Co-funded by the European Union

INTUX PROJECT

Literature review

This deliverable has been produced as part of the Erasmus + Key Action 2 Erasmus+ Cooperation Partnership project: “INtroducing training on user Testing with people with disabilities into UX design and related higher education Programmes” / INTUX

Project partners:

The project number: 2022-1-LV01-KA220-HED-000087964
Date of publication: June 2023

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1 Introduction

The aim of the literature review was to gather relevant scientific information about user testing activities and experiences among researchers in the past 10 years. The research activities in this study were divided into several phases. By using the Parsifal tool, keywords and search strings were defined. Next, digital libraries were chosen and distributed among the partners to apply the defined keyword strings. All identified literature units were later compared to predefined inclusion and exclusion criteria. After screening the papers based on the title and the abstract, a quality assessment followed, extracting 83 relevant papers. For the papers, which achieved a high enough quality assessment score, content screening was performed, and data was extracted based on a predefined data extraction form.

Figure 1. Literature review approach

2 Literature review procedure

2.1 Search method

The primary goal of this study was to identify, analyse, and synthesize existing work in the field of user testing, including people with various impairments. The main objective of this study was to (1) systematically review relevant scientific articles and (2) extract important data from the papers, presented in the data extraction form section. The included researchers were:

- Loïc Martínez Normand,
- Cristian Moral Martos,
- José Luis Fuertes Castro,
- Boštjan Šumak,
- Maja Pušnik,
- Elena Villalba Mora,
- Angelica De Antonio Jiménez,
- Katja Kous,
- Janis Peksa.

To cover as many related papers as possible, various keywords and synonyms were used (presented in Table 1).

Table 1. Keyword structure

Keyword	Synonyms
"user test*"	"user evaluation"
UX	"user experience", accessibility, accessible, barriers, diversity, usability
disab*	"Down's syndrome", "hard of hearing", "intellectual disability", "low dexterity", "low vision", ASD, autis*, blind*, deaf*, dyslex*, hemiplegia, impairment, paraplegia, wheelchair

As we wanted to provide a comprehensive overview of the research area, broad keywords were used. The elementary search query string used for finding published articles was the following:

("user test" OR "user evaluation") AND ("UX" OR "user experience" OR "accessibility" OR "accessible" OR "barriers" OR "diversity" OR "usability") AND ("disab*" OR "Down's syndrome" OR "hard of hearing" OR "intellectual disability" OR "low dexterity" OR "low vision" OR "ASD" OR "autis*" OR "blind*" OR "deaf*" OR "dyslex*" OR "hemiplegia" OR "impairment" OR "paraplegia" OR "wheelchair")*

For finding the relevant literature, we used the following established publicly available digital libraries: ACM, IEEE, ScienceDirect, Scopus, and Web of Science. The first search conducted using the digital libraries yielded 1173 articles (that were used as input into the next selection process steps). Several inclusion and exclusion criteria were applied (see the criteria specification described in Selection Criteria) and the search strings had to be changed accordingly to the demands of digital libraries.

ACM Digital Library (http://portal.acm.org)

("ASD" OR "Down's syndrome" OR "accessible" OR "accessibility" OR "barriers" OR "diversity" OR "autistic" OR "blind" OR "deaf" OR "deafblind" OR "disabilities" OR "disability" OR "dyslexia" OR "hard of hearing" OR "hemiplegia" OR "intellectual disability" OR "low dexterity" OR "low vision" OR "paraplegia" OR "usability" OR "human-centred design" OR "user experience" OR "ux" OR "wheelchair") AND (""user test*"")

El Compendex (http://www.engineeringvillage.com)

("ASD" OR "Down's syndrome" OR "accessible" OR "accessibility" OR "barriers" OR "diversity" OR "autistic" OR "blind" OR "deaf" OR "deafblind" OR "disabilities" OR "disability" OR "dyslexia" OR "hard of hearing" OR "hemiplegia" OR "intellectual disability" OR "low dexterity" OR "low vision" OR "paraplegia" OR "usability" OR "human-centred design" OR "user experience" OR "ux" OR "wheelchair") AND (""user test*"")

IEEE Digital Library (http://ieeexplore.ieee.org)

("ASD" OR "Down's syndrome" OR "accessible" OR "accessibility" OR "barriers" OR "diversity" OR "autistic" OR "blind" OR "deaf" OR "deafblind" OR "disabilities" OR "disability" OR "dyslexia" OR "hard of hearing" OR "hemiplegia" OR "intellectual

disability" OR "low dexterity" OR "low vision" OR "paraplegia" OR "usability" OR "human-centred design" OR "user experience" OR "ux" OR "wheelchair") AND (""user test*"")

ISI Web of Science (http://www.isiknowledge.com)

TS = (("user test" OR "user evaluation") AND (ux OR "user experience" OR accessibility OR accessible OR barriers OR diversity OR usability) AND (disab* OR "Down's syndrome" OR "hard of hearing" OR "intellectual disability" OR "low dexterity" OR "low vision" OR ASD OR autis* OR blind* OR deaf* OR dyslex* OR hemiplegia OR impairment OR paraplegia OR wheelchair))

Science@Direct (http://www.sciencedirect.com)

("ASD" OR "Down's syndrome" OR "accessible" OR "accessibility" OR "barriers" OR "diversity" OR "autistic" OR "blind" OR "deaf" OR "deafblind" OR "disabilities" OR "disability" OR "dyslexia" OR "hard of hearing" OR "hemiplegia" OR "intellectual disability" OR "low dexterity" OR "low vision" OR "paraplegia" OR "usability" OR "human-centred design" OR "user experience" OR "ux" OR "wheelchair") AND (""user test*"")

Scopus (http://www.scopus.com)

("ASD" OR "Down's syndrome" OR "accessible" OR "accessibility" OR "barriers" OR "diversity" OR "autistic" OR "blind" OR "deaf" OR "deafblind" OR "disabilities" OR "disability" OR "dyslexia" OR "hard of hearing" OR "hemiplegia" OR "intellectual disability" OR "low dexterity" OR "low vision" OR "paraplegia" OR "usability" OR "human-centred design" OR "user experience" OR "ux" OR "wheelchair") AND (""user test*"")

Springer Link (http://link.springer.com)

("ASD" OR "Down's syndrome" OR "accessible" OR "accessibility" OR "barriers" OR "diversity" OR "autistic" OR "blind" OR "deaf" OR "deafblind" OR "disabilities" OR "disability" OR "dyslexia" OR "hard of hearing" OR "hemiplegia" OR "intellectual disability" OR "low dexterity" OR "low vision" OR "paraplegia" OR "usability" OR "human-centred design" OR "user experience" OR "ux" OR "wheelchair") AND (""user test*"")

2.2 Selection Criteria

The following inclusion and exclusion criteria were used to address over 1000 literature review units:

Inclusion Criteria:

- FIELD: The paper seems to provide information about user testing involving persons with disabilities.

Exclusion Criteria:

1. Year of publication before 2012 - Exclude literature, published before the Year 2012.

2. Duplicated - Exclude any duplicated studies found in multiple databases.
3. Language not supported by INTUX team - The article must be written in English, Spanish or languages, supported by project partners.
4. Cannot access the full content - The article must be accessible electronically.
5. Not original research (i.e., systematic literature review, mapping studies...) - Include articles. published in peer-reviewed journals, conference proceedings, or a book (e.g., lecture notes).
6. Only extended abstract or poster.
7. Title clearly unrelated to user testing of a product or service - Exclude articles with the title clearly unrelated to user testing of a product or service.
8. Abstract clearly unrelated to user testing of a product or service - Exclude articles with abstract clearly unrelated to user testing of a product or service.
9. Full text clearly unrelated to user testing of an interactive product or service - Exclude articles full text clearly unrelated to user testing of a product or service.

2.3 Quality Assessment Checklist

The assessment checklist to screen all papers, which were reviewed according to the inclusion criteria, was conducted with help of the following four questions and three possible answers:

Questions:

- Q1 - The quality of the writing is sufficient.
- Q2 - The quality of the venue (conference, journal) is sufficient.
- Q3 - The description of the user testing process is sufficient.
- Q4 - Persons with disabilities are included in the user testing.

Answers:

All questions in quality assessment checklist were evaluated based on three levels:

- High (10 points)
- Medium (5 points)
- Low (0 points)

Articles containing well-written essential elements such as an abstract, introduction, materials and methods, discussion and conclusions from which it is possible to under-stand the data that interested us in our research effectively (Q1) received all points and less, if this was not the case. If the article was published in a journal, it received 10 points, if it was only a conference proceeding, 5 points (Q2). The paper received all points, if the description of the testing process contained detailed and comprehensively described procedures of individual testing phases, such as preparation of tasks, recruitment, execution of the test, etc. (Q3). If persons with disabilities were included in the user testing (Q4), it received 10 points, otherwise 0 points.

The papers were able to achieve 0 to 40 points (10 for each question) and the cut-off score was 20. So only papers, which received more than 20 points, were included.

2.4 Data Extraction Form

For all selected papers, which made it through the inclusion criteria as well as reached a high enough quality assessment score, the following data (if available) was extracted:

1. Type of disability:
   01. Not specified,
   02. Blind,
   03. Low vision,
   04. Deaf,
   05. Hard of hearing,
   06. Low dexterity,
   07. Wheelchair user,
   08. Hemiplegia,
   09. Paraplegia,
   10. Quadriplegia,
   11. Intellectual disability,
   12. Dyslexia,
   13. ASD (autism),
   14. Down's syndrome,
   15. Other
2. Stage(s) of usability testing described:
   - Preparation of tasks - details
   - Prototype preparation - details
   - Ethical issues - details
   - Recruitment - details
   - Welcome to users - details
   - Pre-test questionnaires - details
   - Test execution - details
   - Post-test questionnaires - details
   - Post-evaluation feedback - details
3. Number of users involved
4. Tools/instruments used
5. Best practices identified
6. Challenges identified

3 Results

3.1 Selected papers

The search resulted in several identified papers, distributed among different libraries:

ACM Digital Library: 562

El Compendex: 0
IEEE Digital Library: 152
ISI Web of Science: 115
Science@Direct: 1
Scopus: 255
Springer Link: 0

The process of all selection steps is presented in Figure 2:

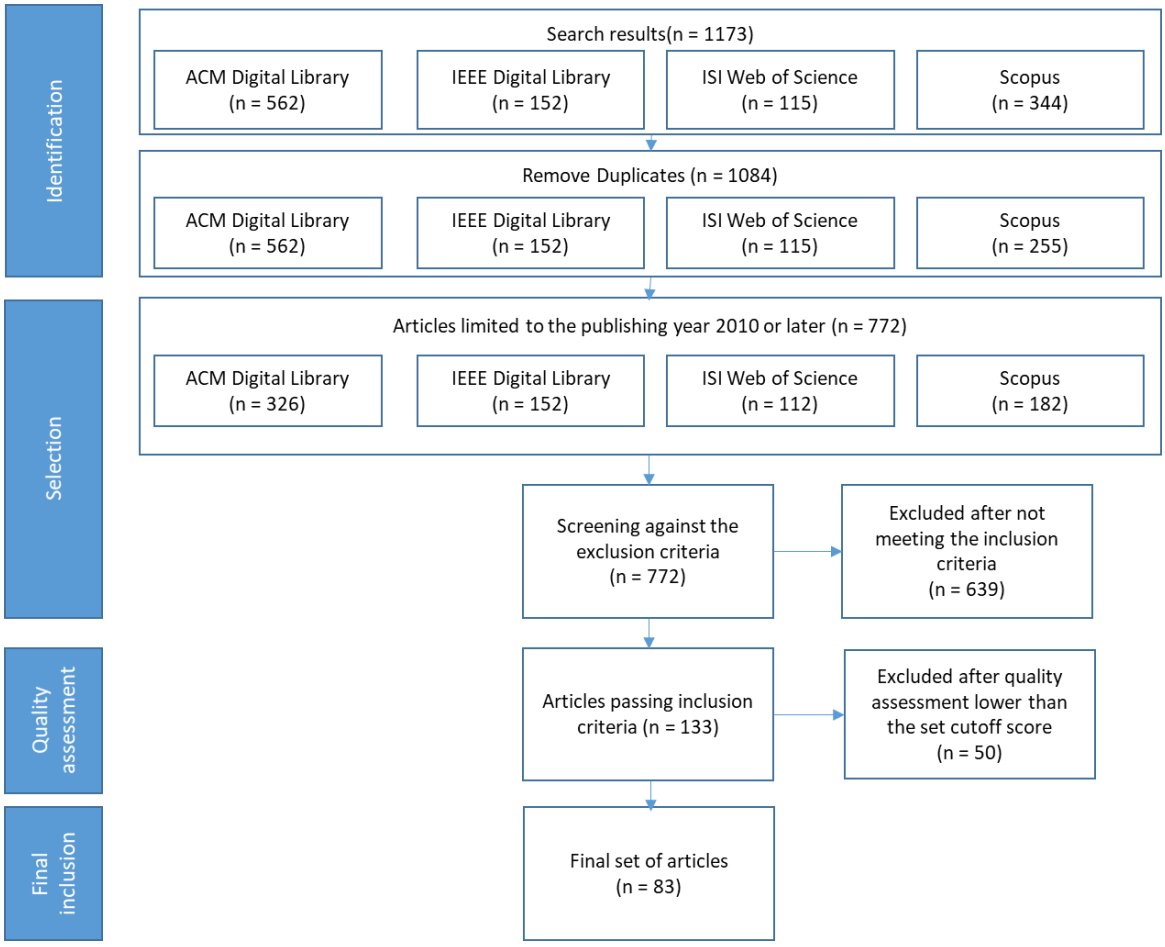

Figure 2. Identification of the final set of articles

Table 2 presents the numbers of identified literature by different libraries. As presented in Figure 3, the most relevant literature was identified in the digital library ACM, while the least was found in the digital library Web of Science.

Table 2. Identified literature in digital libraries

LIBRARY	COUNTRY	Number of literature units after KEYWORD-STRING search	Number of literature units after removing duplicates	Number of literature units, published in last 10 years
ISI Web of Science	Spain	115	115	112
Scopus	Slovenia	344	255	182
IEEE Digital Library	Latvia	152	152	152
ACM Digital Library	Slovenia	562	562	326
SUM		**1173**	**1084**	**772**

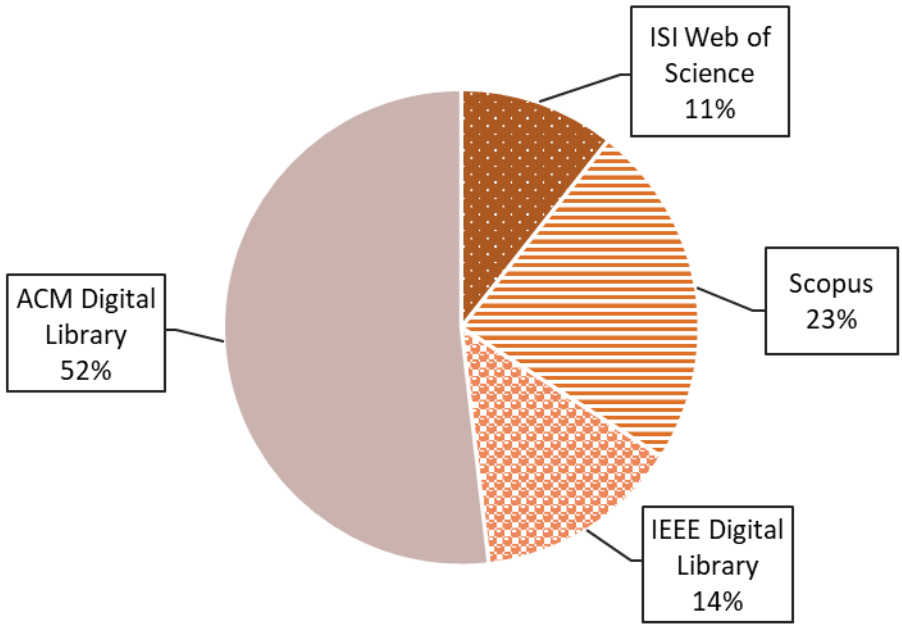

Figure 3. Digital libraries distribution

Figure 4 shows the relation between the selected and accepted papers according to the digital library. The best proportion was identified in the digital library Web of Science.

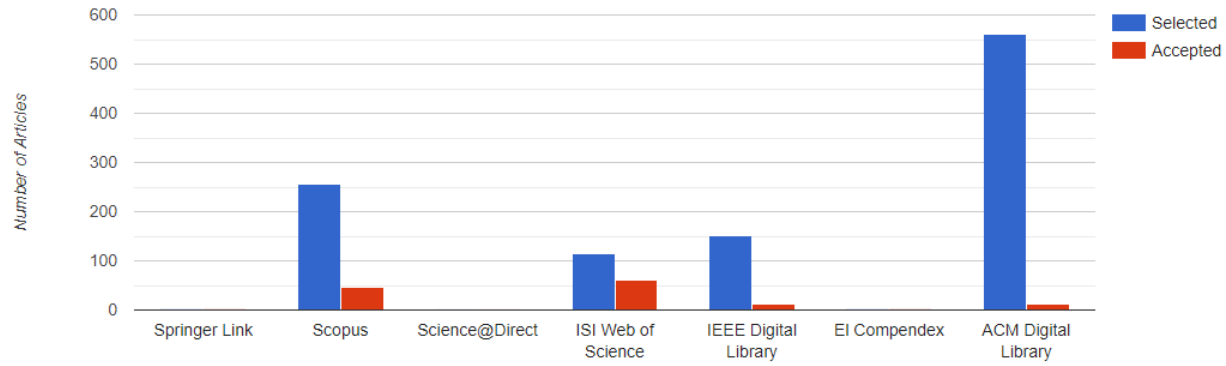

Figure 4. Digital libraries distribution based on selected and accepted papers

3.2 Results based on studies characteristics

Figure 5 presents the years when the identified papers were published. The results indicated that the number of published studies has been increasing in the last decade.

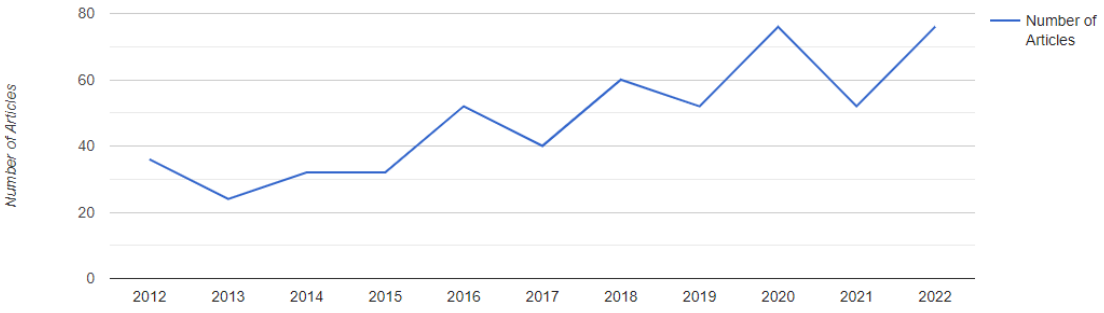

Figure 5. Distribution of years, identified papers were published

3.3 Results based on data extraction

Based on data extraction, we performed the analysis presented below.

3.3.1 Identification of disability types

Table 3 and Figure 6 present the number of different types of disabilities of people who were included in the user testing. We see that blind users (N=40) and users with low vision (N=33) were included in user testing most often, following the users with intellectual disabilities (N=12), users in wheelchairs (N=7), and deaf users (N=7). In 30 studies, the type of disability was marked as “others”, which means that types of disabilities were not included on the list.

Table 3. Number of different types of disability

	NUMBER of OCCURRENCES
01. Not specified	0
02. Blind	40
03. Low vision	33
04. Deaf	7
05. Hard of hearing	5
06. Low dexterity	5
07. Wheelchair user	7
08. Hemiplegia	4
09. Paraplegia	3
10. Quadriplegia	5
11. Intellectual disability	12
12. Dyslexia	1
13. ASD (autism)	2
14. Down's syndrome	1
15. Other	30

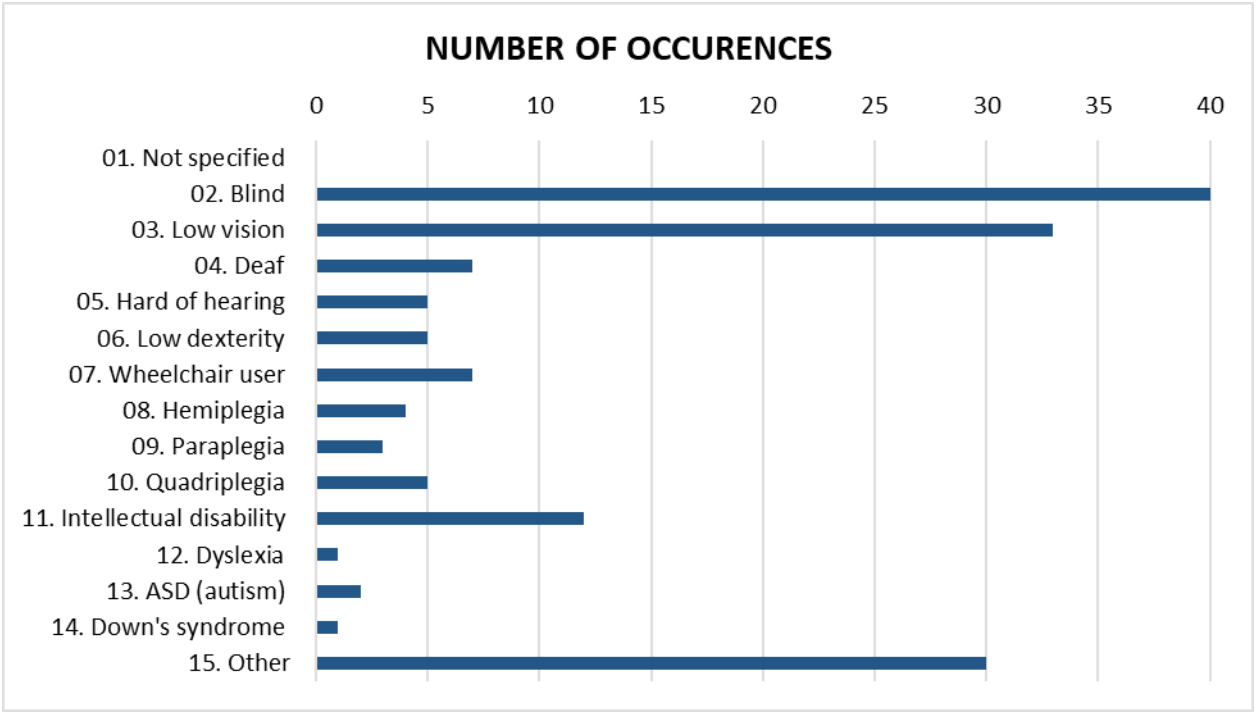

Figure 6. Disability types of users that participated in existing user testing research

While performing data extraction activities, we realized that there were missing values such as older people and more general disability descriptions.

3.3.2 Usability testing stages description frequency

Table 4 and Figure 7 present the number of usability stages that were included and described in the user testing procedure. More than half of the selected papers described the test execution (72%), post-test questionnaires (60%), and recruitment of users with disabilities (60%), while the welcome speech was presented only in 21 selected papers (25%).

Table 4. Occurrences of usability stage(s)

	NUMBER of OCCURRENCES	**%**
1. Preparation of tasks	31	36
2. Prototype preparation	**41**	**48**
3. Ethical issues	27	32
4. Recruitment	**51**	**60**
5. Welcome	21	25
6. Pre-test questionnaires	31	36
7. Test execution	**61**	**72**
8. Post-test questionnaires	**51**	**60**
9. Post-evaluation feedback	31	36

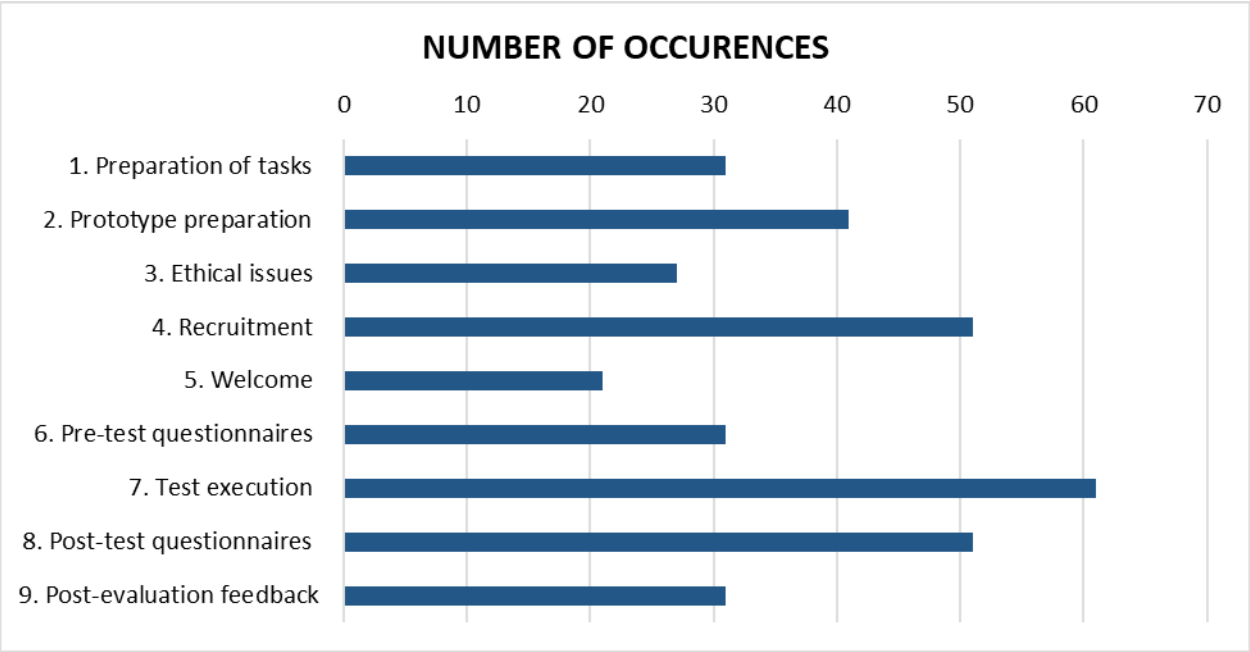

Figure 7. Occurrences of usability stage(s)

3.4 Best practices for user testing

Based on the classification presented in Figure 8, we focused on good practices related to users involved in user testing procedures. Thus, we identified 15 good practices and divided them into three different classes: (1) good practices before testing, (2) good practices during the testing, and (3) good practices after testing. The details are presented in Figure 9.

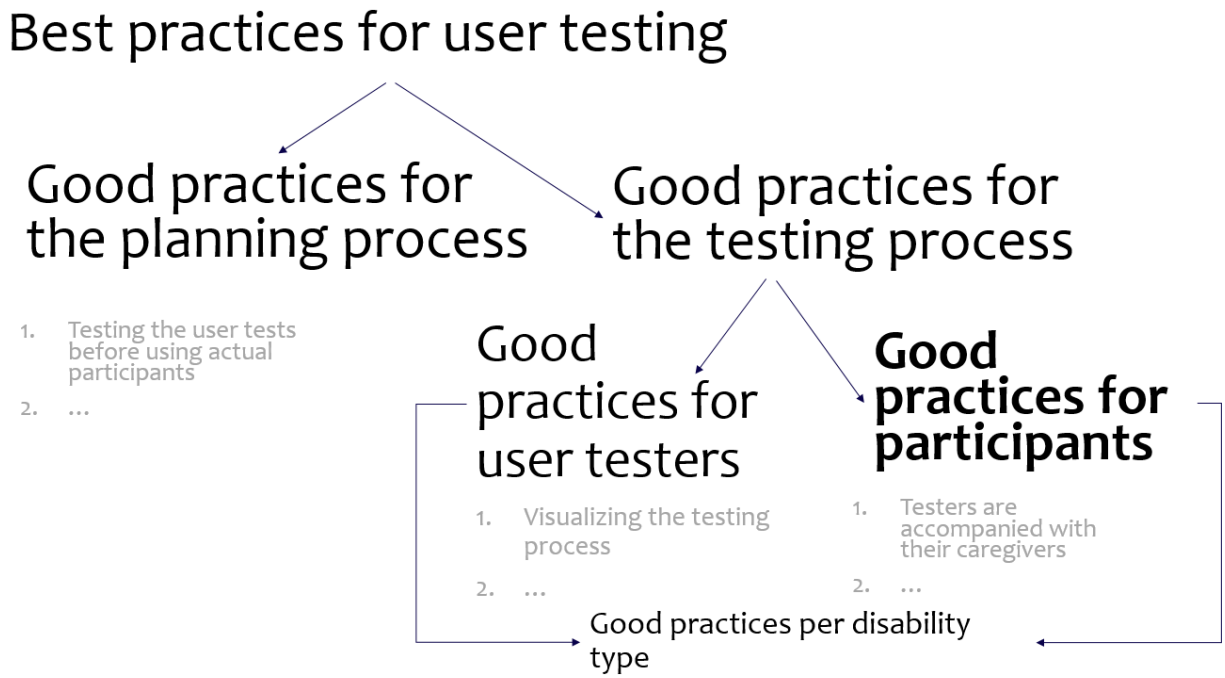

Figure 8. Classification of best practices of user testing

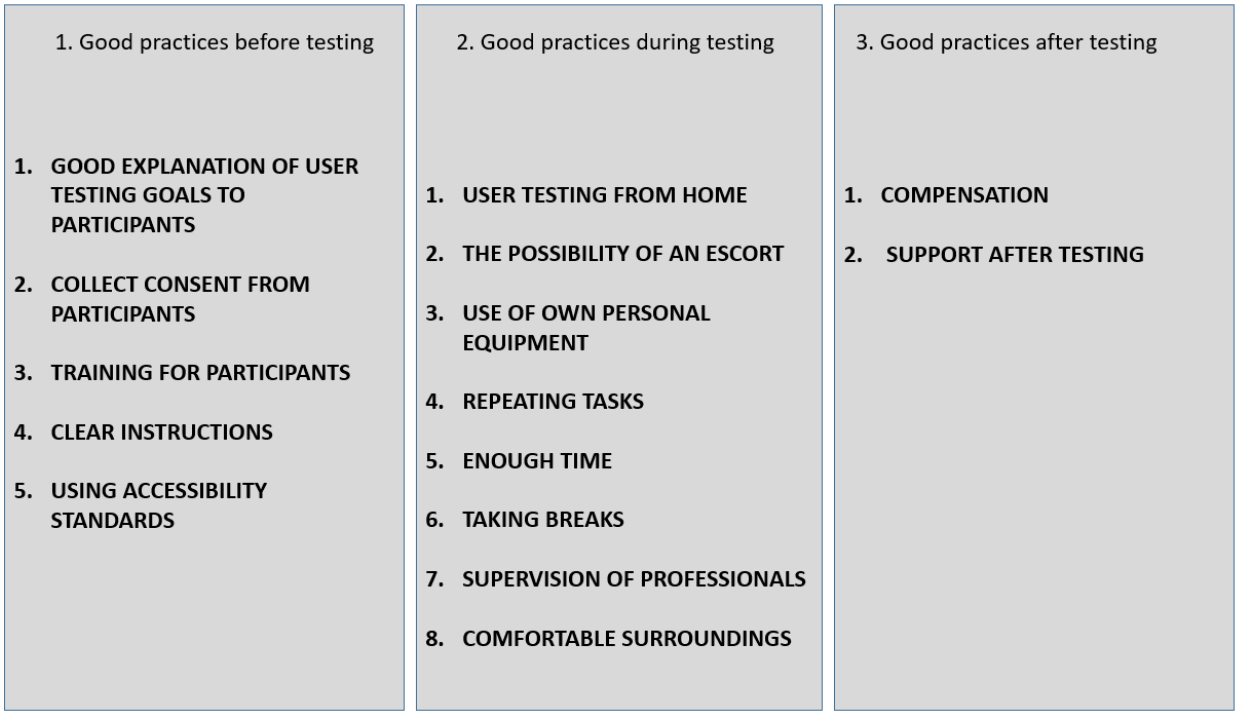

Figure 9. Classification of best practices of user testing for participants

1. Before user testing

1.1 Explanation of user testing goals to participants

Providing information in accessible format about user testing activities before starting the test will motivate participants, increase their assurance, self-confidence and self-efficiency, and motivation.

- *Goncu, Cagatay and Finnegan, Daniel J. `Did You See That!?' Enhancing the Experience of Sports Media Broadcast for Blind People*
- *Smaradottir, Berglind F. and Haland, Jarle A. and Martinez, Santiago G. User Evaluation of the Smartphone Screen Reader VoiceOver with Visually Disabled Participants*

1.2 Collect consent from participants

Providing the user's ethical approval and informed consent enables fair, transparent, and accurate research, minimizing harm.

- *Kulich, Hailee R. and Bass, Sarah R. and Koontz, Alicia M. Rehabilitation professional and user evaluation of an integrated push-pull lever drive system for wheelchair mobility*
- *Creed, Chris and Frutos-Pascual, Maite and Williams, Ian. Multimodal Gaze Interaction for Creative Design*

1.3 Ethical approval

- *Deems-Dluhy, Susan L. and Jayaraman, Chandrasekaran and Green, Steve and Albert, Mark V. and Jayaraman, Arun. Evaluating the Functionality and Usability of*

Two Novel Wheelchair Anti-Rollback Devices for Ramp Ascent in Manual Wheelchair Users With Spinal Cord Injury

- *Creed, Chris and Frutos-Pascual, Maite and Williams, Ian. Multimodal Gaze Interaction for Creative Design*

1.4 Replicating normal life

- *Schroeter, Ch and Mueller, S. and Volkhardt, M. and Einhorn, E. and Huijnen, C. and van den Heuvel, H. and van Berlo, A. and Bley, A. and Gross, H-M. Realization and User Evaluation of a Companion Robot for People with Mild Cognitive Impairments*

1.5 Emotional Likert scale

- *Keskinen, Tuuli and Heimonen, Tomi and Turunen, Markku and Rajaniemi, Juha-Pekka and Kauppinen, Sami. SymbolChat: Picture-Based Communication Platform for Users with Intellectual Disabilities*
- *Efthimiou, Eleni and Fotinea, Stavroula-Evita and Goulas, Theodore and Vacalopoulou, Anna and Vasilaki, Kiki and Dimou, Athanasia-Lida. Sign Language Technologies and the Critical Role of SL Resources in View of Future Internet Accessibility Services*
- *Ahmetovic, Dragan and Bernareggi, Cristian and Leporini, Barbara and Mascetti, Sergio. WordMelodies: Supporting the Acquisition of Literacy Skills by Children with Visual Impairment through a Mobile App*

1.6 Personalization, collaboration, and all diversities considered

- *From disabilities to capabilities: Testing subtitles in immersive environments with end users (De discapacidades a capacidades: Testando subtítulos en medios inmersivos con usuarios)*
- *Personalizing Pedestrian Accessible way-finding with mPASS*
- *Prejudices, memories, expectations and confidence influence experienced accessibility on the Web*
- *Writing Centers and Students with Disabilities: The User-centered Approach, Participatory Design, and Empirical Research as Collaborative Methodologies*
- *An evaluation of web-based voting usability and accessibility*

1.7 Training for participants

Providing the opportunity for training the participants before they start with user testing increases self-confidence, self-efficiency and motivation and reduces stress.

- *Kulich, Hailee R. and Bass, Sarah R. and Koontz, Alicia M. Rehabilitation professional and user evaluation of an integrated push-pull lever drive system for wheelchair mobility*

- *Sato, Daisuke and Oh, Uran and Guerreiro, João and Ahmetovic, Dragan and Naito, Kakuya and Takagi, Hironobu and Kitani, Kris M. and Asakawa, Chieko. NavCog3 in the Wild: Large-scale Blind Indoor Navigation Assistant with Semantic Features*
- *Sato, Daisuke and Oh, Uran and Naito, Kakuya and Takagi, Hironobu and Kitani, Kris and Asakawa, Chieko. NavCog3: An Evaluation of a Smartphone-Based Blind Indoor Navigation Assistant with Semantic Features in a Large-Scale Environment*

1.8 Clear instructions

Providing clear and concise instructions increases the success rate of testing.

- *Arrue, Myriam and Valencia, Xabier and Eduardo Perez, J. and Moreno, Lourdes and Abascal, Julio. Inclusive Web Empirical Studies in Remote and In-Situ Settings: A User Evaluation of the RemoTest Platform*

1.9 Using accessibility standards

Ensuring that all documents are accessible and standards-compliant to ensure compatibility with assistive technologies increases the effectiveness of testing and increases accessibility for all participants.

- *Arrue, Myriam and Valencia, Xabier and Eduardo Perez, J. and Moreno, Lourdes and Abascal, Julio. Inclusive Web Empirical Studies in Remote and In-Situ Settings: A User Evaluation of the RemoTest Platform*

2. During the user testing

2.1 User testing from home

Providing the option for participants to perform usability activities in their homes reduces stress, increases the participants' well-being and relaxation, and avoids costs.

- *Miralles, F. and Vargiu, E. and Rafael-Palou, X. and Solà, M. and Dauwalder, S. and Guger, C. and Hintermüller, C. and Espinosa, A. and Lowish, H. and Martin, S. and Armstrong, E. and Daly, J. Brain-computer interfaces on track to home: Results of the evaluation at disabled end-users' homes and lessons learnt*
- *Boštjan Šumak and Matic Špindler and Mojca Debeljak and Marjan Heričko and Maja Pušnik. An empirical evaluation of a hands-free computer interaction for users with motor disabilities*

2.2 The possibility of an escort

Allowing participants to be accompanied by their caregivers, friends or family members increases their safety, better comfort, self-confidence and self-efficiency.

- *Torrado, Juan C. and Jaccheri, Letizia and Pelagatti, Susana and Wold, Ida. HikePal: A mobile exergame to motivate people with intellectual disabilities to do outdoor physical activities*
- *Sato, Daisuke and Oh, Uran and Naito, Kakuya and Takagi, Hironobu and Kitani, Kris and Asakawa, Chieko. NavCog3: An Evaluation of a Smartphone-Based Blind Indoor Navigation Assistant with Semantic Features in a Large-Scale Environment*

- *Schroeter, Ch and Mueller, S. and Volkhardt, M. and Einhorn, E. and Huijnen, C. and van den Heuvel, H. and van Berlo, A. and Bley, A. and Gross, H-M. Realization and User Evaluation of a Companion Robot for People with Mild Cognitive Impairments*
- *Keskinen, Tuuli and Heimonen, Tomi and Turunen, Markku and Rajaniemi, Juha-Pekka and Kauppinen, Sami. SymbolChat: Picture-Based Communication Platform for Users with Intellectual Disabilities)*

2.3 Use of own personal equipment

Allowing participants to use their own personal equipment if that is what they prefer increases self-confidence, self-efficiency, and motivation because the participants are more accustomed to their own hardware and software or other equipment.

2.4 Repeating tasks

Giving the possibility to repeat each test for participants during the user testing activities increases positive user experience, and motivation and reduces stress.

- *Kulich, Hailee R. and Bass, Sarah R. and Koontz, Alicia M. Rehabilitation professional and user evaluation of an integrated push-pull lever drive system for wheelchair mobility*

2.5 Enough time

Providing enough time for performing user testing activities allows participants to get a good feeling with minimal stress, motivating them, and giving them enough time for preparation without rushing to perform the activities.

- *Thorsen, Rune and Dalla Costa, Davide and Beghi, Ettore and Ferrarin, Maurizio. Myoelectrically Controlled FES to Enhance Tenodesis Grip in People With Cervical Spinal Cord Lesion: A Usability Study*
- *Deems-Dluhy, Susan L. and Jayaraman, Chandrasekaran and Green, Steve and Albert, Mark V. and Jayaraman, Arun. Evaluating the Functionality and Usability of Two Novel Wheelchair Anti-Rollback Devices for Ramp Ascent in Manual Wheelchair Users With Spinal Cord Injury*

2.6 Taking breaks

Providing breaks between user testing activities allows a longer concentration of participants.

- *Arrue, Myriam and Valencia, Xabier and Eduardo Perez, J. and Moreno, Lourdes and Abascal, Julio. Inclusive Web Empirical Studies in Remote and In-Situ Settings: A User Evaluation of the RemoTest Platform*

2.7 Supervision of professionals

Including expert supervision in user testing activities increases the likelihood that testing is carried out by requirements and good practices.

- *Day, Phil and Jokisuu, Elina and Smith, Andrew W. D. Accessible Touch: Evaluating Touchscreen PIN Entry Concepts with Visually Impaired People Using Tactile or Haptic Cues*
- *Deems-Dluhy, Susan L. and Jayaraman, Chandrasekaran and Green, Steve and Albert, Mark V. and Jayaraman, Arun. Evaluating the Functionality and Usability of Two Novel Wheelchair Anti-Rollback Devices for Ramp Ascent in Manual Wheelchair Users With Spinal Cord Injury*

2.8 Include at least two evaluators

One of the main precautions that should be taken while conducting a usability test with learners who are blind is to always include at least two evaluators: one mediator and one observer. If the same evaluator who gives instructions and mediations also tries to make detailed field notes, this person is more prone to neglect some usability issues.

- *Darin, T. and Andrade, R. and Sánchez, J. Usability evaluation of multimodal interactive virtual environments for learners who are blind: An empirical investigation*

2.9 Comfortable surroundings

Providing comfortable surroundings and accessible infrastructure has an impact on concentration and better test performance.

3. After user testing

3.1 Compensation

Providing the compensation to attend the user testing for participants increases the assurance of participation in testing and the seriousness of participation.

- *Sato, Daisuke and Oh, Uran and Guerreiro, João and Ahmetovic, Dragan and Naito, Kakuya and Takagi, Hironobu and Kitani, Kris M. and Asakawa, Chieko. NavCog3 in the Wild: Large-scale Blind Indoor Navigation Assistant with Semantic Features*
- *Sato, Daisuke and Oh, Uran and Naito, Kakuya and Takagi, Hironobu and Kitani, Kris and Asakawa, Chieko. NavCog3: An Evaluation of a Smartphone-Based Blind Indoor Navigation Assistant with Semantic Features in a Large-Scale Environment*

3.2 Support after testing

Providing participants a possibility to be driven and/or accompanied to their homes if user testing activities have to be performed outside their homes increases the positive user experience, reduces stress and increases relaxation and concentration during the testing.

3.5 Challenges for user testing

Along with best practices, the authors identified numerous challenges in user testing in general as well as when including users with disabilities. Among the most documented were poor experience when performing testing online, which was often the case in the

pandemic. The results were unreliable when testing remotely and the users with disabilities reported confusing and not clear enough instructions as the main source of the problem. In several cases, the user testing could not be completed without the help of caregivers, especially in cases when children and young adults with communication difficulties were involved. The complexity of tools and difficulties to set up the devices to each individual needs were also reported, mainly in cases of people with visual impairment and people with postural problems, making long sitting sessions impossible, as well as older adults. Cultural differences were also addressed, in cases of user testing with both people with or without disabilities, and lastly, no compensation to users was noted as a larger barrier. All identified challenges from the literature review are reported bellow.

Reported barriers of inclusion from the literature review are presented in a form of list:

1. Before user testing

1.1 Participant chosen with potential bias

Participants have previous interest or knowledge, which affects user testing results.

- *Torrado, Juan C. and Jaccheri, Letizia and Pelagatti, Susana and Wold, Ida. HikePal: A mobile exergame to motivate people with intellectual disabilities to do outdoor physical activities*

1.2 Cultural differences

If international user testing participants are included, disregard of cultural differences is potentially problematic.

- *Wesselman, Linda M. P. and Schild, A. K. and Hooghiemstra, A. M. and Meiberth, D. and Drijver, A. J. and Leeuwenstijn-Koopman, M. V. and Prins, N. D. and Brennan, S. and Scheltens, P. and Jessen, F. and vander Flier, W. M. and Sikkes, S. A. M. Targeting Lifestyle Behavior to Improve Brain Health: User-Experiences of an Online Program for Individuals with Subjective Cognitive Decline*

1.3 Protocol differences for healthy and impaired users

Due to individual differences in capabilities between different users, results cannot be directly compared.

- *Kaethner, Ivo and Halder, Sebastian and Hintermueller, Christoph and Espinosa, Arnau and Guger, Christoph and Miralles, Felip and Vargiu, Eloisa and Dauwalder, Stefan and Rafael-Palou, Xavier and Sola, Marc and Daly, Jean M. and Armstrong, Elaine and Martin, Suzanne and Kuebler, Andrea. A Multifunctional Brain-Computer Interface Intended for Home Use: An Evaluation with Healthy Participants and Potential End Users with Dryand Gel-Based Electrodes*

1.4 Complex experimental design

Participants with intellectual disabilities have difficulties completing complex tasks.

- *Keskinen, Tuuli and Heimonen, Tomi and Turunen, Markku and Rajaniemi, Juha-Pekka and Kauppinen, Sami. SymbolChat: Picture-Based Communication Platform for Users with Intellectual Disabilities*

1.5 Understanding participants

Researchers do not understand the specific needs and mindsets of students, both with and without disabilities.

- *Brizee, A. and Sousa, M. and Driscoll, D.L. Writing Centers and Students with Disabilities: The User-centered Approach, Participatory Design, and Empirical Research as Collaborative Methodologies*

2. During the user testing

2.1 Challenges with tool accustoming

The users have difficulties accustoming to the tools that they are using for the first time.

- *Doush, I.A. and Al-Jarrah, A. and Alajarmeh, N. and Alnfiai, M. Learning features and accessibility limitations of video conferencing applications: are people with visual impairment left behind*

2.2 Unfamiliar and complex tools

Older adults struggle to use unfamiliar tools.

- *Weir, K. and Loizides, F. and Nahar, V. and Aggoun, A. and Pollard, A. I see therefore i read: improving the reading capabilities of individuals with visual disabilities through immersive virtual reality*

2.3 Tool bugs and malfunctions

While performing user testing, there is a risk of the tested environment malfunctions (freezing, failing to update, …)

- *Nair, Vishnu and Olmschenk, Greg and Seiple, William H. and Zhu, Zhigang. ASSIST: Evaluating the usability and performance of an indoor navigation assistant for blind and visually impaired people*

2.4 Tool setup challenges

Difficulties occur when setting up the device for each individual.

- *Thorsen, Rune and Dalla Costa, Davide and Beghi, Ettore and Ferrarin, Maurizio, Myoelectrically Controlled FES to Enhance Tenodesis Grip in People With Cervical Spinal Cord Lesion: A Usability Study*

2.5 Tools support shortcomings

Lack of a functionality for easy access to the application for people with different impairments (for example visually impaired).

- *Fogli, Daniela and Arenghi, Alberto and Gentilin, Fulvio. A universal design approach to wayfinding and navigation*

2.6 Tools inappropriate for all users

Tools appropriate only for normal vision users.

- *Carvalho, Michael Crystian Nepomuceno and Dias, Felipe Silva and Reis, Aline Grazielle Silva and Freire, André Pimenta. Accessibility and Usability Problems Encountered on Websites and Applications in Mobile Devices by Blind and Normal-Vision Users*

2.7 Infrastructure difficulties

Technical infrastructure can be unsuitable for an evaluation with visually disabled users.

- *Smaradottir, Berglind F. and Haland, Jarle A. and Martinez, Santiago G. User Evaluation of the Smartphone Screen Reader VoiceOver with Visually Disabled Participants*

2.8 Unproductiveness of assistive technology

The lack of screen reader support on smart glasses, a rapidly draining battery, and a dependency on Internet connection decrease the success of the testing process.

- *Lee, K. and Hong, J. and Jarjue, E. and Mensah, E.E. and Kacorri, H. From the Lab to People s Home: Lessons from Accessing Blind Participants Interactions via Smart Glasses in Remote Studies*

2.9 Participant's obligation feelings

If the researchers are present, the participants feel obliged to make them happy, participants express opinions which are favorable to the researchers or their caregivers.

- *Torrado, Juan C. and Jaccheri, Letizia and Pelagatti, Susana and Wold, Ida HikePal: A mobile exergame to motivate people with intellectual disabilities to do outdoor physical activities*

2.10 Social desirability

Setting with observers, due to social desirability, users tend to increase their emotional control in disadvantageous conditions.

- *Pascual, A. and Ribera, M. and Granollers, T. Impact of accessibility barriers on the mood of users with motor and dexterity impairments*

2.11 Needed support of the caregivers

Children and young adults with special communication needs cannot participate by themselves.

- *Guasch, Daniel and Martin-Escalona, Israel and Macias, Jose A. andFrancisco, Virginia and Hervas, Raquel and Moreno, Lourdes and Bautista,Susana. Design and evaluation of ECO: an augmentative and alternative communication tool*

2.12 Online testing

Usability testing on-line due to the pandemic or other reasons often results in unreliable findings.

- *Silva, Jorge Sassaki Resende and Freire, André Pimenta and Cardoso, Paula Christina Figueira. When Headers Are Not There: Design and User Evaluation of an Automatic Topicalisation and Labelling Tool to Aid the Exploration of Web Documents by Blind Users*

2.13 Remote evaluations

Disadvantages and problems around conducting remote evaluations with participants with disabilities, as too little support is provided.

- *Goncu, Cagatay and Finnegan, Daniel J. `Did You See That!?' Enhancing the Experience of Sports Media Broadcast for Blind People*

2.14 Accessibility of web courses

Insufficient accessibility of web courses prevents successful user testing.

- *Królak, A. and Zając, P. Analysis of the accessibility of selected massive open online courses (MOOCs) for users with disabilities*

2.15 Testing from home

Poor internet and other challenges can make testing at home not always feasible.

- *Miralles, F. and Vargiu, E. and Rafael-Palou, X. and Solà, M. and Dauwalder, S. and Guger, C. and Hintermüller, C. and Espinosa, A. and Lowish, H. and Martin, S. and Armstrong, E. and Daly, J. Brain-computer interfaces on track to home: Results of the evaluation at disabled end-users' homes and lessons learnt*

2.16 Testing on site

As some experiments require strict laboratory conditions and rigorous protocols that cannot be performed from home.

Boštjan Šumak and Matic Špindler and Mojca Debeljak and Marjan Heričko and Maja Pušnik. An empirical evaluation of a hands-free computer interaction for users with motor disabilities

2.17 Journey difficulties

Long travel journeys can present a challenge to participants.

- *Boštjan Šumak and Matic Špindler and Mojca Debeljak and Marjan Heričko and Maja Pušnik. An empirical evaluation of a hands-free computer interaction for users with motor disabilities*

2.18 Danger of persuasive technologies

Integration of persuasive technologies influences behavior and attitudes.

- *Wesselman, Linda M. P. and Schild, A. K. and Hooghiemstra, A. M. and Meiberth, D. and Drijver, A. J. and Leeuwenstijn-Koopman, M. V. and Prins, N. D. and Brennan, S. and Scheltens, P. and Jessen, F. and vander Flier, W. M. and Sikkes, S. A. M. Targeting Lifestyle Behavior to Improve Brain Health: User-Experiences of an Online Program for Individuals with Subjective Cognitive Decline*

2.19 Short time for evaluation

Complete novelty, limited experience or unfamiliarity may impact the results.

- *Mattie, Johanne and Wong, Angie and Leland, Danny and Borisoff, Jaimie. End user evaluation of a Kneeling Wheelchair with "on the fly'' adjustable seating functions*

2.20 Shortage of time

Subjects can have difficulties while performing user testing and require more time than expected.

- *Lee, Sang M. and Hong, Soon-Goo and An, Dong-Han and Lee, Hyun-Mi. Disability users' evaluation of the web accessibility of SNS*

2.21 Controlled environment over real setting

Testing in a controlled setting, does not produce the same results as in a real setting, performing when users are performing regular daily activities.

- *Mattie, Johanne and Wong, Angie and Leland, Danny and Borisoff, Jaimie. End user evaluation of a Kneeling Wheelchair with "on the fly'' adjustable seating functions*

2.22 Environment problems

Multiple wires on the floor present a fall risk, loud sounds provide stress, hard to lift and heavy devices provide obstacles.

- *Chu, C.H. and Biss, R.K. and Cooper, L. and Linh Quan, A.M. and Matulis, H., Exergaming platform for older adults residing in long-term care homes: User-centered design, development, and usability study*

2.23 Difficulties envisioning the tasks

Participants find it difficult to only visualize the problems as they need more real experiences (they cannot judge a game only by watching but must experience playing a game).

- *Chu, C.H. and Biss, R.K. and Cooper, L. and Linh Quan, A.M. and Matulis, H. Exergaming platform for older adults residing in long-term care homes: User-centered design, development, and usability study*

2.24 Physical barriers

Sitting straight without being able to move the head is potentially challenging.

- *Alonso-Virgós, L. and Baena, L.R. and Espada, J.P. and Crespo, R.G. Web page design recommendations for people with down syndrome based on users' experiences*

2.25 Technical difficulties

Time-consuming and challenging activities which are not directly connected to user testing.

- *Lopes, P. and Pino, M. and Carletti, G. and Hamidi, S. and Legué, S. and Kerhervé, H. and Benveniste, S. and Andéol, G. and Bonsom, P. and Reingewirtz, S. and Rigaud, A.-S. Co-Conception Process of an Innovative Assistive Device to Track and Find Misplaced Everyday Objects for Older Adults with Cognitive Impairment: The TROUVE Project*

2.26 Unclear instructions

Risk of instructions being unclear and confusing.

- *Agulló, B. and Matamala, A. and Orero, P. From disabilities to capabilities: Testing subtitles in immersive environments with end users)*

3. After user testing

3.1 No compensation

No compensation to users creates a bad user experience.

- *Creed, Chris and Frutos-Pascual, Maite and Williams, Ian. Multimodal Gaze Interaction for Creative Design*

3.2 Unmet expectations or preconceptions

Expectations that are not satisfied and can be understood as deception, frustration or poor user experience.

- *Aizpurua, A. and Arrue, M. and Vigo, M. Prejudices, memories, expectations and confidence influence experienced accessibility on the Web*

4 Primary studies

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