation. en. 4, 9.

Introducing a Solution:
The Self-Evaluation Tool in Practice*

Isabel Leandro García†
Project Department
INERCIA DIGITAL
Huelva, Spain
isabelleandro@inerciadigital.com

Marta Mármol Muñoz
Innovation Department
INERCIA DIGITAL
Huelva, Spain
martamarmol@inerciadigital.com

Abstract / Povzetek

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

http://doi.org/DOI_RECEIVED_AFTER_REVIEW

Digitalization of education in Higher Education Institutions can have many positive impacts on students and their learning success still, at the same time, it can also pose a significant barrier for some students, especially students with different disabilities or special needs. Digital inclusion is crucial in providing equitable and just access to educational materials for every student, irrespective of their origins, capacities, or impairments. The structured pedagogical content is supplied to the user through a recommendation model that constitutes an online Self-Evaluation Tool to determine the inclusiveness of their digital education. [1].

Keywords / Ključne besede

Digital Education ,Inclusiveness, equality, disabilities.

1 Introduction

In modern education, continuous improvement is key to both student and organizational success. One effective method to foster this growth is through self-evaluation. The Self-Evaluation Tool is a practical solution designed to empower institutions to assess digital inclusion, set goals, and track progress over time.

Based on that, the theoretical framework of inclusive digital education including all 3 elements, technology, pedagogy, content, and management aspects, considering different e-learning settings and modes is the base foundation to develop a Self-Evaluation Tool for HEI on inclusive digital education in HEI. [2].

Self-Evaluation Tool has to be used as a practical guide for the management to define the good and not-so-good things about digital education and communication about inclusion. On the other hand, a Self-Evaluation Tool for HEI teachers on inclusive digital teaching practice is used as a practical guide for the teachers to define the good and not-so-good things about their digital teaching practice concerning inclusion. (Bennett, 2021)

The article focuses on the introduction of the Self-evaluation Tool **developed under the Erasmus+ project "SET4Inclusion".** The SET4Inclusion project is a European collaborative initiative designed to tackle these challenges by developing and implementing a Self-evaluation Tool tailored for HEIs. [3].

1

Figure 1:The tool on the website set4inclusion.eu

Figure 2 :Self evaluation tool questions with multiple choice answers.

2 How does it works

The self-evaluation tool serves as a practical guide for the management and teachers to define the good and not-so-good things about their digital education and communication concerning inclusion.

Our Self-Evaluation Tool is a practical guide **for HEI management to help them assess the capabilities of the HEI regarding inclusive digital education.** It consists of many questions, representing influence factors, described through specific indicators. This self-evaluation tool is also a practical guide for HEI teachers to help them assess the capabilities of their teaching practice about inclusive digital education. It consists of many questions, representing influence factors, described through specific indicators.

Structured Reflection for users are prompted to review their access to the digital inclusion practices, focusing on relevant performance indicators:

Twelve questions regarding Leadership/ School's perspective. These questions are designed to evaluate the support provided to teachers in digital literacy for inclusive digital education. The responses and subsequent questions are categorized into different variables, which will be used to determine the final results of the report. The categories for responses are: Not applicable, Totally agree, Agree, Somewhat agree, Disagree, and Totally disagree.

The following section is Collaboration and Networking. It consists of eight questions that support the progress in inclusive teaching and learning with digital technologies.
The third section involved Infrastructure and Equipment. It is developed with twelve questions that cover the digital infrastructure that supports inclusive and accessible education with digital technologies.

Next, a section called Tools and Technology, and aims to investigate technology itself. Continuing Professional Development section contains five management-related questions that support us in acquiring the knowledge and pedagogical skills necessary for inclusive education.
From the Teacher's perspective, the Pedagogy, Supports, and Resources section contains 7 questions about how it is developed to provide inclusive digital resources to support their inclusive teaching.¡

Pedagogy, Implementation in the classroom, consists of seven questions that cover Digital technologies in the classroom to facilitate the organization of teaching groups in which students can collaborate by valuing the diversity of each one. The student's perspective covers thirteen questions that are related to the proper use of the technology as an inclusion tool.

Figure 3: Percentage of answers by categories.

Finally, the tool offers the results with a percentage of answers by categories. Once you have done the self evaluation, the E-platform where the tool is located, automatically creates a smart report for the users of Self-Evaluation Tools with links to recommended e-learning content according to the result of the self-evaluation. You can find the tool in multiple languages.

3 Conclusion

In conclusion,the Self-Evaluation Tool is a powerful solution for those seeking to improve their performance and grow in their careers. By providing a structured way to reflect, set goals, and track progress, this tool empowers individuals to take charge of their development and contributes to the overall success of the organization. The pilot study of the Self-Evaluation Tool developed under the SET4Inclusion project has yielded significant insights into the tool itself, and its effectiveness for the development of Digital Inclusion in HEIs.

4. References / Literatura

[1] UNESCO, Global Education Monitoring Report 2020: Inclusion and education: All means all. Paris: UNESCO, 2020. [Online]. Available: https://unesdoc.unesco.org/ark:/48223/pf0000373718

[2] P. R. dos Santos, D. N. Barbosa, E. G. A. Neto, J. L. Barbosa, S. D.Correia, and V. R. Leithardt, “Learning and well-being in educational practices with children and adolescents undergoing cancer treatment,”Education Sciences, vol. 11, no. 8, p. 442, 2021.
[3] Bennett, S. (2021). Self-Evaluation Tools in higher education: Bridging the gap between assessment and improvement. Assessment & Evaluation in Higher Education, 46(5), 723-738. https://doi.org/10.1080/02602938.2020.1853698

ANALYSIS OF THE SELF-EVALUATION TOOL: A PILOT STUDY*

Tuncer Can†
Department of Foreign Language Education, Hasan Ali Yücel Faculty of Education/ Istanbul University-Cerrahpasa, Istanbul Türkiye
tcan@iuc.edu.tr

Irfan Simsek
Department of Computer Education and Instructional Technology, Hasan Ali Yücel Faculty of Education/ Istanbul University-Cerrahpasa, Istanbul Türkiye
irfan@iuc.edu.tr

Hüseyin Göksu
Open and Distance Education Application and Research Center Istanbul University-Cerrahpasa Istanbul Türkiye
huseyin.goksu@iuc.edu.tr

ABSTRACT

This article focuses on the analysis of the self-evaluation tool developed under the SET4Inclusion project, with a particular emphasis on its application within the context of a pilot study. Pilot studies are crucial for testing the validity and reliability of new tools or methods. The primary objective of this pilot study is to evaluate the effectiveness of the Self-Evaluation Tool (SET) developed within the SET4Inclusion project in facilitating e-inclusion processes in higher education institutions (HEIs). The pilot study began with the preparation of an invitation letter, which was sent to potential participants. The pilot study involved participants from higher education institutions in five different European countries: Turkey, Portugal, Slovenia, Italy, and Spain. The number of HEIs participating in the piloting was at least five, with at least fifty HEI teachers involved.

KEYWORDS

SET4Inclusion project, Self-Evaluation Tool, Micro Learing Units

1 INTRODUCTION

The rapidly evolving dynamics within higher education have made inclusivity and accessibility more significant than ever before. The increasing number of students with diverse learning needs, including those with disabilities, necessitates a comprehensive approach to ensure equitable access to education. The rise of digital tools and technologies offers novel opportunities to foster e-inclusivity, particularly within Higher Education Institutions (HEIs). This process not only contributes to enhancing student success rates but also plays a vital role in promoting fairness and justice in education. Inclusivity is closely linked to student satisfaction and academic achievement, making it a strategic priority for HEIs [2].

*Article Title Footnote needs to be captured as Title Note
†Author Footnote to be captured as Author Note

Information Society 2022, 10–14 October 2022, Ljubljana, Slovenia

Modern higher education systems are increasingly focused on acknowledging student diversity and creating educational environments that effectively respond to this diversity.
The SET4Inclusion project is a European collaborative initiative designed to tackle these challenges by developing and implementing self-evaluation tools tailored for HEIs. These tools are intended to help institutions critically assess their current practices, identify gaps, and take concrete steps toward creating a more inclusive educational environment. By enabling institutions to analyze their performance, self-evaluation tools create an internal cycle of continuous improvement [1]. They provide not just a snapshot of the current state but also support the development of forward-looking improvement strategies. When viewed through the lens of inclusivity, such tools significantly enhance the capacity of learning environments to cater to the needs of all students, irrespective of their backgrounds or abilities.
This article focuses on the analysis of the self-evaluation tool developed under the SET4Inclusion project, with a particular emphasis on its application within the context of a pilot study. Pilot studies are crucial for testing the validity and reliability of new tools or methods. They serve as a foundational step before wider implementation and can provide valuable insights into the practical challenges and opportunities associated with new initiatives [3]. In this study, key elements such as the functionality of the self-evaluation tool and the developed micro-learning units in diverse contexts, areas requiring improvement, and user feedback will be thoroughly evaluated. The results of the pilot study have facilitated necessary adjustments to the tool and units before their broader application in various HEIs across Europe.

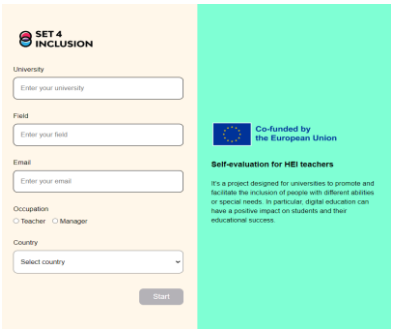

Figure 1: Home page of Self-Evaluation Tool

Figure 2: Home page of e- learning materials

2 METHODOLOGY

The primary objective of this pilot study is to evaluate the effectiveness of the Self-Evaluation Tool (SET) developed within the SET4Inclusion project in facilitating e-inclusion processes in higher education institutions (HEIs). The pilot study began with the preparation of an invitation letter, which was sent to potential participants. This letter provided detailed information about the project, the scope of the pilot study, and the tools that participants would be evaluating. Links to the tools and a survey were included in the invitation, allowing participants to engage directly with the materials.

The tools developed for the project, including the Self-Evaluation Tool and the associated micro-learning units, were distributed to participants via email. Participants were given a two-week period to complete their evaluations. At the end of this period, they were asked to complete a survey that provided feedback on their experiences with the micro-learning units and the self-evaluation process.

2.1 Participants

The pilot study involved participants from higher education institutions in five different European countries: Turkey, Portugal, Slovenia, Italy, and Spain. The number of HEIs participating in the piloting was at least five, with at least fifty HEI teachers involved. Participants were selected based on voluntary participation, and efforts were made to ensure diversity by including individuals from various departments and academic levels. This approach aimed to gather a wide range of perspectives and insights, thereby enriching the study's findings.

Table 1: Number of participants

No	Participants	f(x)
1	HEI participating	5
2	HEI teachers	50

2.2 Instruments

The key instruments used in this research were the Self-Evaluation Tool and the Micro Learning Units developed within the SET4Inclusion project. The Self-Evaluation Tool was designed to assist HEIs in assessing their e-inclusion processes, identifying areas for improvement, and implementing strategies to enhance inclusivity. The Micro Learning Units complemented the tool by providing focused, easily accessible learning content that could be used to support inclusive practices within the institutions. Participants used these tools to evaluate and reflect on the e-inclusion processes in their respective institutions.

2.3 Data Collection

The key instruments used in this research were the Self-Evaluation Tool and the Micro Learning Units developed within the SET4Inclusion project. The Self-Evaluation Tool was designed to assist HEIs in assessing their e-inclusion processes, identifying areas for improvement, and implementing strategies to enhance inclusivity. The Micro Learning Units complemented the tool by providing focused, easily accessible learning content that could be used to support inclusive practices within the institutions. Participants used these tools to evaluate and reflect on the e-inclusion processes in their respective institutions.

2.4 Data Analysis

The data collected from the surveys were systematically analyzed using graphical representation methods to visualize the feedback and results. These graphs provided clear insights into the effectiveness of the Self-Evaluation Tool and the micro-learning units. The feedback from participants was thoroughly reviewed, with particular attention paid to their suggestions for improvements and their overall experience with the tool. The analysis revealed several key areas where the tool could be refined and optimized to better meet the needs of HEIs and their diverse student populations.

The pilot study's findings provided valuable information that will inform the further development and dissemination of the Self-Evaluation Tool. The insights gained from this study will help ensure that the tool is effective, user-friendly, and capable of supporting HEIs in their efforts to create more inclusive learning environments. As the tool is refined and prepared for broader application, these findings will serve as a crucial foundation for its successful implementation.

In conclusion, the pilot study of the Self-Evaluation Tool developed under the SET4Inclusion project has yielded significant insights into the tool's effectiveness and the user experiences associated with it. The feedback gathered from participants has highlighted both the strengths and areas for improvement, which will be addressed in the subsequent development phases. By incorporating these insights, the tool will be better equipped to support HEIs in fostering inclusivity and accessibility in their educational offerings. The study also underscores the importance of pilot testing in the development of educational tools, as it provides a critical opportunity to refine and enhance the tools before they are implemented on a larger scale.

REFERENCES

[1] Bennett, S. (2021). Self-evaluation tools in higher education: Bridging the gap between assessment and improvement. Assessment & Evaluation in Higher Education, 46(5), 723-738. https://doi.org/10.1080/02602938.2020.1853698

[2] Ehlers, U. D. (2020). Quality in e-learning from a learner's perspective. European Journal of Open, Distance and E-Learning, 23(1), 10-28. https://doi.org/10.2478/eurodl-2020-0002

[3] Van der Kleij, F. M., Adie, L., & Cumming, J. J. (2019). The role of feedback in self-assessment: A systematic review of educational research. Review of Educational Research, 89(4), 635-676. https://doi.org/10.3102/0034654

Definition of a Framework for Self-Evaluation Tool: Optimizing Evaluation Practices for Enhanced Performance in HEI

Maja Pušnik†
Faculty of Electrical Engineering and Computer Science
University of Maribor, Slovenia
maja.pusnik@um.si

Boštjan Šumak
Faculty of Electrical Engineering and Computer Science
University of Maribor, Slovenia
bostjan.sumak@um.si

Katja Kous
Faculty of Electrical Engineering and Computer Science
University of Maribor, Slovenia
katja.kous@um.si

Florian Gallo
Fondazione Istituto dei Sordi di Torino ONLUS
Torino, Italy
erasmus@istitutosorditorino.org

Enrico Dolza
Fondazione Istituto dei Sordi di Torino ONLUS
Torino, Italy
direzione@istitutosorditorino.org

Abstract

This paper proposes a framework for a self-evaluation tool to support the evaluation of inclusive digital education in Higher Education Institutions (HEIs). The idea was motivated by the COVID-19 pandemic, which emphasised inequalities in digital learning, particularly for students with Special Educational Needs and Disabilities (SEND). The enhanced digitalisation of education showed that many students and professionals struggled to engage with online content due to rigid teaching methods and inaccessible resources. By focusing on inclusivity, the proposed framework aims to address these challenges by tackling digital technologies to create adaptive, equitable learning environments for diverse student needs. The framework will support HEIs in evaluating and enhancing their digital education practices, ensuring all students can fully participate and succeed in education.

Keywords

Inclusive Digital Education, Self-Evaluation Tool, Higher Education Institutions, Special Educational Needs and Disabilities

1. Introduction

In the rapidly evolving higher education, integrating Information and Communication Technology (ICT) has become essential for enhancing teaching and learning processes. However, ensuring that digital education is inclusive—particularly for SEND students—remains a significant challenge [4]. This paper addresses the challenges exposed by the COVID-19 pandemic, particularly the accelerated digitalization of teaching and learning in higher education, which has disproportionately disadvantaged SEND students. Recognizing that several students struggle with online education, it is fundamental to promote inclusiveness as a key solution. HEIs aim to create an inclusive digital environment that supports students from the earliest stages of education (from primary school to higher education), helping them reach their full potential. We believe this endeavor would be supported by a self-evaluation tool, providing specific feedback to HEIs and helping increase inclusive digital education capabilities in formal and non-formal settings [1].

Within the scope of Erasmus+ SET4Inclusion project (2023-1-SI01-KA220-HED-000160853) the partners developed a theoretical framework for inclusive digital education to address the HEIs challenges and prepare for a self-evaluation tool. This framework was built upon the well-established TPACK model (Technological Pedagogical Content Knowledge), which guides the integration of ICT in education. TPACK outlines the essential knowledge areas for effectively integrating technology into teaching, such as technological knowledge (focusing on accessibility), pedagogical knowledge (emphasizing Universal Design for Learning - UDL), and content knowledge (innovative applications of new technologies to overcome barriers for SEND students). The TPACK framework also incorporates the latest standards, such as the Web Content Accessibility Guidelines (WCAG 2.2), and insights from contemporary research. Additionally, we aimed to include the SELFIE tool for self-reflection on schools' digital capabilities [2], an evaluation survey promoted by the European Commission, by integrating a stronger focus on inclusivity. Our framework and developed self-evaluation tool aim to identify and describe the key factors and indicators that define inclusive digital education, providing HEIs with an inclusive tool to evaluate and enhance their digital education practices. The development of the framework involved several key tasks:

- A literature review, which included 131 papers and explored existing research, best practices, and the challenges of implementing inclusive digital education (due to the length it is not included in this

*Article Title Footnote needs to be captured as Title Note
†Author Footnote to be captured as Author Note

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

https://doi.org/10.70314/is.2024.DIGIN.12

paper, however, it is available as one of the deliverables of SET4Inclusion project.
- Development of two surveys — one targeting HEI staff and another focused on SEND students— to gather insights on their experiences and needs. The surveys were performed with the help of Google Forms and the reports will be available as one of the deliverables of the SET4Inclusion project.
- The co-development workshops involving collaboration with HEIs partners, researchers, and experts. The report is available as one of the deliverables of the SET4Inclusion project.

The results from the listed activities present a foundation for the final framework that will enable HEIs to create and maintain inclusive digital learning environments, ensuring access to education for all students. It is also the foundation for developing self-evaluation tools and other project results, providing a structured basis for institutions to assess and enhance their practices. The main results, for which described framework is necessary, are the following:
- Two Self-evaluation tools for HE institutions and HE teachers to determine the inclusiveness of their digital education,
- A set of micro-learning units on Inclusive digital education for HE leaders and HE teachers,
- Collection of several good practices on Inclusive digital education,
- E-learning platform as a central knowledge point for Inclusive digital education.

2. Definition of the framework

To make digital education and communication in HEIs more accessible and inclusive for all other students, a theoretical framework of inclusive digital education was defined, considering different possible e-learning settings and modes (ICT-supported classroom learning, distance e-learning, hybrid, blended learning, self-paced, guided etc.). A theoretical framework for inclusive digital education was created based on a literature review, survey and workshops, presented in the following sections.

2.1. The literature review

First, a literature review was conducted to (1) identify good practices for inclusive digital education, (2) identify the challenges of inclusive digital education, and (3) identify the factors that affect inclusive digital education. The aim was to identify the relevant literature in journal papers, articles published in conferences, reports, and other relevant sources. The search was conducted in different databases and search engines, such as Scientific databases: WoS, ScienceDirect, IEEExplore, ACM, Google Scholar, Search engines: Google. The included literature was in English, dated from 2017 or newer. One hundred thirty-one literature units were identified and recorded. Based on the results from the literature review, factors that impact inclusive digital education were defined and later validated with the help of a survey.

The literature review provided an idea of levels of inclusiveness within digital education, which are divided into eight categories, further defined by factors and evaluated with indicators on a Likert scale from strongly agree to strongly disagree, presented in the following paragraphs [3]. The categories are the following: (1) Leadership/ School's perspective, (2) Collaboration and Networking, (3) Infrastructure and Equipment/ Tools and Technology, (4) Continuous Professional Development, (5) Pedagogy: Supports and Resources, (6) Pedagogy: Implementation in the classroom, (7) Assessment Practices/ Inclusion Assessment and (8) Student Digital Competence/ Student's Perspective.

Category Leadership/ School's perspective includes the following factors:
- (1.1.) Inclusive digital strategy education strategy
- (1.2.) Collaborative digital strategy development
- (1.3.) Contemporary pedagogical approaches
- (1.4.) Scheduled time to explore digital teaching
- (1.5.) Efforts to minimize discrimination,
- (1.6.) Collaboration and communication encouragement between school and teacher,
- (1.7.) Inclusion policies,
- (1.8.) Digital literacy.

The examples of indicators for each factor are transformed into statements in the self-evaluation tool, connected to the leadership/school's perspective, and are shown in Figure 1. For example, "Inclusive digital strategy would" is evaluated based on an indicator: "At our HEI we have an inclusive digital education strategy". The same principle is applied to all other factors in other categories.

Figure 1: Category Leadership/ School's perspective

Category Collaboration and Networking includes the following factors:

- (2.1.) Progress review,
- (2.2.) Discussion on the use of technology,
- (2.3.) Collaboration of HEI, local communities, caregivers and parents,
- (2.4.) Synergies for Blended Learning,
- (2.5.) Staff, governors, students and parents/careers share a philosophy of inclusion,
- (2.6.) Teachers plan, teach and review in partnership and
- (2.7.) Encouraged collaboration and communication between students and teachers.

Category Infrastructure and Equipment/ Tools and Technology includes the following factors:

- (3.1.) Accessible infrastructure and tools,
- (3.2.) Digital devices and assistive products for teaching,
- (3.3.) Internet Access,
- (3.4.) Technical Support,
- (3.5.) Available digital devices and assistive products for learning,
- (3.6.) Devices and assistive products for students,
- (3.7.) Measures to identify the digital divide,
- (3.8.) Support to address the digital divide,
- (3.9.) Bring your device and assistive products,
- (3.10.) Reduced physical barriers,
- (3.11.) Assistive products,
- (3.12.) Online libraries,
- (3.13) Fairly distributed resources.

Category Continuous Professional Development includes the following factors:

- (4.1.) Discussion of CPD needs,
- (4.2.) Participation in CPD activities,
- (4.3) Face-to-face or online sharing experiences between staff.

Category Pedagogy: Supports and Resources includes the following factors:

- (5.1.) Online educational resources,
- (5.2.) Creating digital resources,
- (5.3.) Using virtual learning environments,
- (5.4.) Communicating with the school community,
- (5.5.) Open educational resources,
- (5.6.) Staff development activities help staff to respond to student diversity,
- (5.7.) Student difference is used as a resource for teaching and learning and
- (5.8.) Staff develop resources to support learning and participation.

Category Pedagogy: Implementation in the classroom includes the following factors:

- (6.1.) Personalization according to students' needs,
- (6.2.) Fostering students' creativity,
- (6.3.) Engaging and motivating students,
- (6.4.) Student collaboration,
- (6.5.) Everyone is made to feel welcome and treated with respect,
- (6.6.) The partnership between staff and parents/careers,
- (6.7.) Students are equally valued,
- (6.8.) Staff and students treat one another as human beings, and discipline is based on mutual respect,
- (6.9.) The school arranges teaching groups so that all students are valued, and differences are understood,
- (6.10.) Training and education on inclusiveness.

Category Assessment Practices/ Inclusion Assessment includes the following factors:

- (7.1.) Assessing skills,
- (7.2.) Digital assessment,
- (7.3.) Timely feedback,
- (7.4.) Self-reflection on learning,
- (7.5.) Feedback to other students,
- (7.6.) Using data to improve learning,
- (7.7.) Evaluation metrics.

Category Student Digital Competence/ Student's Perspective includes the following factors:

- (8.1.) Learning to communicate and
- (8.2.) Digital skills across subjects.

2.2. The survey

Two surveys were conducted. The first survey was conducted to acquire empirical evidence about teachers' perceptions of inclusive digital education in their classrooms. The survey was constructed based on the existing literature, where we identified the most significant factors that can affect inclusive digital education (such as Inclusive Digital Strategy and Policy for Empowering Inclusive Digital Education, Inclusive Digital Pedagogy & Supportive Culture and similar). Over 100 survey responses positively rated the proposed framework, with moderate variability. The responses suggest that while many respondents rated the indicators highly, there were diverse opinions among the participants, particularly in areas such as Infrastructure and Technology (IET) and Pedagogy: Implementation in the Classroom (PIC), where variability was slightly higher. These findings highlight areas of strength as perceived by respondents and potential areas for further improvement and targeted interventions. The positive feedback on professional development, collaboration, and digital competence underscores the importance of continuing, supporting and enhancing these aspects within educational institutions. The second survey was conducted to acquire empirical evidence about students' perceptions of inclusive digital education.

Overall, the survey results highlight strong satisfaction with various dimensions of educational practice, particularly in leadership, collaboration, infrastructure, pedagogy, assessment practices, and digital competence. The consistently high median scores and excellent internal consistency across indicators suggest that respondents

perceive these areas positively, reflecting well-implemented practices and supportive educational environments.

2.3. The co-creation workshops

The framework co-creation workshops were designed to refine and validate the framework for inclusive digital education, focusing on finalizing the key factors and indicators. During the ten conducted workshops in various European countries, participants engaged in collaborative discussions to shape the framework's layout, ensuring it accurately reflects the needs and challenges of inclusive digital education. The workshop's outcomes included the creation of validated self-evaluation questionnaires and refining indicators that would later be used for the development of the SET and micro-learning units. These online workshops played a critical role in fine-tuning the variables and indicators that form the foundation of the self-evaluation tool, ensuring they are both relevant and effective for HEIs.

3. Self-evaluation tool based on the framework

A self-evaluation tool [5] was created based on the developed framework, which encompasses key factors and indicators of inclusive digital education. This tool is designed to serve as a practical guide for management and educators within HEIs, enabling them to assess and identify strengths and areas for improvement in their digital education and communication practices related to inclusion. In addition to its evaluative function, integrated with an E-platform, the self-evaluation tool aims to raise awareness about the importance of inclusive digital education among stakeholders. The implementation of these practical tools, along with the provision of free learning opportunities through the E-platform, is expected to contribute significantly to fostering more inclusive digital education environments within HEIs.

The results of the self-evaluation tool are presented in (Figure 2). For each category, suggestions on how to improve inclusion in HEI are provided, which are connected to micro-learning units, one of the additional outputs of the project.

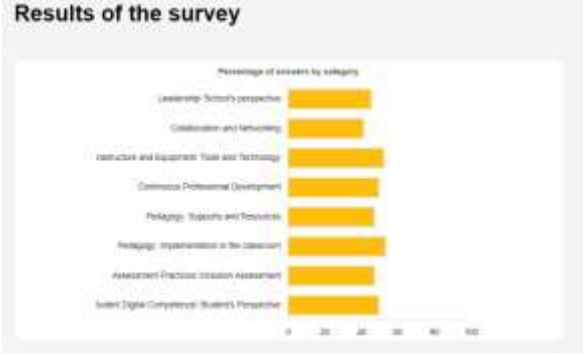

Figure 2. Final results of the self-evaluation tool, based on the framework

4. Conclusion

This paper has established a comprehensive framework for a self-evaluation tool to optimize evaluation practices within HEIs, mainly promoting inclusive digital education. The framework is designed to address the disparities that became evident during the rapid digitalization of education, especially those affecting students with Special Educational Needs and Disabilities. By equipping HEIs with this evaluative tool, the framework seeks to create more equitable and adaptive learning environments that can better accommodate the diverse needs of all students.

The future stages of this work will involve the systematic collection and classification of at least 15 exemplary practices from five partner countries of the project in the domain of inclusive digital education. These practices will be categorized according to the framework's components—self-evaluation tools and e-learning materials—and will be methodically documented using textual and multimedia formats. This iterative process will refine the framework and extend its relevance and effectiveness across various educational settings. Applying this framework is expected to lead to improved learning outcomes, promoting greater inclusivity and equity in higher education.

Acknowledgments

This research was conducted within the activities of the SET4Includion (Self-Evaluation Tools for e-Inclusion in HEI) project, co-funded by the Erasmus+ Programme of the European Union. The authors (Boštjan Šumak, Maja Pušnik, Katja Kous) acknowledge the financial support from the Slovenian Research Agency (Research Core Funding No. P2-0057).

References

[1] Pušnik, M., Kous, K., Welzer Družovec, T., & Šumak, B. (2024). Identification and Analysis of Factors Impacting e-Inclusion in Higher Education. 308–317. https://doi.org/10.3233/faia231164

[2] P. Kampylis and A. Sala, "Improving the digital capacity of schools by using the "SELFIE" tool for collective reflection," Eur. J. Educ., vol. 58, no. 2, pp. 331–346, Jun. 2023.

[3] C. Sahli Lozano, S. Wüthrich, J. S. Büchi, and U. Sharma, "The concerns about inclusive education scale: Dimensionality, factor structure, and development of a short-form version (CIES-SF)," Int. J. Educ. Res., vol. 111, p. 101913, 2022.

[4] N. Zahid, A. Jamil, and I. Nawaz, "Behavioral problems and academics of children in inclusive education – A cross-sectional survey," Heliyon, vol. 9, no. 2, p. e13496, Feb. 2023.

[5] Self-evaluation tool: https://set4inclusion.eu/self-evaluation-tools/

Good practices in creating an inclusive environment in Education Institution

Darja Ivanuša Kline
INUK inštitut
Maribor, Slovenia
darja.ivanusa.kline@inuk.si

José Carlos Neves
CICANT
Lusófona University
Lisbon, Portugal
p1568@ulusofona.pt

Carla Sousa
CICANT
Lusófona University
Lisbon, Portugal
carla.patricia.sousa@ulusofona.pt

Alfonso Infante Moro Neves
Economía Financiera, Contabilidad y Dirección de Operaciones
University of Huelva
Huelva, Spain
alfonso.infante@uhu.es

Silvia Doratiotto
International Department
Istituto dei Sordi di Torino
Turin, Italy
cooperation@istitutosorditorino.org

Irfan Simsek
Hasan Ali Yücel Faculty of Education
İstanbul University - Cerrahpaşa
Istanbul, Turkey
irfan@iuc.edu.tr

Boštjan Šumak
Faculty of Electrical Engineering and Computer Science, University of Maribor
Maribor, Slovenia
bostjan.sumak@um.si

Maja Pušnik
Faculty of Electrical Engineering and Computer Science, University of Maribor
Maribor, Slovenia
maja.pusnik@um.si

Abstract / Povzetek

The shift toward digital education has created opportunities and challenges in ensuring inclusion for all students, especially for those with disabilities or special needs. To promote inclusivity in digital education within higher education institutions (HEIs), the ERASMUS+ project SET4Inclusion initiated a Call for Good Practices, inviting educators and institutions to share effective practices across various areas, such as leadership, infrastructure, and pedagogy. Out of 15 collected and evaluated good practices, five exemplary practices were selected for their impact on fostering inclusive learning environments. This paper presents these five practices, offering insights and recommendations for HEIs to enhance digital inclusivity in their educational offerings.

Keywords / Ključne besede

Inclusion, digital education, inclusive pedagogy

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

http://doi.org/DOI_RECEIVED_AFTER_REVIEW

1 Introduction

The digitization of education offers transformative potential to enhance student learning outcomes by providing flexible, personalized learning opportunities. However, it also presents significant challenges, particularly for students with disabilities or special needs who may face barriers if their diverse learning requirements are not adequately addressed. As higher education institutions (HEIs) cater to an increasingly diverse student population, ensuring that digital education is inclusive and accessible to all students has become a critical priority.

To address this need, the ERASMUS+ project SET4Inclusion was established to enhance inclusive digital education in higher education. The project aims to foster environments where all learners feel valued, regardless of their abilities or needs. An important initiative of the project was the Call for Good Practices, which invited educators and educational institutions to share examples of their inclusive digital practices. The call focused on various areas, such as leadership, collaboration, infrastructure, professional development, pedagogy, and assessment, encouraging contributors to highlight how they prioritize inclusion and adapt to diverse student needs.

2 Good Practices

To collect good practices on inclusive digital education, several methodological steps were employed. A call for good practices was developed and widely disseminated by all project partners, who translated and promoted the call to maximize reach across different regions.

A standardized template was developed to guide submissions, ensuring consistency in how good practices were described, including details such as context, methodologies and lessons learned. A total of 15 submissions were received from four countries, providing a diverse array of practices related to inclusive digital education.

An online workshop was conducted with all project partners to present and discuss each submitted practice. This collaborative workshop served as a preliminary evaluation forum where participants could provide feedback and highlight key aspects of each practice.

Following the workshop, a detailed survey was created based on the project's established factors and indicators for inclusive digital education. This survey facilitated a systematic evaluation by all partners.

The received practices were also categorized according to the SET4Inclusion Digital Education Framework, aligning them with specific inclusion areas such as leadership, collaboration, technology, professional development, pedagogy, assessment, and student competence. Table 1 summarizes the distribution of practices across these categories.

The data in the table indicate a broad distribution of practices across various inclusion areas, with a notable emphasis on pedagogical supports and resources, infrastructure and technology, and student digital competence. This distribution suggests a balanced approach to inclusive digital education, addressing both the technical and pedagogical aspects needed to create equitable learning environments.

Table 1: Covered inclusion areas by received practices

Inclusion areas	No. of practices
Leadership/School's perspective	60,0%
Collaboration and Networking	33,3%
Infrastructure and Equipment/Tools and Technology	66,7%
Continuous Professional Development	60,0%
Pedagogy: Supports and Resources	86,7%
Pedagogy: Implementation in the classroom	53,3%
Assessment Practices/Inclusion Assessment	26,7%
Student Digital Competence/Student's Perspective	66,7%
Other areas	6,7%

This approach ensured a robust and systematic process for identifying, evaluating, and categorizing good practices in inclusive digital education, promoting the exchange of effective strategies across diverse educational contexts.

This paper presents the best five practices identified through this evaluation process, offering insights and practical guidance for other institutions seeking to enhance their inclusive digital education initiatives. Brief overview of these exemplary practices illustrates their potential to enhance an inclusive educational environment in higher education.

2.1 "Inclusive Glossary of Mathematical Terms: A Hybrid Pedagogical Tool for the Inclusive Education of Deaf and Hearing Children" by José Carlos Neves, and Carla Sousa (Portugal)

The Inclusive Glossary of Mathematical Terms (GIM) is an educational tool to support deaf children, particularly those using Portuguese Sign Language (LGP). GIM combines physical cards and digital videos to create a memory game that enhances mathematical learning through interactive play. It fosters inclusivity by allowing both deaf and hearing children to learn together. It is accessible online and includes an adaptation of Brazilian Sign Language (LIBRAS).

GIM is designed for primary and preschool teachers and is user-friendly, requiring no advanced technical skills. Developed through collaboration among experts in education, design, animation, and deaf culture, it ensures the content is relevant and accessible. Teachers specializing in deaf and hard-of-hearing (DHH) students contributed to the development and testing, involving 120 children across three schools. The game has shown positive impacts on student engagement and learning outcomes.

The game integrates physical cards with animated videos to illustrate mathematical concepts. These cards can be used with a mobile app that displays corresponding videos in LGP or LIBRAS, making it adaptable to different classroom settings. The game's components can be produced at low cost through laser cutting or 3D printing or printed on paper for traditional use.

Research supports GIM's effectiveness in teaching mathematics and sign language to young children, particularly DHH students. However, further studies are needed to explore its application in various educational contexts and assess its long-term impact on learning.

2.2 "The Inclusive working group at Faculty of Business UHU" by Alfonso Infante Moro (Spain)

Accessibility for individuals with specific needs in digital education is a fundamental obligation for universities. Alfonso Infante Moro, who leads the "special needs technical unit" at the University of Huelva's Faculty of Business and Tourism, has been instrumental in promoting this principle. Since its presentation at the 2021 International Congress of University and Disability, the model continues to play a crucial role in ensuring inclusive education at the university level. Under Infante's leadership, the faculty advocates for all students' right to access higher education and emphasizes the necessity of digital accessibility provisions.

Spanish regulations, such as the Ley General de Derechos de las Personas con Discapacidad (General Law on the Rights of Persons with Disabilities, 2013) and the Plan de Acción para las Personas con Discapacidad (Action Plan for Persons with Disabilities, 2014-2020), highlight the importance of inclusivity

in higher education. However, the digital aspects of accessibility still require significant attention to ensure that all students can fully participate. The University of Huelva's Faculty of Business has addressed these needs by organizing educational technology conferences focusing on inclusion and diversity. A dedicated working group led by Alfonso Infante promotes inclusive practices and classroom accessibility, supporting students across various degree levels through tailored adaptations and collaboration with clinical health specialists.

Innovative digital tools, such as synchronous subtitles, have been implemented to support students with hearing impairments, benefiting a broader student population. Approximately 0.3% of the faculty's students require specific educational support, and efforts continue to enhance their digital learning experiences. Beyond the University of Huelva, Infante advocates for a standardized system of inclusive practices across European universities. His work contributes to developing a Standards Guide for the Inclusion of University Students with Disabilities, aimed at improving access and support for students in the digital era.

2.3 "EcoDigi: A Practice for Sustainable Digital Transformation in Adult Education" by Silvia Doratiotto (Italy)

EcoDigi is an initiative to promote digital transformation in adult education while prioritizing environmental sustainability and inclusivity. The project supports the development of digital readiness in an eco-friendly and accessible way, addressing the needs of adult learners, including those with disabilities or special needs. EcoDigi emerged in response to the growing reliance on digital platforms during the COVID-19 pandemic, recognizing both the opportunities for inclusion and the need to minimize environmental impact. The project helps educators and institutions adopt more sustainable and inclusive practices by providing self-assessment tools, teaching materials, and guides.

The initiative targets a broad audience, including adult learners, educators, specialists, and NGOs involved in education and sustainability. Through specialized training, EcoDigi will create a pool of skilled trainers across partner countries, strengthening the capacity of adult education providers to act as leaders in their communities. The project will produce several vital resources, including a self-assessment tool, a report on best practices, an online platform, and guidelines for creating green and accessible education.

EcoDigi also plans to host webinars and organize an international conference to promote the exchange of good practices across partner countries. The initiative aims to ensure that digital transformation in adult education is sustainable and inclusive, contributing to a greener and more equitable digital society in Europe.

2.4 "Innovative XR Technologies Research and Development Center (YETAM-XR)" by Irfan Simsek (Turkey)

The Innovative XR Technologies Research and Development Center (Yetam XR) at Istanbul University-Cerrahpaşa, led by Associate Professor Irfan Simsek, focuses on advancing virtual reality (VR) and augmented reality (AR) technologies in education and industry. Supported by the Istanbul Development Agency, Yetam XR develops 3D virtual technologies tailored for academic and industrial applications. The centre offers educational programs in 3D modelling, visual design, animation, and Unity programming, ranging from beginner to advanced levels, equipping participants with theoretical and practical skills for the professional use of VR and AR technologies.

Yetam XR integrates advanced technologies into educational environments, transforming traditional learning with immersive and interactive content. The centre prioritizes inclusivity, ensuring its educational tools are accessible and adaptable to diverse learning needs. Equipped with state-of-the-art VR headsets and 3D modelling tools, Yetam XR provides a high-quality digital learning experience.

The centre's projects include the Virtual Factory Simulation, hands-on experience with virtual industrial machines, and the Basic First Aid VR Project, which trains students in emergency response. Additionally, the Occupational Health and Safety Project educates workers and students on safety through VR simulations of hazardous situations, providing valuable real-world experience in a safe environment.

While Yetam XR has successfully enhanced education with immersive technologies, challenges remain, such as limited access to VR equipment for some students. There is also a need to develop more inclusive content for students with disabilities. Future plans include expanding educational content, increasing collaborations with schools and industry partners, and refining programs to meet evolving needs based on feedback from educators and students.

2.5 "INTUX - Introducing training on user Testing with people with disabilities into UX design and related higher education program" by Boštjan Šumak, Maja Pušnik and Katja Kous (Slovenia)

The INTUX project, "Introducing training on user Testing with people with disabilities into UX design and related higher education programs", focuses on making UX design education more inclusive by integrating accessibility into user testing. The project addresses a gap in UX design practices, where people with disabilities are often excluded from testing, leading to products that do not fully meet their needs.

A vital outcome of the project is a specialized training course for UX design students, teaching them how to conduct user testing with people with disabilities. This course is supported by a handbook for university staff, guiding the creation of more inclusive teaching environments. This ensures that students are prepared to design accessible products and meet the challenges they will face as professionals.

The project also develops a framework to integrate these training modules into UX design programs, embedding accessibility into the curriculum. Additionally, it empowers people with disabilities by educating them about their rights in user testing and encouraging their active participation in the design process.

For higher education institutions, INTUX enriches educational programs by incorporating inclusive practices. By adopting the training modules and recommendations, institutions ensure that their students graduate with the skills to design

accessible products and services, aligning with growing societal and professional expectations for inclusion and accessibility.

3 Conclusion

The ERASMUS+ project SET4Inclusion has emphasized the critical importance of fostering inclusive digital education environments within higher education institutions. By systematically collecting and evaluating a diverse range of good practices, the project has illuminated various strategies and tools that can effectively address the needs of all learners, particularly those with disabilities or special needs. The five exemplary good practices presented in this paper highlight innovative approaches to creating accessible learning environments, from hybrid pedagogical tools that integrate digital and physical elements to enhance mathematical understanding, to comprehensive frameworks that address multiple dimensions of inclusivity such as leadership, pedagogy, and technology infrastructure.

These findings suggest that successful inclusive digital education requires a holistic approach that combines technological solutions with pedagogical innovation and collaboration among educators. As digital education continues to evolve, the insights and recommendations drawn from these good practices provide a valuable roadmap for higher education institutions aiming to enhance their inclusivity efforts. Future research should continue to explore the scalability and adaptability of these practices across different educational contexts, ensuring that all students, regardless of their backgrounds or abilities, have equitable access to high-quality digital education.

Note that there is a section break at the end of references to balance the columns (and this text is a part of the new section). If you have no space left at the end of your paper, you can delete it.

Acknowledgments / Zahvala

This paper was prepared based on the results of the ERASMUS+ SET4Inclusion project: Self-Evaluation Tools for e-Inclusion in Higher Education Institutions. Therefore, we would like to express our sincere gratitude to all the authors who contributed their valuable practices in response to our call and to everyone involved in the successful development of the project.

Technological Speech Adaptation for Professional Work as a Lawyer and Law Professor: A Case of a Patient with Multiple Sclerosis

Sara Ahlin Doljak
European law faculty
New University
Nova Gorica, Slovenia
sara.ahlin-doljak@epf.nova-uni.si

Abstract

This paper presents a case study of a female patient with multiple sclerosis (MS) who has successfully adapted to the challenges of her condition through the use of advanced assistive technologies. Focusing on the use of speech-generating devices and predictive text software, this study highlights the practical applications of these tools in supporting her career as a lawyer and lecturer. The findings underline the critical role of technology in maintaining professional roles and the patient's resilience in overcoming significant physical disabilities.

Keywords

Speech-generating device, AAC technology, communication methods, SwiftKey, mobility, voice

1 Introduction

Multiple sclerosis (MS) is a chronic, progressive neurological condition that affects the central nervous system, leading to a wide range of physical and cognitive impairments. Among these, communication difficulties are common, particularly in cases where the disease progression results in the need for a tracheostomy, as it impairs the patient's ability to speak [1]. This paper presents a case study of a female patient with MS who, despite facing severe communication barriers due to a tracheostomy and loss of speech, has successfully adapted to the challenges of her condition through the use of advanced assistive technologies.

The central focus of this study is on speech-generating devices and predictive text software, specifically the Tobii Dynavox i-16 and Microsoft SwiftKey, and their role in enabling the patient to maintain her dual professional roles as a lawyer and a lecturer. These technologies, part of the broader category of Augmentative and Alternative Communication (AAC) systems, have been demonstrated to significantly improve communication capabilities for individuals with severe speech impairments [2].

Information Society 2024, 7–11 October 2024, Ljubljana, Slovenia

https://doi.org/10.70314/is.2024.DIGIN.14

The aim of this research is to evaluate the effectiveness of these tools in supporting her professional activities and to explore the strategies she employed to overcome the physical limitations imposed by MS. By examining her journey, the study underscores the importance of resilience, adaptability, and the integration of technology in enabling individuals with disabilities to remain active in high-demand professions.

The paper is organized as follows: Section 2 describes the methods used, including the case study approach and data collection techniques. Section 3 presents the results of the study, with discussions on communication methods, technological advancements, and adaptive strategies. The conclusion offers insights into the potential for future technological developments to further enhance the quality of life for individuals with severe disabilities.

2 Empirical Research Procedure

2.1 Problem Definition and Purpose

The primary problem addressed in this empirical research is understanding how a patient with a 12-year diagnosis of multiple sclerosis (MS), who has a tracheostomy and is unable to speak, has adapted to her professional roles as a lawyer and lecturer. The study also seeks to evaluate the role that assistive technologies play in enabling her to maintain her professional activities despite severe physical limitations. The purpose of this research is to explore both the emotional and practical aspects of her adaptation process, providing insights into the benefits and limitations of technological interventions in helping her continue to work in high-demand professional environments.

2.2 Objective of the Empirical Research

The objective of this empirical research is to identify the key strategies and tools that allow a person with severe MS to adapt to and continue working in professional settings. The study focuses on understanding how the patient copes with the limitations imposed by her condition and examines the impact of assistive technologies on her ability to perform her professional tasks. Specifically, the research aims to:

- Investigate how the participant has adapted emotionally and practically to her condition, focusing on her mindset, routines, and coping mechanisms.
- Identify the technological interventions that facilitate her ability to work as a lawyer and lecturer, with a particular focus

on the use of assistive devices like speech-generating tools and predictive text software.

• Analyse the practical implementations and challenges of using assistive technologies in real-world professional settings such as courtrooms and lecture halls.

2.3 Methodology

This research employs a qualitative case study methodology, chosen for its suitability in exploring complex real-life phenomena, particularly when the boundaries between the phenomenon and its context are not clearly evident [3]. The case study focuses on a single participant-a female patient with a 12-year diagnosis of MS, who has a tracheostomy and is unable to speak-allowing for an in-depth analysis of her experiences, adaptations, and the role of assistive technologies in her professional life.

2.3.1 Procedure

The study involved data collection through in-depth interviews with the participant and systematic observations of her professional activities, including lectures and court sessions. These methods provided firsthand insights into how assistive technologies are applied in her day-to-day life, allowing for a detailed exploration of their practical uses and effectiveness [4].

2.3.2 Measuring Instruments

The effectiveness of various assistive technologies was assessed using several tools, chosen based on their role in aiding communication and mobility. Key instruments included:

• Speech-Generating Device (Tobii Dynavox i-16): Used to convert text to speech, this device was analysed for its usability, customization options, and reliability in different professional environments [5].

• Predictive Text Software (Microsoft SwiftKey): Evaluated for its predictive capabilities, learning curve, and integration with other devices, focusing on its efficiency in aiding communication [6].

• Augmentative and Alternative Communication (AAC) Systems: These systems were analysed for their speed, accuracy, and user-friendliness during interactive professional sessions [7].

2.3.3 Research Questions

The following research questions guided the investigation:

• How has a patient with MS adapted to her professional roles as a lawyer and lecturer? The study explores the emotional and practical strategies the participant employed to adjust to her condition and continue working. It aims to reveal how she overcame challenges, adjusted her routines, and adopted new tools to maintain her career.

• What technological interventions have facilitated her continuation as a lawyer and lecturer? The research identifies key technological aids, such as speech-generating devices and predictive text software, that assist her in communicating effectively and performing professional tasks.

• What are the practical implementations and challenges associated with the assistive technologies she utilizes? This question addresses the real-world applications of the assistive technologies, evaluating both their strengths and limitations in various professional settings like courtrooms and classrooms.

2.3.4 Participants

A single female participant with a 12-year diagnosis of MS, who has a tracheostomy and is unable to speak, was selected for this case study. This unique case allows for an in-depth exploration of her adaptation to her condition and the role of assistive technologies in her professional life. The personalized focus on one participant enabled a detailed examination of her experiences, providing valuable insights that might be diluted in a study involving multiple participants.

3 Results

The collected data refers to the information gathered during the study on how the patient adapted to her condition and utilized various assistive technologies to maintain her professional roles. This data was gathered through comprehensive interviews, observations, and assessments of the tools she used, such as the Tobii Dynavox speech-generating device and Microsoft SwiftKey predictive text software.

Figure 1: Tobii Dynavox i-110, dry-erase board and Tobii Dynavox i-16 (All photos are from the personal archive of the participant of the study)

The data were analysed to identify recurring themes related to the efficacy of these technological aids, challenges encountered, and their overall impact on her professional life as a lawyer and lecturer. The results aim to provide insights into how the assistive technologies supported her communication and work, as well as the practical implementations of these tools.

3.1 Early Communication Methods

Initially, the participant's primary channel of communication was the dry-erase board. Because she could not speak, she used the avenue to document (write) her cases or notes, which was effective then, especially in classrooms. The students acquired comprehensive notes, which allowed them to gain vast knowledge of European law. A dry-erase board is an effective interactive teaching tool, considering that lecturers can project notes to help students understand complex concepts [8].

However, this approach was slow and laborious. However, this approach was slow and laborious, leading to delays in covering the syllabus and impacting the efficiency of her work. Additionally, within a few weeks, she lost the ability to write with her right arm, necessitating the search for alternative communication methods. This early phase is illustrated in Figure 1, which shows the Tobii Dynavox i-110, dry-erase board, and Tobii Dynavox i-16.

3.2 Technological Advancements

The improvement in technology made communication easier for her. Kumar et al. (2019) and Unwin (2017) asserted that technology enables instant communication, irrespective of geographical limitations [9, 10]. Kumar et al. (2023) and Sahoo and Choudhury (2023) added that applications, software, and voice-controlled devices (wheelchairs), which are elements of the latest technologies, facilitate easier communication with MS patients, illustrating their criticality in her life [11, 12]. Mainly, she uses a speech-generating device that converts text to speech. She controls the narration by typing on the keyboard of Tobii Dynavox i-16. In addition, she uses Microsoft SwiftKey, a predictive text software, to improve her communication speed, ensuring that she is competitive in class and court. Google Inc. (n.d.) stated that SwiftKey is an intelligent keyboard that learns a person's writing style to hasten writing [13]. These tools enabled her to communicate more efficiently, maintaining competitiveness in her professional roles. A real-world example of her using the Tobii Dynavox i-110 and i-16 in public is shown in Figure 2.

Figure 2: A patient with MS in public with Tobii Dynavox i-110 and i-16 (All photos are from the personal archive of the participant of the study)

3.3 Lecturing Strategies and Public Engagement

The technologies mentioned above play an integral role in the preparation and execution of her lectures. She is an organized individual who prefers to define the lecture's content and prepare in advance. Thus, a few days prior to a class, she usually types out her speech using the predictive text system. This technology gives her enough notes and follow-up assignments or questions to engage the classroom. Narang et al. (2022) noted that an open discussion forum is an evidence-based strategy that bolsters students' engagement and awareness of the coursework [14]. During interactive sessions, she utilized augmentative and alternative communication (AAC) systems to compose feedback, although this process required patience from the audience due to time delays. Despite these challenges, her lectures remained thorough and engaging.

3.4 Evolution and Adaptation

Since the onset of her condition, she has realized the significance of transforming and adapting to the emerging life changes and latest technologies. Cahill (2020), Singh (2021), and Sampathkumar (2020) argued that change is inevitable, warranting individuals to modify their behaviours or actions to succeed [15, 16, 17]. She actively researched and adopted new systems to facilitate communication, recognizing the importance of evolving alongside technological developments.

The evolution of AAC technology has been particularly beneficial, reflecting advancements in both hardware and software that support her ability to communicate sophisticated ideas and engage professionally. Her current use of the Tobii Dynavox i-16 in her daily professional life, at both work and home, is shown in Figure 3.

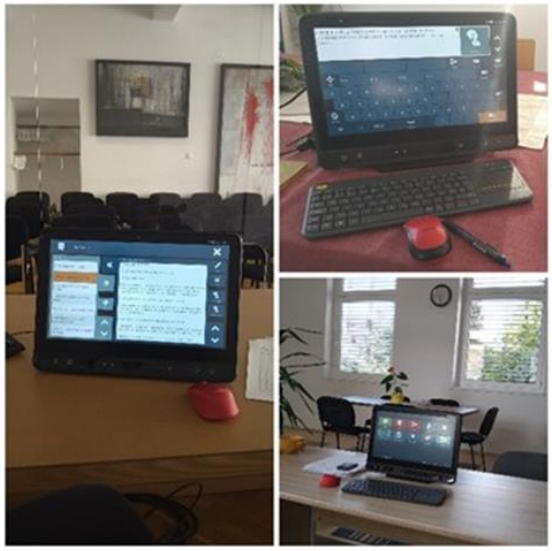

Figure 3: A patient with MS uses the Tobii Dynavox i-16 nowadays at work and home (All photos are from the personal archive of the participant of the study)

4 Conclusion

This study examined how a patient with multiple sclerosis adapted to her condition to continue her professional roles as a lawyer and lecturer. The findings address the research questions as follows:

The patient adjusted her mindset and routines to accommodate her physical limitations. She demonstrated resilience by seeking alternative methods to fulfil her professional responsibilities, including extensive preparation and the use of assistive technologies. Her determination enabled her to overcome initial setbacks and maintain her career.

Key technological aids, such as the Tobii Dynavox i-16 speech-generating device and Microsoft SwiftKey predictive text software, were instrumental in facilitating her communication. These tools supported her professional tasks by compensating for her lost abilities, allowing her to prepare lectures, engage with students, and represent clients effectively.

The assistive technologies were implemented in real-world settings, such as classrooms and courtrooms. While they significantly enhanced her communication capabilities, challenges included the slower pace of real-time interactions and the need for audience patience during interactive sessions. Technical issues and the learning curve associated with new devices also presented obstacles. Nonetheless, these technologies succeeded in enabling her to continue her professional activities.

In conclusion, the case study underscores the critical role of advanced assistive technologies in supporting individuals with severe disabilities to maintain their professional roles. The patient's experience highlights the importance of adaptability.

Acknowledgments

The author would like to express sincere gratitude to the participant for her cooperation and invaluable insights shared throughout this study. Special thanks are also extended to the European Law Faculty at New University, Slovenia, for their support in facilitating the research.

References

[1] Ilana Katz Sand. 2015. Classification, diagnosis, and differential diagnosis of multiple sclerosis. *Current Opinion in Neurology*, 28, 3 (2015), 193–205.

[2] Katherine C. Hustad, Kirsten Keppner, Amanda Schanz and Alycia Berg. 2008. Augmentative and alternative communication for preschool children: intervention goals and use of technology. *Seminars in Speech and Language*, 29, 2 (2008), 83–91. DOI: 10.1055/s-2008-1080754.

[3] Robert K. Yin. 2018. Case Study Research and Applications: Design and Methods. *SAGE Publications*.

[4] Sharan B. Merriam. 1998. Qualitative Research and Case Study Applications in Education. *Jossey-Bass Publishers*

[5] TD I-16 Gaze Interaction. Accessed September 9, 2024 from https://linkassistive.co.nz/product/td-i-16-gaze-interaction-2/

[6] Microsoft. *How does the Microsoft SwiftKey Prediction Bar work*? Accessed September 9, 2024, from https://support.microsoft.com/en-au/topic/how-does-the-microsoft-swiftkey-prediction-bar-work-2fbbac0f-ad7e-490d-bc92-2eb4538a3f3d

[7] Katherine C. Hustad, Kirsten Keppner, Amanda Schanz and Alycia Berg. 2008. Augmentative and alternative communication for preschool children: intervention goals and use of technology. *Semin Speech Lang*. 2008 May; 29, 2 (2008), 83–91. DOI: 10.1055/s-2008-1080754. PMID: 18645910; PMCID: PMC2493612.

[8] Idoghor Uduak and Rebecca Oluwayimika Kasumu. 2022. The use of interactive whiteboards for teaching and learning in tertiary institutions. *International Journal of Trendy Research in Engineering and Technology* 6, 6 (2022): 28–33. https://doi.org/10.54473/IJTRET.2022.6606

[9] Sachin Kumar, Prayag Tiwari and Mikhail Zymbler. 2019. Internet of Things is a revolutionary approach for future technology enhancement: a review. Journal of Big Data 6, 1 (2019): 1–21. https://link.springer.com/article/10.1186/s40537-019-0268-2%23article-info

[10] Tim Unwin. 2017. Reclaiming information and communication technologies for development. *Oxford University Press*, 2017.

[11] Sravan Kumar, Pamanji Deepika, Mahamad Farzana, Ojja Kaveri, Kumari Preethi and Pemmaraju Bharati Sai Sailaja. 2023. A Real-time Voice Controlled Wheelchair for Specially Abled People. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)* 14, 2 (2023): 742–751. https://doi.org/10.17762/turcomat.v14i2.13729.

[12] Sushil Kumar Sahoo and Bibhuti Bhusan Choudhury. 2023. Voice-activated wheelchair: An affordable solution for individuals with physical disabilities. *Management Science Letters* 13, 3 (2023): 175–192. https://doi.org/10.5267/j.msl.2023.4.004

[13] Microsoft Corporation. SwiftKey Keyboard. Version 9.10.15.5. Google Play Store. Accessed September 9, 2024 from https://play.google.com/store/apps/details?id=com.touchtype.swiftkey&hl=en&pli=1

[14] Unnati Narang, Manjit S. Yadav and Aric Rindfleisch. 2022. The "idea advantage": How content sharing strategies impact engagement in online learning platforms. *Journal of Marketing Research* 59, 1 (2022): 61–78. https://doi.org/10.1177/00222437211017828

[15] Naomi Cahill. 2020. Change is inevitable… *Canadian Journal of Dietetic Practice and Research* 81, 4 (2020): 169–169. https://doi.org/10.3148/cjdpr-2020-036

[16] Divya Singh. 2021. Change is inevitable. *Just Africa 6, 1 (2021), 4–5*. Accessed September 9, 2024 from https://hdl.handle.net/10520/ejc-ajcj_v6_n1_a1

[17] Arkalgud Sampathkumar. 2020. Change is inevitable. *Asian Cardiovascular and Thoracic Annals* 28, 1 (2020): 5–6. https://doi.org/10.1177/0218492319897805

Indeks avtorjev / Author index

Digitalna vključenost v informacijski družbi

Digital Inclusion in Information Society

Urednika > Editors:
Matjaž Debevc, Ines Kožuh