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**MASARYK UNIVERSITY
TEIRESIÁS, SUPPORT CENTRE FOR STUDENTS
WITH SPECIAL NEEDS**

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SECTION 1

Standards of Universal Learning Design at Universities and Testing of Persons with Special Needs

Hybrid book – A New Perspective of Synchronized Multimedia Content Publishing

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Keywords: hybrid book, multimedia

1 Short introduction

Hybrid book, which is, as a document format, developed at Masaryk University and funded by the European Social Fund and the Ministry of education, youth and sports of the Chzech Republic as part of the Education for competitiveness operational programme, already came to its third generation, being a continuator to the older “Hybrid book on-line” system.

As an electronic document type, hybrid book belongs to the family of documents with synchronized multimedia content – other representative of that publication type could be for example the Daisy Consortium DTB. Ritcher multimedia equipment and aiming to wider target group of users, however, predestinate hybrid book to slightly another way of use.

2 The content

Hybrid book consists of three media types:

- electronic text,
- audio track (usually containing a recording of text did by human interpreter),
- video track (usually containing a translation of text to the sign language for deaf).

All these media should support a sufficient information, but they also act as a complement to each other, especially multimedia to text. This means, that user can follow only chosen media without a serious information loss. On the other side, the complementary function of multimedia track might highly improve the accuracy of information retrieval. Simple but great example may be pronunciation of unfamiliar terms or names. When one studies a text in foreign language, than may help, if an unknown terms are pronounced by a native speaker and simultaneously shown in text; in the same manner is helping, when such passages are interpreted in sign language (for a hearing impaired user, naturally). This technique may be used backwards to clarify an information retrieved from multimedia track by comparing it to matching part of text. For example, if actual read part of document is a table, ordinarily is better to switch from audio (or video) to text, especially if user is blind and is using screenreader, which afterall offer comprehensive navigation in such structures.

3 Synchronization

All the content of any hybrid book is synchronized. If possible, every part of text has its multimedia equivalent.

Accurate synchronization is reached by dividing document content to small parts called “phrases”; a phrase can contain a sentence, paragraph, list item or whole list, table column or row or cell, or any other logically (but also non-logically) separated text element. Every such part has its internal name (number), which a reader software application uses to manage synchronous playback and navigation steps.

4 Special content

Hybrid book can contain practically any linear (textual) or non-linear or graphical material; these non-linear types of content needs to be adapted not only to multimedia form (translation to sign language and reading up by voice), but in most cases they have to be adapted as a special addition to the text. For example no graph or schema, which is presented as a graphical object, is accessible for blind user, even if appropriate screenreader is used. Voice interpretation also does not match needs of subtle navigation in these structures. For that purpose has hybrid book a system of layers, which can keep such additional textual content and can be shown/hide on the user demand. As hybrid book content is fully synchronized, the multimedia form of these “alternative” texts is processed only, when they are visible.

5 Used technology

While the reader application for hybrid books is actually HTML 5 compliant, the hybrid book’s content coding has respect to HTML 5 standards too. Any outside usage of that content is, however, kept by choosing standard and widely supported data formats for each type of its media.

- Text is treated as a standard HTML code with its all advantages and limitations.
- Audio records are present in MP3 and OGG format, video tracks are coded as H.264 (MPEG-4) and OGG Theora formats.
- Synchronization data are stored in pure XML code.

6 Reading Hybrid Book

Actually the only platform, where hybrid books can be read, is the Hybrid Book Reader web application at <http://www.teiresias.muni.cz/hybridbook>. It actually allows to take use of most hybrid book possibilities, including:

- full content synchronization;
- complex navigation
 - by phrases,
 - by heading with/without respect to its hierarchical structure,
 - by using tree structured outline view;

- alternative media (text layers) processing;
- muting audio playback;
- hiding video screen;
- repositioning screen elements;
- every command or function can be reached by graphical on-screen controls or via computer keyboard shortcuts.

6.1 Ways of reading

While the hybrid book inside structure is complex, it must allow a simple access to all of its content. It wants to be highly affordable to all users and respect their style of work. We aim its usage to be as ready as standard printed book or electronic document in the hand of a human without any disabilities.

This accessibility is all above done by dedicated navigation functions, including these steps:

- go forward: phrase, heading, same-level heading;
- go backward: phrase, heading, same-level heading;
- go up (a higher level heading).

These navigation steps help reader to get the idea of document structure very quickly. They are enough to ensure quick going through the content and navigating to a specific position, but they are not too much to remember.

The user do not need to take care of actually followed media – navigation steps act exactly the same way in any state of content display, no matter if only text or all of media types are processed or wheather multimedia playback is turned on or off.

To quick find a specific part of content – meaning chapter heading or another named passage – the outline view can be used. It is a tree-structured view of all headings and looks and acts as any other tree view. Its secondary function is to display actual position in the document by highlighting heading of actually read named passage.

6.2 User Environment Matching And Adjustment

The Hybrid Book Reader application offers some adjustment to its user interface. It is based on “layout system”, which means, that there are several predefined screen layouts. Users can then choose one satistying their actual needs. Allowing dynamic changes to user interface made directly by moving objects on the screen is also planned. These settings are kept with user profile for further use.

7 To which content type the hybrid book is suitable?

Hopefully there are no exact borders of using the Hybrid Book technology in any type of multimedia plus text synchronization, but some types of content stay in the foreground anyway:

- Language studying materials – because there will be natural record of native interpreters of any used language;

- Self-studying material in general – an extensive textual content, where its audio interpretation may prevent eye-strain of (not only) visually impaired user; or complex, indented or highly structured document, where subtle navigation is helpful;
- Material originally provided in sign language for deaf, which can be supplied with textual track to improve its lucidity for people using another language.

There are also some known issues with publication of a hybrid book: firstly, the production of a hybrid book may be somewhat expensive job. The most resources consuming process is, naturally, preparation of multimedia content, especially the translation to the sign language. But there is some methodics yet, which can straighten the cost and the time needed to produce final document. There are also production tools to automate standard processing to narrow the effort of those, who prepare the contents.

8 Next steps

Hybrid book needs to accommodate to actual world-wide technical conditions and to modern users requirements, which includes:

- improving of the Hybrid Book Reader web application to offer support for all main suitable today's devices, which can connect to the internet;
- building desktop applications for reading documents off-line;
- building web-based or native mobile applications (mainly IOS and Android platforms) to empower their users to work with hybrid books (on-line/off-line);
- improve layers system for working with alternative content in documents;
- implementing “native” navigation in tabular structures to hybrid book code and to reader applications;
- working on implementation of displaying and navigating mathematical formulas, flow charts etc.

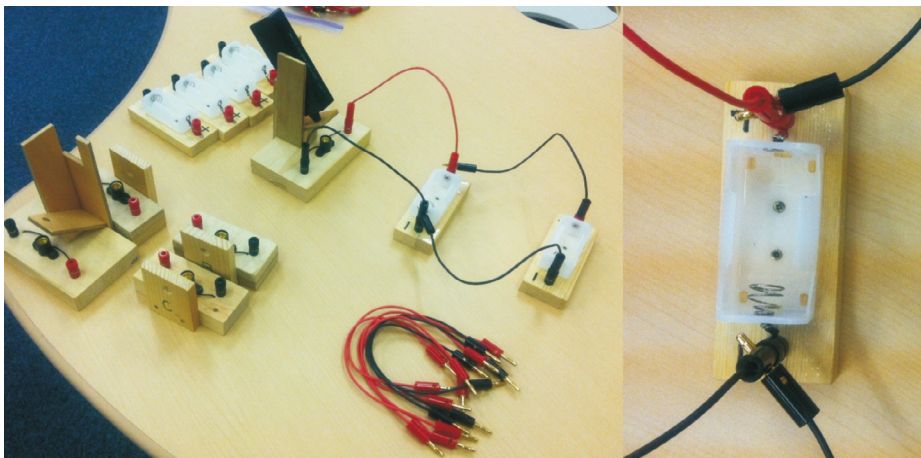
9 In fine

In today's state, the Hybrid Book technology can help in a couple of situations, where synchronized multimedia content is needed to prevent information distortion; it is especially well suited for language studying materials and for publishing materials to a wide range of people with some disabilities. It eases sharing information amongst these users and helps in cooperative work of impaired and non-impaired people.

Hybrid book tends to be a heavily complex document format; complex inside, but all the more simple in its usage.

By the way, our university is unique one which accepts only students with visual impairment or hearing impairment, and there is a lecture class in the field of mechatronics for the students with visual impairment. In this class, students try to make a circuit using breadboard and weakly sighted students who have enough visual acuity can enjoy learning it. However, for students with severe visual impairment including totally blind, it might be really difficult to search right position of the tiny hole and insert small parts to it.

To support such visually impaired students when they make simple electric circuit and study it, some solutions or materials already exist. One of them is shown in the Figure 2. It is a kit for studying electric circuit for visually impaired students who are in under junior high school. It is used in Special Needs Education School for the Visually Impaired, University of Tsukuba [2]. In the interview with a teacher who used this studying kit, he told that it has two features which were important for teaching visually impaired students. The first point was that the length of the cable. Because too long cable confuses visually impaired students and too short cable disturbs flexible alignment of parts. The second point was the shape of the plug. As it is shown in the right side of the figure 2, it has a hole to connect another plug. Because of this construction, the number of the connection of the plug is not limited, theoretically. Nevertheless to say, the feature is not only for visually impaired students but it helps to make a circuit as a same style in the textbooks.



[Fig 2] Studying circuit kit for junior high school students with visual impairment

However, this kit is only for studying elementary electronics and not fit for tertiary education. We need material to make more complex circuit and to study it, like a normal breadboard. Because of the background, a large breadboard kit with electrical parts were developed and tried to use it in our class.

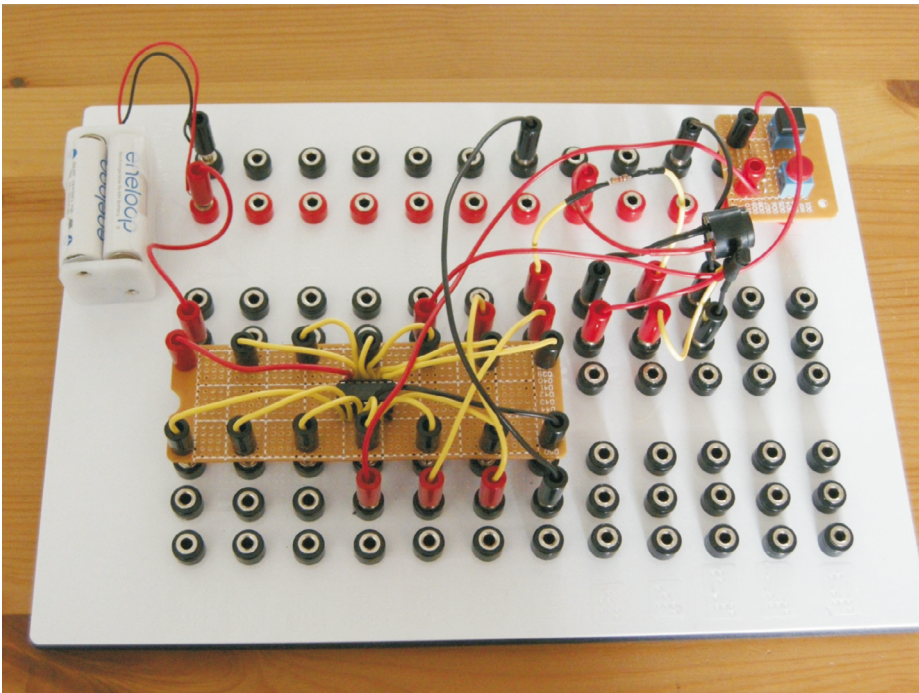
2 Features of developed breadboard kit

The basic idea of the developed breadboard is really simple. It is just making original breadboard to be enlarged using banana plugs and jacks, and adding Braille or tactile

information. Students with severe visual impairment can find right position touching the tactile cues. Figure 3 shows an overview of the developed breadboard kit. Unfortunately I could not acquire the banana plug with hole mentioned above though, the length of cable is considered as not too long and not too short. And to fit for the enlarged breadboard, electric parts also should be enlarged by connecting banana plugs with cables. The connecting point between cables and terminals of the electric parts is covered by heat-shrinking rubber tube to insulate terminals and to avoid electrical short, but it does not cover the body of the parts.

The coverage area of the parts is important point and one of the features of the developed kit. Keeping original shape of the electric parts and it enables students to touch the original one and understand what it is. There are several electrical block systems of consumer version in the market [3] and they can construct arbitrary circuit, but these blocks of the parts are completely covered and visually impaired students cannot understand real shape of the parts.

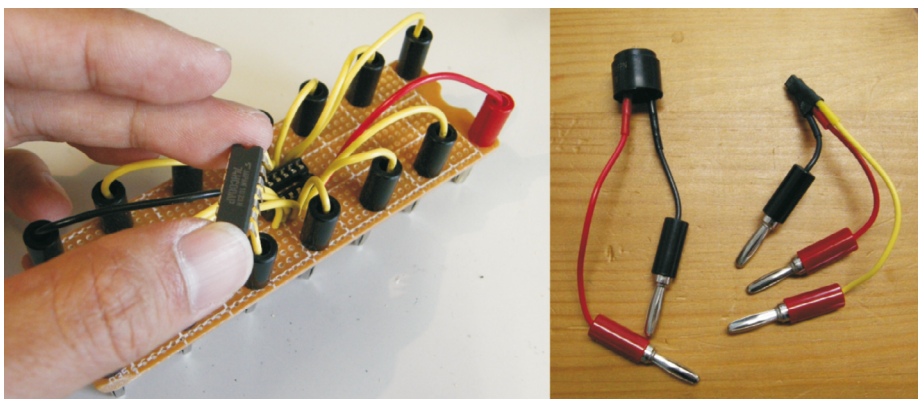
The balance between to cover and uncover, modify and keep original shape makes always argument in the field of teaching visually impaired students. Too modified material gives wrong information to the students and original material sometimes includes dangerous factors and unclear information. The basic stance of making this enlarged breadboard kit was, 'Don't cover the original parts, allow the students to touch them.' If the slightly sighted students want to see the shape or printed character and number or printed color code, they can use magnifier to see them.



[Fig. 3] An overview of developed breadboard kit for the visually impaired students

This strategy also applied to the Dual Inline Package (DIP) parts like logic ICs. Enlarged IC board allows the students to touch and see the original IC and it can be separated because the board equips IC socket. It also allows the user to change another IC. Moreover, it has a cutout point where indicates the position of the pin number one.

The other feature is that the length of cables and its color. For example, transistor has three different terminals called emitter, collector, and base. These terminal lengths are same and difficult to distinguish in the original shape. Therefore in the enlarged version of the transistor, the lengths and colors of cables was made as different so that visually impaired students can distinguish them. Emitter has short black cable, collector has red middle length cable, base has yellow long cable. The same strategy is applied to the parts which have polar character, like capacitor or electrical buzzer. Figure 4 shows these features of the parts. It is clear that DIP IC board and original IC can be separated and the cables of buzzer and transistor have different color and length.



[Fig. 4] Enlarged DIP board (left) and buzzer and transistor (right)

3 Trial using of the kit

Developed kit was used in the class of 'mechatronics' in our university in the second semester of 2012. During the lecture, visually impaired students learned how to use transistor as a switching and how to make RS flip-flop using 74 series of IC. From the interview of the Students, it was clear that students could construct these circuits only by themselves and the kit is useful to understand the circuit and easy to make it compare with using normal bread board and normal electric parts.

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- [3] <<http://otonanokagaku.net/products/kit/index.html>>

Universal Design of Inclusive Learning Environment

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Keywords: inclusive environment, universal design, accessibility, physical barriers

1 Importance of Inclusive Environment

Education and work are the main conditions of human independence and substantially contribute to the fulfillment of life. Therefore is essential to create an environment that does not restrict an access of persons with disabilities to education and work. To improve the inclusion of persons with disabilities into society, it is necessary to strengthen the inclusive education and to create favorable conditions for this type of education. The aim of inclusion is not to eliminate all differences among people, but to enable every person with different abilities and capabilities to be accepted by the community based on human rights.

Accessibility of school facilities is a prerequisite for ensuring the integration and inclusion of people with disabilities into the mainstream school environment among their peers. Architects, civil engineers and urban planners should use the methods and principles of **Universal Design** with the main goal to create an **inclusive nondiscriminatory environment** that is designed to help all people to fulfil basic human rights, including the right to education.

2 Situation in Slovakia

Situation in Slovakia in the field of inclusion of people with disabilities into educational process is insufficient. Although there were adopted some policy and legislative actions, but effective enforcing them in practice is failing. One of the biggest obstacles is the **existence of physical barriers** in schools and campuses. When designing new buildings or renovating existing ones, the architects are often focusing only on barrier-free entrance to the building, while another movement, use and orientation in other parts of the building remain unresolved. In past years, modernizations and renovations of school buildings, funded by European grants, were aimed to improve the energy efficiency of the building and to create complex barrier-free environment. Therefore, despite partial renovations, many school facilities still have a lot of barriers, and it is often a reason for not allowing the integration, which is in contrary to the adopted government regulations.

3 Concept of accessibility

To ensure a consistent inclusive learning environment, it is necessary to use Universal Design to create a barrier-free environment of the whole school facilities, not only for students but also for teachers and other staff with limited mobility and orientation.

The aim is to achieve an environment that is **accessible, comfortable and safe for all** its users as much as possible. The **overall concept** must include accessibility of outdoor

spaces, parking, building entrance, sanitary facilities, classrooms, the library, the dining room and other school and campus spaces and also access to information and service counters. Within the campus and its facilities is necessary to ensure easy orientation for people with sensory disabilities through orientation and information systems (such tactile plans and models, and other multi-sensorial components). For the safety of persons with visual impairments it is also necessary to apply the principles of clear and easy identification of different elements in the built environment.

4 Entrance and circulation areas

New buildings must have the **main entrance** at the same height level as pavements without any steps. Renovated buildings should have the barrier-free entrance and the level differences can be overcome with ramp or exterior elevator. When designing the ramp is necessary to use proper slope, appropriate width, slip-resistant surface and correctly placed handles. For bigger height differences or in case of a lack of the space, a better solution is to use exterior elevator or platform, but it is not recommended to use a staircase lift installed on the staircase handrails. This staircase lift is not universally accessible for all people and has operational deficiencies (slow speed, complicated to use, or unsightly appearance).

In front of the entrance to the building is necessary to create enough space to manoeuvre with the wheelchair or pram. There should be an unobstructed flat space with minimum dimensions of 1,5 to 1,5 metre which can not be reduced by the opened door. **Entrance door** should be easily identified for people with visual impairment. Glazed entrance door must be contrasting marked, for example by logo, or the title of the school. In front of the entrance is recommended to place the signal strip in form of embossed tiles, which help to lead the person using white cane to the entrance door. Especially, in case of big space in front of the entrance without any natural orientation elements, it is necessary to help blind people to find the entrance doors by artificial component (tactile strip).



[Fig. 1, 2] Barrier-free entrance at the Faculty of Civil Engineering STU in Bratislava

The principles of Universal Design should be implemented also in interior spaces of the school facilities. At the **entrance halls** is necessary to make accessible services and

counters (information, internet kiosk, cloakroom and refreshments) for all people. All information and orientation systems should be solved in **multi-sensorial form**, which uses combination of minimum two different sensory perceptions. The counters and kiosks should be designed to enable an access for a person on a wheelchair or small stature, therefore some part of the counters should have reduced height. If we propose in cloakroom area self storage space (shelves, racks, cabinets), they must be placed within easy reach for wheelchair users.

Hall and corridor areas of school facilities should allow easy orientation in space with natural or artificial guiding lines for people with visual impairment. Corridors should be simple and clear, so it is suitable to use orthogonal system with minimal walking distance. Adequate lighting and colour contrasting wall and floor solutions facilitate orientation in the hallways and staircases. It is appropriate to distinguish different units with colour-blocks of classrooms, dining spaces and sanitary facilities. Each room is necessary clearly to mark with label in tactile form placed at the wall next to the door, but never directly on the door because of safety reason.

5 Learning and community spaces

Learning spaces is necessary to design accessible and comfortable for every students or teachers with limited mobility and orientation so to allow smooth movement without any collision. **Auditorium** must allow easy access for the students, but also for the lecturers. In the auditorium with stepped floor is required to reserve an appropriate number of places for wheelchair users. These places have to be situated on a flat floor and should not reduce the width of escape corridors. Furnishings and interior equipments should allow the possibility for comfortable use also for wheelchair users therefore there must be a space to insert a wheelchair towards a school desk, bench or a table. According to the requirements of Universal Design is necessary to create a barrier-free access for teachers (lecturers), that is why the classical elevated podium is not allowed in auditorium, so there should be a flat surface offering a convenient access to the board or screen.



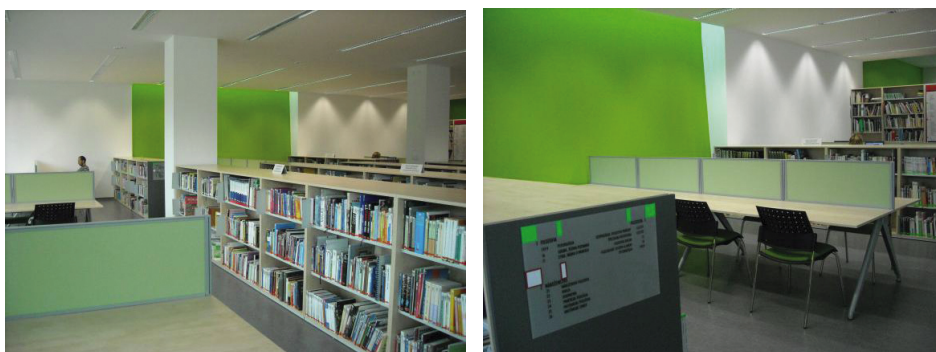
[Fig. 3, 4] Auditorium at the VŠB – Technical University of Ostrava

Lecture rooms need to be designed comfortable for students or teachers on the wheelchair so to allow good manoeuvring between furniture elements. School furniture arrangement should be flexible (depending on the type of teaching methods and students' requirements) and shall allow all students good visual angle on the board. Near

the lecture rooms is recommended to place a **small group rooms** (classrooms) to allow individual instruction or work in small groups, or they can serve as rest rooms.

The **library, resource centre and reading rooms** should accommodate also people with physical or sensorial disabilities or a lower stature and provide them an access to the different kind of books and multimedia. The library shelves must have reduced height and appropriate space for manoeuvring among shelves, so that a people on wheelchair were able to serve ourselves. Individual reading tables and internet kiosks, especially their height and sitting space, should be designed to enable comfort access for wheelchair users. The books and resources should be accessible in multi-sensorial form for the people with visual impairment.

The **university pastoral centre** must be design with barrier-free access to the premises of the chapel, as well as other meeting spaces and club premises with the necessary sanitation facilities, which must include at least one wheelchair-accessible toilet cabin.



[Fig. 5, 6] University Library UKF in Nitra

6 Conclusion

Inclusive environment of school facilities and sites must be solved comprehensively by the principles of Universal Design – Design for All, not only partial modifications such as installing ramps or staircase lifts at the entrance to the building. All students and staff of higher education establishments should have an equal opportunity to participate in educational activities, but also in community life so as not limiting by any architectural or communication barriers.

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Universal Design of Student Housing

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Keywords: Architecture, Universal Design, Adaptable Design, Sustainability

1 Purpose and methodology

There are many types of housing suitable for student accommodation. They range from the single dwelling unit to shared houses, institutional residential colleges, hostels and rooming houses. The basic design criteria for the student housing are to provide a functional, flexible, universally designed and aesthetically pleasant environment.

Universal Design, in the broadest term, is “design for all people”. *“Universal design addresses the scope of accessibility and suggests making all spaces and elements accessible to and usable by all people to the greatest extent possible. This is accomplished thoughtful planning and design at all stages of any design project.”* [1]. It means to create an environment addressing the basic needs for all age groups and people of different abilities including temporary disability. This method does not propose special features for the disabled, but instead promotes the solutions to access and usability for all students through the use of standard building products and practices. For example, designing an entry without the need for stairs removes the need for the later addition of a ramp and handrails for wheelchair users, while improving current access for children’s prams. Universal design accommodates not only people who use wheelchairs or are visually disabled, but also parents with children, older learners, and nontraditional learners of all sorts.

Adaptable Design is aimed to fulfill the individual needs of each student and *“adaptable features are either adjustable or capable of being easily and immediately added or removed to “adapt” the unit to individual needs or preferences”* [1]. Our research is focused on the positive connection of both design methods, because of frequent changes of occupants in the units and there is not to anticipate how many from them will have special needs. New criteria for student housing are creating flexible and adaptable environment, which should offer universally designed spaces in all parts of facility. The aim is to integrate equality and diversity within the planning and design processes.

2 Design of Student Housing

The student housing complex offers an appropriate mix of accommodation options and common spaces such as foyer, terrace, grill, convenience store, mail collection areas, waste management facilities, storage lockers, laundry, washing and drying facilities, bike lockers, parking and outdoor areas and support spaces to meet the student needs. These spaces must generally avoid barriers that may discriminate against students living in or visiting the facility.

The aim of Universal Design is not only to allow wheelchair access to the physical environment, but also to create orientation and information systems in the built envi-

ronment to improve ability to perceive an environment for users with limited spatial orientation or altered color perception. This concept removes barriers to communication and services, taking into account the safety of users and similar aspects of everyday life. The environment created by this method ensures adequate conditions for all users and therefore can be a measure of the quality of physical environment.

Application of adaptable design can enhance the quality of the facility by additional modifications, which should be required to meet the specific needs of each student. This may include the modification of number and size of rooms, alterations to the bathroom to increase access and usability, the increase of lighting levels in response to sensory disability or the introduction of support devices such as grab rails and/or additional security measures. Design for adaptability enables rapid response to changing student's needs which can be quick and unexpected. It also increases the building's serviceable life span prior to remodeling, with associated financial, material and energy savings.

Universal and adaptable design has the potential to make a key contribution to more sustainable buildings, showing how it has clear social and economic benefits. Both of methods require an understanding and consideration of the broad range of human abilities throughout the lifespan.

3 Key elements of Universal design:

- Direct access without steps
- Wide front doors and internal doors
- Wide corridors and access to the passenger lift between floors
- Easy movement, appropriate circulation space for manipulation
- Knee spaces under information desks, kitchen, tables, sinks etc.
- Control elements within reach of seated person
- Public restrooms and bathrooms designed for easy and independent access and use
- Multisensory information systems
- Easy orientation outside and inside building (including colour contrast)
- Low window sills, wheelchair access to a balcony, terrace or loggia
- Slip resistant surfaces, safe materials...

4 Adaptable Design of apartment units

What used to be considered luxuries – kitchens, private bathrooms, study lounges, and social spaces – are now considered basic necessities. In response to these concerns, students are viewed as preferring more privacy, more single rooms, computer access, private bathrooms, more conveniences, and the opportunity to prepare their own food.

Design of student dwelling unit must incorporate flexibility and choice in moving to, from and within a unit, including level entries, wider doorways and passage ways. Apartment units will combine the living, dining, kitchen, and bedroom into one space. This will provide a greater sense of spaciousness to the area and will promote flexibility in

arranging space and the furnishings to suit the resident's individual requirements. Design process should incorporate a range of room types while a single bedroom is the preferred module.



[Fig. 1] Classic four bedroom unit

As shown figure 1, studio apartment unit is divided into separate four bedrooms, each two sharing a bathroom. Between two room clusters is situated the central shared area for living, dining, and kitchen. Shared space should be available also for visitors or other students to gather for group study. Bedrooms are designed to be more efficient spaces suitable to accommodate the sleeping, study and storage needs of each individual resident. The necessity of each student to have easy access to a toilet at any time, there should be an adequate ratio of bathing and toilet facilities to keep waiting time to a minimum.



[Fig. 2] Unit after adaptation – left cluster is adapted for family with a toddler, and right cluster for wheelchair user with assistant.

As shown figure 2, removable wall between two single bedrooms allows for conversions into family bedroom or double room. If separate bathroom and toilet facilities are

preferred at the time of construction, an adaptable approach might be taken to achieve the same outcome, such as the use of a removable wall between the toilet, bathroom and storage to create a accessible toilet or bathroom. For adaptable units, it is better to create a roll-in shower in all bathrooms. Grab bars however, can be omitted and installed when needed. There are many ways to create spaces using removable walls. For this reason, the architect must think of adaptable features that can be adjusted in a short time by unskilled labor without involving structural or finished material changes.

5 Conclusion

The principles of equality and diversity through Universal Design must apply to every new building. However, the involvement of access experts and consultants allow applying Universal Design also by renovation of existing buildings. Universal Design shows how landscape, urban, building and product design may be used to satisfy human needs and improve the built and social environment. This movement brings socially responsible design to every space and product that we create and looks beyond that to include many aspects of design that work to improve quality of life for all people.

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Architectonic Solution of Making Accessible Tertiary Education for Disabled, Campus CTU in Prague-Dejvice

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Keywords: accessibility, barrier free education, inclusive education, equality for all

1 Interaction between making accessible higher education and its environment for people with disabilities

About 5 years ago request came from the Handicap advisory on behalf of Mgr. Barbara Čalkovská on solving barrier – free campus CTU in Praha-Dejvice. University campus CTU in Praha-Dejvice is not closed area. It is a complex of buildings CTU, that is included in Praha 6. Buildings of the campus are for education as well as dormitories and students restaurants.

There are also sports facilities, that are not included in the case study. Because sports field is not in study plans CTU and issue of sports facilities for people with disabilities is solved in detail at the Faculty of Physical Education and Sport etc.

1.1 CTU access to education of persons with disabilities

Support for students with special needs at CTU is anchored in Methodical instruction about support for students with special needs. Methodical instruction published in 2007, was updated in 2012. The basis is university statement that guarantees the minimum technical and technological background and its accessibility to students with special needs.

Information and Advice Service Centre, founded in 2008 on the basis guidance CTU, ensured this support. Centre is divided into 5 advisory. Handicap advisory is intended for students with sensory, mobility or other disabilities, psychic illness, or specific learning disabilities.

1.2 Analysis of data on students with disabilities studying at CTU

At CTU are studying 80 students with disabilities. For 26 of them should be environment adjusted according to the Public Notice No. 398/2009. Number of students with disabilities in the CTU and in campus Dejvice is very low. Analysis of data shows that in the 2012–2013 academic year will be studying 48 students with disability on the campus Praha-Dejvice. Only on disability 5 of them apply building adjustments in accordance with the Public Notice No. 398/2009. It is 1 student with hearing impairment and 4 students with limited movement. Student with hearing impairment is using services, that are offered by the centre. Handicap center provides study materials in electronic form, hire and train the work on assistive technology, training of spacial orientation, mediation with teachers about editing mode (extended time, writing tests on the premises of the support center where they are needed assistive technology centered). Other 4 students with limited mobility did not use centre support yet.

This 5 students with disability attend three objects on the campus Dejvice. Student with hearing impairment studying at Faculty of Mechanical Engineering. One student with limited movement is accommodated on Masaryk College and attend classes with 3 students in the new building of Faculty of Architecture and Faculty of Information Technology.

1.3 Case study

The solution is divided into three parts. Based on an analysis students with disabilities in CTU campus is in the main part of the work published case study solution on the objects of the Faculty of Mechanical Engineering, Faculty of Architecture and the Faculty of Information Technology, and Masaryk dormitory. Other campus buildings are published in the Annex.

1.3.1 Part 1 – Mapping the current state of the campus CTU-Dejvice in terms of accessibility for persons with disabilities

This part is focused on the description of the current state of objects in Dejvice CTU campus in terms of barrier-free access and use. Brief schematic description of barriers appropriate for gripping the problem comprehensively. Not suitable as a basis for removal of particular barriers. Results of mapping comes from information obtained through local investigation as a building inspections, interviews with managers of objects, rails, gatekeepers and disability counseling deputy Mgr. Barbara Čalkovská, but without a direct reflection of students with disabilities.

1.3.2 Part 2 – Building adjustments in accordance with the Public Notice No. 398/2009

In ground plan schemes are designed for major modifications to the movement and orientation of people with disabilities in the building.

1.3.3 Part 3 – Adjustments based on the clients' requirements – Information and Advice Service Centre

Description and characteristics of requirements from students with disabilities to access environment. The only change which required a student with hearing impairment at the Faculty of Mechanical Engineering was induction loop, which is in the lecture hall since 2010, i.e. before have raised claim.

1.3.4 Results – summary of conclusions case study

The barrier-free mapping of objects is the apparent absence of address accessibility for people with visual impairment. Compared with barriers for people with limited mobility are barriers for people with hearing impairment less perceived. In total with one exception, the entry at the Faculty of Mechanical Engineering, it is possible to talk about disadvantage rather than barriers. It is not insurmountable barrier. Building adjustments in accordance with the Public Notice No. 398/2009 can be classed as soft adjustments. These are mainly adjustments within the interior, such as door signs, handrails on stairways, etc. Vertical communication in all three buildings have deficiencies that would eliminate upgrading elevators cabins, repairing control settings. Exception is the already

mentioned building Mechanical Engineering Faculty, where construction intervention produce larger space for lifts and sanitary facilities.

Student with a hearing impairment studying at the Faculty of Mechanical Engineering was granted handicap advisory at the level of special education:

- Provision of study materials in electronic form
- Hire and train the work on assistive technologies
- Training of spatial orientation
- mediation with teachers on adjustments mode (extended time, writing tests on the premises of the support center where they are needed assistive technology center, etc.)

These adjustments make accessible campus buildings to persons with disabilities, globally. Present students with disabilities studying in CTU campus in Dejvice did not demand any removal of physical barriers. It shows that the current state is for the current students barrier free:

- since objects are sufficiently accessible regardless of the Public Notice;
- because of character and needs of their disability these adjustments do not need;

2 Summary

The case study shows the difference between support resources, requirements, needs for access to university education and access to higher education environments. And their interaction.

Based on the case study began in autumn 2013 project Barrier free CTU. It includes a detailed mapping of objects CTU in terms of accessibility for persons with disabilities. Publishing accessibility of buildings, a description of the accessibility and availability. Proposal to remove barriers in accordance with the Public Notice No. 398/2009. These proposals will be continuously updated based on the actual requirements of the disabled. These requirements may not be identical to the structural modifications in accordance with the Public Notice No. 398/2009.

Vision into future: due to efforts to access education and employment opportunities not only in Europe, was established identical degree structure at universities, identical certification. Now would be a good idea follow up on accessing unified environment for people with disabilities and then to make accessible university education to people with disabilities not only within the Czech republic.

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Appendix

Monoblok Faculty of Mechanical Engineering

Entry	During reconstruction arose 15 cm high stair step to the object.
Accessibility Building the movement	In the entrance hall there are 3 steps. For their overcoming si used wooden mobile ramp.
Barrier free toilets	Available in monoblock of faculty of electrical engineering.
Note	Due to interconnection monoblock with faculty of electrical engineering, it allows wheelchair movement and access to barrier free toilets.



[Fig. 1] Monoblok Faculty of Mechanical Engineering – entrance



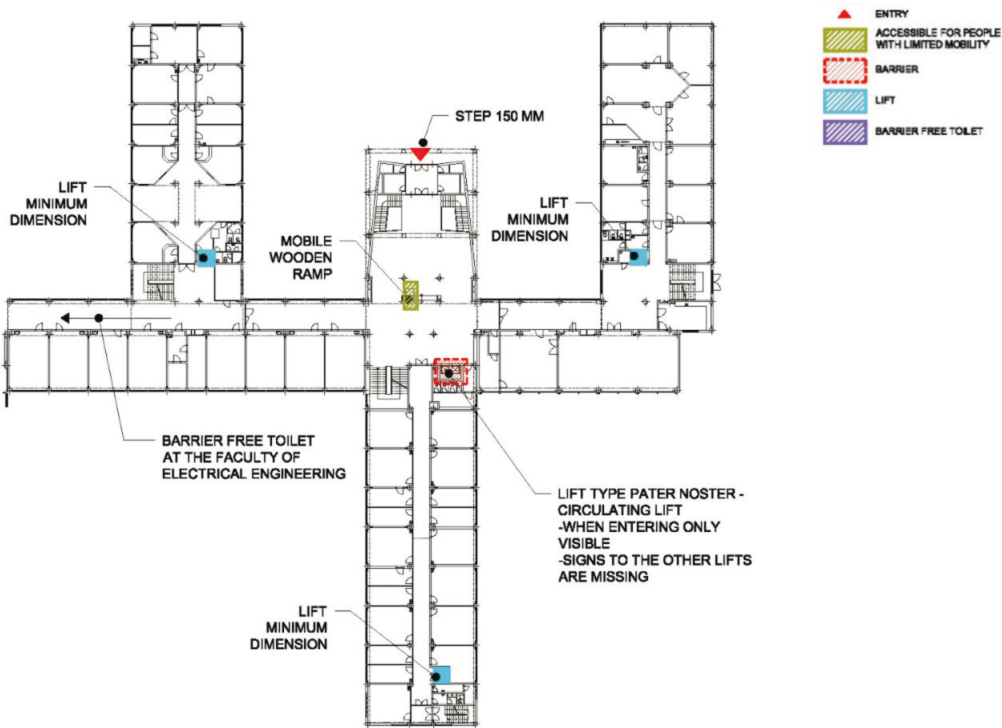
[Fig. 2] Monoblok Faculty of Mechanical Engineering – detail the step at the entrance to the building



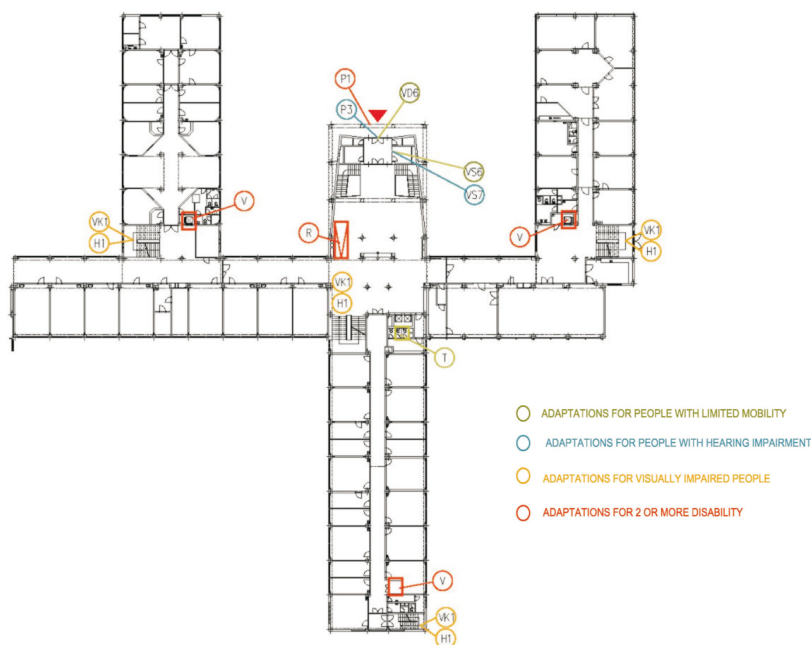
[Fig. 3] Monoblok Faculty of Mechanical Engineering – ramp in the entrance hall



[Fig. 4] Monoblok Faculty of Mechanical Engineering – reference to the disabled toilets at the Faculty of Electrical Engineering



[Fig. 5] Monoblok Faculty of Mechanical Engineering Ground Plan, 1:500



[Fig. 6] Building adjustments in accordance with the public notice No. 398/2009
Ground floor, 1:500

Legend

- **Access to buildings**
 - P1 Access must be without steps and equalization degrees.
 - P3 Acoustic defined
- **Entry into buildings**
 - VS6 Gatehouse, information – secured passage width min. 900 Mm, max. 800 Mm sill height above the floor in min. 900 Mm lenght, the entire lenght of the forward area completed with a width of 250 mm for underride wheelchair.
 - VS7 Gatehouse, information – must enable induction listening, and spatial arrangement must enable lip-reading. Requires medium level of illuminance 300 lx.
- **Door to the object**
 - VD6 The door may be glazed from a height of 400 mm or be protected against mechanical damage wheelchair.
- **Visual contrast**
 - VK1 Entrance and exit of each level of the stair
- **Complementary haptic information**
 - H1 Complementary information for example, the floors are given in braille on the information label located on the staircase handrails.
- **Ramps, Lifts, Barrier free toilet**

How to Ensure Accessibility of Study Materials Published at Masaryk University

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Keywords: accessibility, document, format, conversion, evaluation, assistive technologies

1 Introduction

Universal learning design is an educational framework, which calls for creating curriculum from the outset that provides:

- Multiple means of representation to give learners various ways of acquiring information and knowledge,
- Multiple means of expression to provide learners alternatives for demonstrating what they know, and
- Multiple means of engagement to tap into learners' interests, challenge them appropriately, and motivate them to learn.

Although the vast majority of university students with special needs in the Czech Republic are students of Masaryk University, it is true that study materials are almost exclusively created and published with respect to the needs and preferences of students without special needs and without universal learning design principles. Changes, leading to the document accessibility, are often made only with an intuition and empathy and reflect only actual student's needs. Although this approach is quite common and authors consider it to be sufficient (and for the one particular moment of course it is), inclusion of accessibility principles in authoring process could bring much more benefits to all readers.

Our mission is to change this state and prepare a conception of complex universal learning design environment, in which following goals are reached according to the general standards and regardless this or that specific kind of accessibility is currently required.

In this paper we focused on demands and needs of students with visual impairment. The main reason for this is, that their demands can be covered mostly by technical means and authors could quite easily learn them and start to use them. Needs of students with other impairment (especially demands of deaf students) could be covered by adaptation of source documents by Teiresias Centre specialists.

2 Current state of the art

Resources, where study materials are published, and ways, how they are created, are very heterogeneous. Files are published in different formats (docs, xls, ppt, html, audio/video recordings), their technical quality varies and quite often they are full of (inaccessible) graphic objects.

The Support Centre for Students with Special Needs (Teiresias Centre) provides services for all students of Masaryk University with sensory and other disabilities. Its mission is to guarantee accessibility of all study programmes at Masaryk University. Nowadays we quite often face issues connected with documents inaccessibility and although employees of Teiresias Centre very often moderate its impacts and **we are able to prepare materials, meeting the accessibility requirements**, there is still a lot what should be done to ensure better accessibility of study materials in general and make the preparation easier.

Current state is strongly influenced by a lot of factors – human, legal or technical.

2.1 Human factors

- Authors don't have sufficient awareness and knowledge about accessibility or they aren't interested in accessibility.
- Students don't have sufficient knowledge how to use their assistive technologies to read study materials they are provided.
- Sometimes it's quite difficult to get the information which study materials student really needs.

2.2 Legal factors

- There is no conception yet in evaluating accessibility of study materials. Nowadays it's done only on demand.
- Authoritative source of techniques, practical advices and tutorials how to create accessible study materials (or documents in general) is missing.

2.3 Technical factors

- Students have outdated technical equipment (screen readers, screen magnifiers).
- Some “umbrella web portal”, gathering all the information about accessibility, links to the other resources, contacts, help, etc. is missing.
- There are accessibility issues concerning not only the study materials, but also the environment in which they are presented.
- There is no way how to in time and easily get the information that student with special needs enroll for concrete course.

3 Proposals of possible solutions

Topic of universal learning design and accessibility of study materials is really wide, is influenced by a lot of factors and it's not easy to find a simple way, how to ensure accessibility of study materials in general.

There are several ideas, which would be good to put into practice to improve general accessibility of published materials. Here are my suggestions, how to fix some issues in human, legal and technical factors mentioned above.

3.1 Human factors

- Accessibility training courses for authors.
- Wider technical and methodological assistance to authors of study materials.

3.2 Legal factors

- Include a duty to create accessible documents as a part of some university directive. This would give us a legal background to demand accessibility from authors.

Other legal factor, that could influence this sphere in general, is activity of The European Commission, which has proposed new rules to improve public-sector website accessibility for people with special needs. The proposed Directive on the accessibility of public-sector bodies' websites would introduce "mandatory EU standardized accessibility features" from the end of 2015. It affects also universities, because enrollment in higher education or university will fall under this proposed EU Directive on accessibility.

3.3 Technical factors

- To have a possibility to get information from Masaryk University Information System, that student with special needs enrolled for concrete course. Sometimes we get this information too late.
- To have a permanent approach to sources which can be an alternative for standard printed study materials, which are not publicly available.
- To have a tool, enabling automatic accessibility evaluation of study materials, which are uploaded to Masaryk University Information System. Although this tool could evaluate only technical accessibility issues, it could help us to focus on other accessibility aspects, e.g. understandability or adaptation of visually dependent content.
- To create Web portal (e.g. pristupnost.muni.cz), gathering all the information about accessibility and universal learning design, contacts, tutorial, directives/guidelines, etc. This could be very useful for everybody who is interested in accessibility and search for relevant information.

4 Conclusion

Topic of universal learning design and accessibility of study materials is extremely wide, is permanently influenced by a lot of factors and very often it's not possible to find a simple way, how to ensure accessibility of study materials in general. On the other hand, some ways are quite easy to implement, and because they are already tested and used abroad (e.g. university web portal, concerning accessibility), there is no reason to start right with them.

Implementation of Universal Design for Learning Principles for Development of Spatial Visualization Skills of Students

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Slide № 1

Universal design for learning is a part of the overall movement toward universal design. Universal design for learning requires design not only of accessible information, but also of accessible pedagogy. The distinction between universal design for learning and other domains of universal design is its focus on learning.

Slide № 2

The interior design as well as architecture, in general, is a spatial design. Mastering the basic professional skills for interior design students require development of visual spatial perception. Engineering drawing is a means of graphical communication. Spatial skills are critical to success in engineering graphics.

There are three steps for developing interior design:

- the perception and understanding of the existing room or space,
- mental visualization of new designed object or structure,
- technical drawing for new designed object or structure (top, front, right side view, sectional view etc.) – two-dimensional representations of a 3D object.

Understanding drawings means visualizing the geometrical form and the spatial layout of the object.

Standardized study programs do not contain methodology for evaluation and improvement of needed spatial skills.

Slide № 3

“Spatial abilities” refer to, in general, a collection of cognitive, perceptual, and visualization skills. While lists may differ, substantial agreement exists that spatial abilities involve

- the ability to visualize mental rotation of objects
- the ability to understand how objects appear in different positions
- the skill to conceptualize how objects relate to each other in space
- three-dimensional (3D) understanding.

Two major components of spatial ability have been identified: spatial relations and spatial visualization. In standardized spatial ability tests spatial relations tasks involve 2D and 3D rotations and cube comparisons. Spatial visualization is described as a ability to imagine rotations of objects or their parts in 3D space by folding and unfolding, and the movements must be imagined. The kinds of activities used to measure spatial visualization ability include form board, paper folding and surface development. In a short definition,

spatial visualization is mental manipulation and integration of stimuli consisting of more than one part or movable parts. Understanding drawings means visualizing the geometrical form and the spatial layout of the object. Visual spatial perception involves representing objects in pictorial forms and visualizing objects from their drawings.

Slide № 4

Based on the concept and principles of universal design, providing accessibility of environment, objects and information and the opportunity of their application for everyone, educational researchers of USA have developed several methodologies that emerged in last decade, including Universal Design for Instruction, Universal Instructional Design and Universal Design for Learning (UDL). These models are not competing but rather complementary – all with much to offer. UDL principles offering the most comprehensive and developed theoretical formulations and practical recommendations were applied in the current study.

The framework for Universal Design for Learning is based on findings from cognitive neuroscience providing understanding on the needs of individual learners. UDL principles go deeper than merely focusing on physical access to the classroom; they focus on access to all aspects of learning.

Slide № 5

Universal Design for Learning embeds accessible pedagogy into three specific and central considerations in teaching:

- the means of representing information,
- the means for students expression of knowledge,
- the means of engagement in learning.

Universal design for learning embraces three primary principles based on brain and learning research.

Principle № 1: Multiple means of representation – the “what” of learning with varied ways that new information can be presented to students.

Learners differ in the ways that they perceive and comprehend information that is presented to them. There is more than one way of presenting information or transferring knowledge optimal for all students.

Network-appropriate teaching methods to support diverse recognition networks are:

- Provide multiple examples,
- Highlight critical features,
- Provide multiple media and formats,
- Support background context.

Slide № 6

Principle № 2: Multiple means of expression – the “how” of learning with different ways that learners can navigate a learning environment and demonstrate their mastery. There

is not only one way of expression that will be optimal for all students, nor one kind of scaffolding or support that will help them as they learn to express themselves. Multiple means are essential.

Network-appropriate teaching methods to support diverse strategic networks are:

- Provide flexible models of skilled performance
- Provide opportunities to practice with supports
- Provide ongoing, relevant feedback
- Offer flexible opportunities for demonstrating skill

Slide № 7

Principle № 3: multiple means of engagement – the “why” of learning with the many ways that students can be engaged in their learning and motivated to learn.“

Students also differ markedly in the ways in which they are engaged or motivated to learn. Students must develop the internal standards and motivation that will prepare them for successful work and future learning.

Network-appropriate teaching methods to support diverse affective networks are:

- Offer choices of content and tool
- Offer adjustable levels of challenge
- Offer choices of rewards
- Offer choices of learning context

The goal of education is the development of expert learners, something that all students can become. From the UDL perspective expert learners are: resourceful, knowledgeable, strategic, goal-directed, purposeful and motivated learners.

Slide № 8

Study performed in the period from January 2010 till November 2011 within the scope of basic curriculum of architecture.

Visual spatial perception skills of students at the beginning and in the final stage of this study were evaluated by application of standardised ARCH PROFILE, *Visual-Spatial Intelligence Test*, consisting of three components:

- set of “mental rotation” tasks;
- set of two “mental transformation” tasks;
- 2D–3D relational tasks and “paper folding” tasks.

Slide № 9

In order to perfect visual perception skills of students, the following issues were incorporated in the curriculum:

- Teaching methods corresponding to variety of learning styles;
- Different teaching styles in order to promote students having dominant learning style to build up also other, less developed learning styles;

- Various expressions, types of activity (free hand sketching, layout design of objects into material, virtual modelling tasks provided via software, designing of orthogonal and isometric projective, working individually or in small groups).

Slide № 10

There is one example of presenting information for students during the lesson of architecture, which is complemented by virtual modelling with graphical program Archicad and free hand sketching as well as verbal communication

Slide № 11

Results obtained: level of students spatial visualization skills indicated in the beginning of the study was different i.e. the average data for index of visual special perception was of 0.45. In the end of this study – after principles of universal design for learning have been incorporated in the curriculum students demonstrated considerable increase of their spatial visualization skills, i.e. the index of visual special perception reached 0.79.

Slide № 12

Implementation of universal design for learning principles in learning process of interior design students stimulate development of their spatial visualization skills.

SECTION 2

Linguistic Competence of the Hearing Impaired and the Role of Sign Languages and the Text Reporting in Tertiary Education

Universal Access to Presentations and Lectures Using a Real-time Wireless System Distributing Speech-to-text Reports and Mirroring Presentation Screen to Enhance Legibility for Individuals

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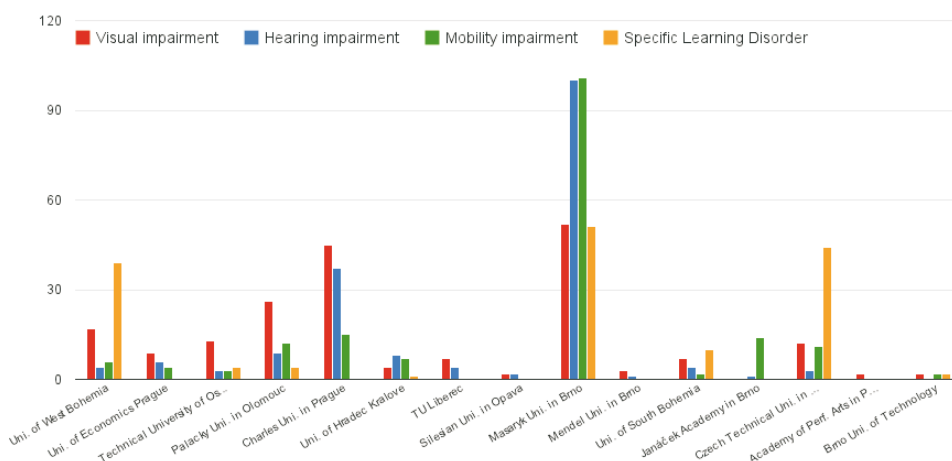
Keywords: speech-to-text reporting, CART provision, document accessibility, blind, deaf, visual impairment, hard of hearing, mobile devices, e-inclusion, universal design of learning, lectures, presentations, conferences

Abstract

A wireless system that provides universal access to presentations and lectures. In real time it distributes synchronous transcription visualisation of speech (speech-to-text reporting) and at the same time it mirrors presentation screen to enhance the legibility on users' mobile devices¹.

1 Introduction

The Support Centre for Students with Special Needs at Masaryk University, Czech Republic, provides hearing impaired students (typically, hard of hearing students that comprehend written Czech) as well as visually impaired students, with services in educational setup.



[Fig. 1] Students with disabilities at Masaryk University and other Czech universities

One of the major services for students with hearing impairment is the speech-to-text reporting service, when a reporter records the speech (a lecture or a seminar in a uni-

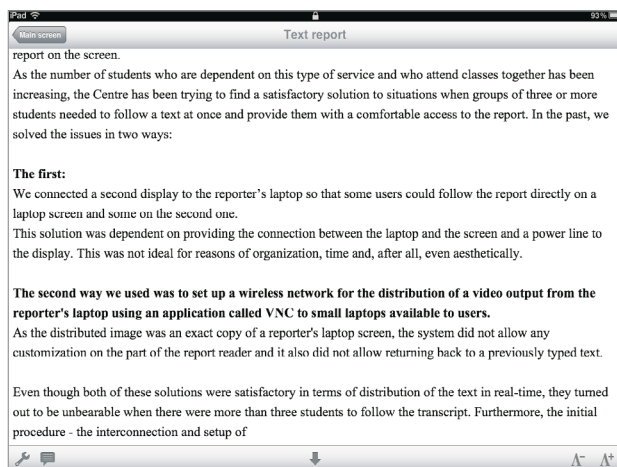
¹ <http://www.teiresias.muni.cz/polygraf>

versity environment or even any similar event outside of a university environment) as a text on a computer by means of a simultaneous typing, and several students reading the report on one common screen at the same time.

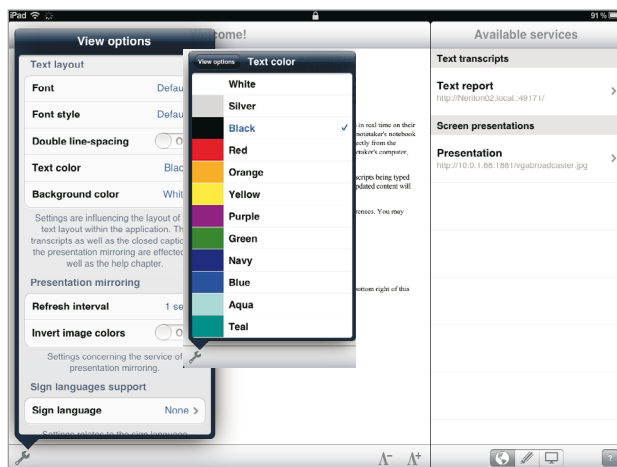
As students with visual impairment are concerned, one of the major problems is the accessibility of the visual documents and other materials presented by a lecturer via a presentation screen. Distance to the presentation screen as well as light conditions or the presentation layout creates readability barriers and obstructs the students to perceive presented information.

2 Visualisation of the Synchronous Transcription (Speech-To-Text Reports)

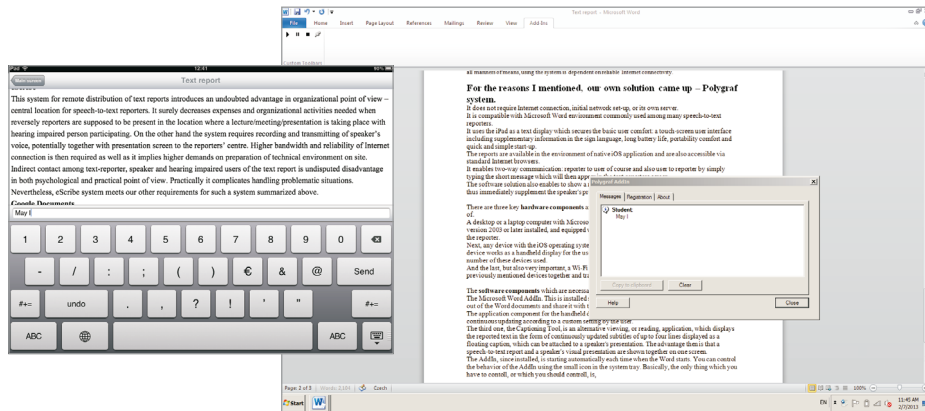
As the number of students who are dependent on that service and who attend classes together has been increasing, Masaryk University tried to find a satisfactory solution to situations when groups of three or more students needed to follow a transcript at once and provide them with a comfortable access to the report.



[Fig. 2] Screenshot of Polygraf – speech-to-text report displayed in the application



[Fig. 3] Screenshot of Polygraf – display options



[Fig. 4] Screenshot of Polygraf – implementation of two-way communication

2.1 Requirements for a Solution

From this experience we gathered several key points which the new system should fulfill. The requirements for a new solution were the following:

- simple and quick technical preparation;
- independence on a local technical infrastructure;
- speech-to-text report must be synchronized with a reporter's typing;
- the look of the reported text should be customizable;
- a possibility of two-way communication;
- support for Czech and English language.

2.2 Analysis of Comparable Existing Systems

When analyzing existing systems comparable, we intentionally skip those which provide speech-to-text transformation based on automatic speech-to-text recognition. Systems which have been analyzed involves a human speech-to-text reporter:

- Google Documents (<http://drive.google.com>)
- Bee Communications (<http://www.bee-communications.com>)
- eScribe (<http://www.escribe.cz>)

Their common denominator is dependency on Internet connectivity in the location of text reporting. We consider this crucial requirement to be the most disadvantageous because utilization of the systems becomes highly dependent on local technical infrastructure. Additionally, most of the systems have quite complicated process of initialization and fail in the requirement of document layout setup independent among users.

2.3 Polygraf – Own Developed System

Defined requirements and analysis led us to the developing of our own system – Polygraf and practising it. The system meets all the requirements listed above and presents a technical solution to all those issues. It is based on a technology which can be used independently and which considers common technical parameters of an environment such as

a wireless network signal coverage. The only requirement is access to electricity. All those make it quite a universal transcript visualisation system.

The key benefits and features of Polygraf visualisation of transcripts:

- It consists of three main hardware parts only, therefore it can be easily transported and prepared for work in a very short time.
- It does not require Internet connection, initial network set-up, or its own server.
- It is compatible with Microsoft Word environment commonly used among Czech speech-to-text reporters.
- It uses handheld devices (e.g. smart phones or tablet) as a text display to ensure the basic user comfort.
- The reports are available in the environment of native applications (Windows, iOS, Android) and are also accessible via standard Internet browsers.
- It enables two-way communication: reporter to user and also user to reporter by simply typing a short message which will then appear in the text-reporters screen.
- The software solution also enables to show a report as dynamic captions on a speaker's computer and thus immediately supplement the speaker's presentation when there is one.

2.3.1 Hardware Components of the System

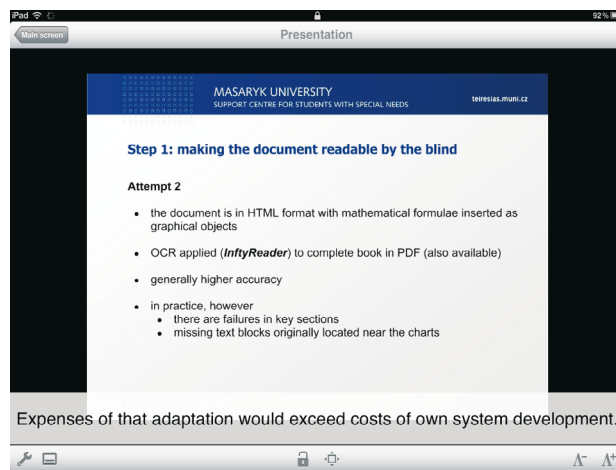
1. The computer for the reporter – desktop or a laptop computer with Microsoft Windows operating system and Microsoft Word in version 2003 or later installed, and equipped with Wi-Fi network interface.
2. The communication bridge – a Wi-Fi access point to create a wireless network connecting all devices together and transfer the text between them. There is no need of Internet connectivity for this wireless network.
3. The display for the user – any device with the iOS, Android or Windows operating system. Typically, a smart phone or tablet computer with Wi-Fi interface. There can be many of those user's devices used as handheld displays to follow a transcript.

2.3.2 Software Components of the System

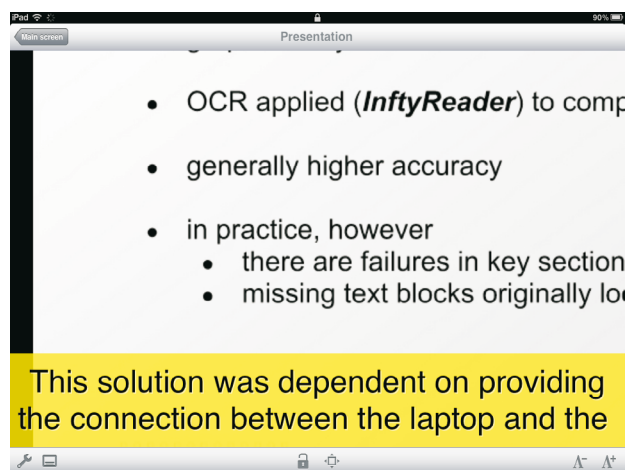
1. The application for the reporter's computer – Microsoft Word AddIn. This is installed separately alongside the Word, and its purpose is to "share" the text out of the Word documents to the users' devices.
2. The application for the handheld devices handles the reception of a text report and its continuous updating and displaying according to a custom setting of the user (font type, font size, colors, line-spacing etc.).
3. The application for the presenter's computer is an alternative viewing application, which displays the reported text in the form of continuously updated subtitles of up to four lines displayed as a floating caption, which can be attached to a speaker's presentation.

3 Presentation Screen Mirroring Enhancing the Readability for Users with Visual Impairment

Many lectures and presentations are supplemented by presentation slides using a projection. Speeches of the presentations often contain only part of information and referring of the speaker to his/her visual documents projected is very common. While blind users may work with accessible formats and have the material at their disposal, visually impaired users try to follow the mainstream visual content. Visually impaired people, but not only them, have to struggle with bad visualization conditions on the spot as well as with slides prepared improperly. To reduce the difficulties and to offer the possibility to magnify the content by the user, Masaryk University has extended its Polygraf application to provide a screen mirroring of the presenter's computer.



[Fig. 5] Screenshot of Polygraf – “mirrored” presentation screen displayed in the application



[Fig. 6] Screenshot of Polygraf – “mirrored” presentation screen displayed magnified

3.1 Requirements for a Solution

Observing students in lectures at the university and participants at presentations on conferences we gathered a list of key features required to such a system:

- simple and quick technical preparation;
- independence on presentation technologies;
- speech-to-text report must be possible to be added;
- magnification of the content must be possible;
- compatible with handheld devices of users;
- nearly real-time update of the mirroring without consuming too much battery power.

3.2 Analysis of Comparable Existing Systems

When analyzing existing systems we encountered software solutions providing the active screen sharing including control handling as well as screen casting solutions.:

- TeamViewer (<http://www.teamviewer.com>)
- Quick ScreenShare (<http://quickscreenshare.com/>)
- Skype Screen Sharing (<http://www.skype.com>)

The common disadvantage on all software solutions is the time needed for the preparation. While it is possible to prepare a presentation computer within a lecture room, it is impossible to maintain the installations and provide the service with personal devices (such as laptops) or, at a conference, to manage a situation when speakers are exchanging together with their presentation computers.

Additionally, the software we tested is quite complicated in processes of initialization of sharing and partially it is limited in number of participating users. None of the software offered the possibility to include a transcript.

3.3 Polygraf – Continuously Developed System for Universal Access

For those reasons mentioned above, Masaryk University considered to continue the development of the Polygraf application, adding the function of screen mirroring. It is implemented utilizing external hardware without needs of adapting presenter's software environment. The combination of screen mirroring and the speech-to-text services should be provided.

The key benefits and features of Polygraf screen mirroring:

- It consist of three main hardware parts only, therefore it can be easily transported and prepared for work in a very short time.
- It does not require Internet connection, initial network set-up, or its own server.
- It is platform independent on the side of presenters
- It uses handheld devices (e.g. smart phones or tablet) as a display to ensure the basic user comfort.
- The mirroring is available in the environment of native applications (Windows, iOS, Android)

- The software solution also enables to show a screen mirroring in combination with a speech-to-text; it offers the magnification and color-inversion of the screen capturing and the transcript can be displayed as closed captions.

3.3.1 Hardware Components of the System

1. A screen capturing device for the presenter – a broadcasting device (e.g. Epiphan VGA Broadcaster) capturing the VGA signal and providing it, apart from the output for data projectors, as a broadcasted motion JPEG through network interface.
2. The communication bridge – a Wi-Fi access point to create a wireless network connecting all devices together and to transfer the text between them. There is no need of Internet connectivity for this wireless network.
3. The display for the user – any device with the iOS, Android or Windows operating system. Typically, a smartphone or tablet computer with Wi-Fi interface. There can be many of those user's devices used as a handheld displays to follow a screen mirroring.

3.3.2 Software Components of the System

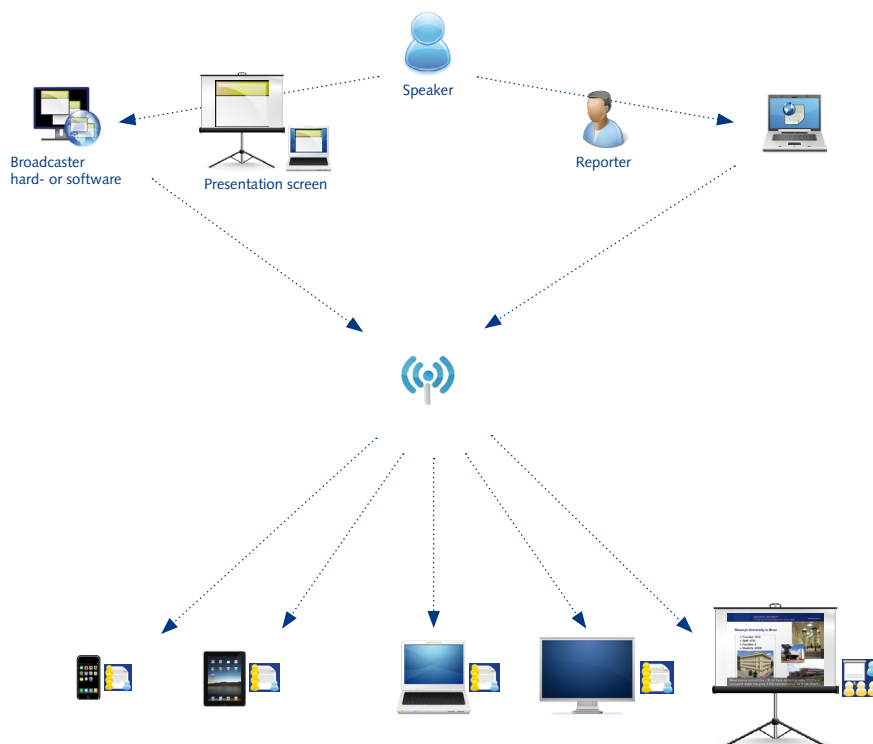
The only software required for the visualisation of screen mirroring is an application for the handheld devices which handles the reception of a screen capturing and it is continuously updating and displaying it according to a custom setting of the user.

4 Summary of the Solution

A text reporter records a transcript of spoken language using a text editor – Microsoft Word is commonly used among Czech speech-to-text reporters. MS Word is extended with Polygraf add-in installed alongside and it “shares” the text report using a wireless network to the user's mobile devices. At the same time, an hardware or alternatively software component of Polygraf (see below) captures the video signal of the presenter's computer and provides it to the user's mobile devices as constantly refreshed images. The transmission of the text report as well as the presentation screen to user's mobile devices is continuously made over a Wi-Fi network. This network connects all devices together and it may be established with any portable WiFi access point, for instance. There is no need of Internet connectivity for the network.

Devices of users, such as mobile phones, tablets or laptops (with iOS, Android or Windows operating system) are installed with Polygraf and they receive the content – both the text report and the “mirror” of the presentation screen. The content can be displayed on mobile devices in the ways as follows:

- To display the speech-to-text record only – the record is continuously updated but a user can still browse earlier parts of the text; view of the report is customizable.
- To display the “mirror” of the presentation screen only – the mirrored screen is continuously updated and the view can be customized (magnified and color-inverted).
- To display the mirrored screen in combination with the speech-to-text report as closed captions; the format of both can be customized.

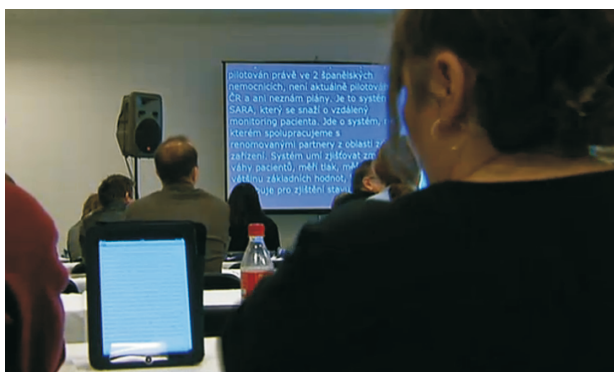


[Fig. 7] Polygraf schema

5 Usage and Practical Experience

Polygraf system was used throughout the last three academic years in lectures of Masaryk University in total amount several hundreds of them. Commonly, there were 3–6 students attending each of the lectures. There were several sessions to adapt the reporters to the new system, which they were supposed to get familiar with.

Polygraf system was also used for the text-reporting and subtitling of presentations in the International Conference Universal Learning Design in Brno, Czech Republic, 2011 and 2013. The text transcript was available to the audience through LCD displays situated on both sides next to the speaker stage as well as to any user of the iPad handheld devices which were available to borrow. At ULD conference, four text-reportings were running simultaneously – one report for each of two languages in each of two conference rooms. Additionally, during the last year, the usage of Polygraf system at conferences has been enhanced. The service was realized at INSPO Conference, Prague, Czech Republic in 2011, 2012 and 2013 as well as at the International conference ICCHP 2012 in its Universal Learning Design Track.



[Fig. 8] Polygraf used at the INSPRO Conference 2011, Prague



[Fig. 9] Polygraf used at the conference Universal Learning Design 2013, Brno



[Fig. 10] Polygraf used within educational setup of Masaryk University

Situation and Experience with Transcribers and On-line Speech to Text Service for Hard of Hearing and Deaf People in Czech Republic

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Keywords: Speech to text service, eScribe, on-line, transkript, transcriber

Abstract

The article deals with history of simultaneous transcription for deaf and hard of hearing people in the Czech Republic. Service as simultaneous transcription with physically present transcribers is offered by Czech Union of the Deaf (CUD) in social situation, as online version of transcription is provided by a new social company Transkript online Ltd as social service in sphere of commercial institutions. Transcription services in educational domain are represented especially by Teiresias Centre of Masaryk University. Transcription services have a huge potential to increase quality of life of hearing impaired people. Expansion of these services require education of transcribers and development of online tools for transcription services which reduce costs, increase quality of service and cover much wider areas, than physically present transcribers.

1 Introduction

Speech belongs to the most natural means for sharing ideas, information or feelings. However, speech may also become a communication barrier for those not knowing the language or unable to use it, like hearing impaired people or the foreign-language speakers. To overcome this barrier there are generally two approaches – *translation* (sign language for the deaf people or native language for foreign-language speakers) or *transcription* (to written form). For those hearing-impaired who lost hearing during their life, transcription is a natural and often the only way of receiving information. To learn new way of communication is especially difficult for those people who lose their hearing in older age. Although simultaneous transcription is a standard service for the deaf in US and west Europe, the situation in the Czech Republic is still different. Till 2008, the hearing impaired people in the Czech Republic could choose only between interpreting from/to Czech sign language and clear articulation with no sure results. Notwithstanding, the Czech Republic adopted a law [1] in 2008 guaranteeing the hearing-impaired the right to choose a communication system that matches their needs (simultaneous transcription including), no conditions were created or funds dedicated to fulfill this law. Because of lack of government funding for simultaneous transcription, CUD and social enterprise Transkript online are trying to remedy this state with help of volunteers, private foundations and ESF grants. New approach is to provide online transcription as a commercial service for large corporation, which have a significant number of hearing impaired people in their customer's basis.

2 Overview of Current and Previous Work

2.1 Historical overview of text based communication (Zdenek Bumbálek)

From the historical point of view, the long-distance transmission of text without a physical transport of letters, known as telegraphy, is older than telephony. Telegraphy was the first telecommunication service which could have been used by the hearing-impaired users for communication in real time. In the period of analog telephony (until the 1990s), hearing-impaired users could benefit from analog facsimile messaging (fax). In that time, the first service designed for the hearing-impaired, known as TTY (Teletypewriter for the deaf) [2], was established and operated. In the nineties, analog telecommunication services were replaced by digital communication (telephone exchanges of the 4th generation). From the wide variety of digital telecommunication services, hearing impaired people could use the TELETEx [3] service for text transmission and TELEWRITING [3] for transmission of hand-written texts in real time. Special digital text phones – TDDs (Telecommunications Devices for the Deaf) [2] – were operated in Western Europe and USA. The expansion of the Internet had high impact on communication of the hearing-impaired. E-mail and instant messaging were services helping to the hearing-impaired to overcome communication barriers. One of the most used services by the hearing-impaired is the Short Message Service (SMS) [3], which was introduced as part of the Global System for Mobile Communications (GSM) [3] series of standards in 1985. Hearing-impaired people often label SMS as the most important discovery after the invention of handwriting. Rapid development of the Internet enabled creation of a large number of multimedia services, some of them focused on the specific needs of the hearing-impaired people. Projects and services known as total communication have appeared. A well-known software platform for total communication is Skype, which was enhanced with videoconferencing in 2006. Special attention of the ITU resulted in the ITU T.140 [4] standard, dedicated to communication of the hearing impaired. ITU T.140 was standardized in 1998 and brings transmission of real-time text (RTT) [5] to Internet telephony and Next Generation Networks (NGN) [6].

With rapid growth of computing abilities systems that can synthesize speech from text (Text-To-Speech (TTS)) or recognize speech from voice (Automated Speech Recognition (ASR)) have recently achieved remarkable progress.

2.2 Simultaneous Transcription – Physically Present Transcribers

The impulse for a quicker introduction of transcription with transcribers was given at the meeting in the Czech Union of the Deaf where the hearing impaired participants did not know exactly what the lecture was talking about in spite of the good pronunciation of the speaker in Czech language. In May 2006, Martin Novak talked about this issue with Vera Strnadova who, in September 2006, proposed to introduce the simultaneous transcription into the Law of Communication Systems for the Deaf and Deafblind which was being emended at that time. The simultaneous transcription was called “recording a spoken speech in real time” [7]. Very important part of law is giving right to a free choice of communication support.

When Communication law was published in legal code book, Czech Union of the Deaf decided to make special project for promotion of simultaneous transcription everywhere in the Czech Republic for people who need this service. This project was supported by Vodafone Foundation and was offered gratis for each institution, organization and people where deaf and hard of hearing people are. We still know that we must make still promotion about this new service.

As an impulse from deaf and hard of hearing people, Czech Union of the Deaf was registration special social service Centre of simultaneous transcription mediation (CZSP) and finished on 13th of August 2010. Centre offers service as simultaneous transcription with transcribers and if it is possible on-line service.

Dominant service is simultaneous transcription with transcribers. During 5 years history service was offered with more than 60 transcribers.

In spite of no support from Ministry of work and social affair, CZSP receive financial support from some regions, organization, Ministry of education, youth and sports, Department of Justice, foundation and some universities.

If student need simultaneous transcription and study some university in Czech, he/she can contact coordinator of CZSP and give him all the necessary information about the subject in question and the time the transcription would be needed.

Centre of simultaneous transcription mediation of Czech Union of the Deaf and Teiresias Centre of Masaryk University realize special project Network of Expert Centers Providing Inclusion in Tertiary Education (Expln) and part of that project have goal to train new transcribers and prepare material for transcriber education.

2.3 *eScribe I a eScribe II*

History of eScribe I began in RDC laboratory at Faculty of Electrical Engineering, Czech Technical University in Prague (FEE CTU) in 2009. Operation of e-Scribe I [8] was based on voice over IP transmission and displaying text on a web page. Transcription was carried out by specially trained typists who used Microsoft Word® software, due to historic and familiarity reasons. The main drawback of eScribe I was the delay of the transcribed text between typing a character by the typist and displaying it on the user screen. In [8] we have proved that the delay was caused mainly by MS Word. In the worst cases, the delay was up to two seconds. Such a delay was contrary to an international recommendation ITU-T.140 [4] for multimedia application text conversation, specifying that maximum buffering time may be 500 ms (300 ms recommended). We have also observed several problems caused by used type of operational system and version of MS Word. To reduce these drawbacks, we have proposed a new cloud-based architecture for online transcription, eScribe II.

The core part of eScribe II [9] was deployed in Google cloud environment. We have used Google Docs as a text editor, as well as storage space for the transcribed texts. eScribe II was interconnected also with ASR system provided by Newton Technologies, partner of eScribe project. The ASR interconnection used the Google App Engine and the Jabber protocol. Using Google cloud services brings several benefits such as lower development effort, faster implementation, minimum requirements on own infrastructure and backups. Also a continuous improvement of services is provided from Google

side. On the other hand, cloud approach brings some risks represented by loss of control over the system and data or future levying of charges for the services. We have observed also several outages and unpredictable loss of synchronization of Google docs during our experiments. Using Google docs as a main technology was also hardly accepted by commercial customers especially because of security reasons. These limitations led us to develop own solution independent on 3rd party SW for providing commercial service.

3 User evaluation

Although eScribe I and II was mainly developed as a prototype proof of concept, we have arranged several test events where eScribe provided speech transcription to the hearing-impaired people. Several lectures at the Czech Technical University in Prague were transcribed using the Lecture mode (one speaker – many listeners). Czech Union of the Deaf also uses eScribe at their conferences or meetings. Using eScribe in the Face-to-face mode was first demonstrated in February 2012, in a cafe at Vodafone headquarters in Prague and later at a Vodafone shop, in communication between a shop assistant and a hearing impaired client. The client later described his experience on his blog: [10]

“The Samsung Galaxy Tab 10.1 tablet with 3G Internet connection was lying on the table and we had a normal chat with Mr. Bumbalek from CTU and I was reading what he was saying. It is great that a microphone in the tablet is sensitive and it is not necessary to give a wired microphone to the speaking person. People are often nervous and talk completely differently (people have stage fright or think they are actors), especially those not used to speaking with a microphone. Without wires, they talk naturally. The tablet lies on the table and people talk normally. Really great, I have experienced nothing like this for 9 years!”

As smartphones and tablets were identified as most suitable user equipments for the face-to-face communication, we have carried out a user survey [11] among the target group to learn more about smartphones, tablets and mobile internet penetration among the hearing-impaired people. The results (see Table 1) were also used for discussion about deployment at the customer centers of the Czech mobile operators.

4 Commercial Proof-of-Concept

In the first half of 2012 we have carried out a pilot project in a prominent Czech bank where we introduced eScribe at customer contact points. The pilot started in July 2012 at 5 representative bank branches in Prague. After one month the pilot was extended to another 31 branches throughout the country. It was decided that it will be operated using bank equipment, i.e. the voice connection is accomplished through a fixed phone line with a headset, and as display device, the computer monitor of a bank employee (see Fig. 1) is used.

[Table 1] User Survey.

The results were collected between March 19 and April 14, 2012, in all Czech regions via several web portals focused on the hearing-impaired people. 63 respondents (46 % from Prague region) participated in total. 60 % of respondents were men. 30 % of respondents were in the age of 18–30 years, 44 % in 31–60 years, 21 % were older than 61 years and 2 % were younger than 18 years.

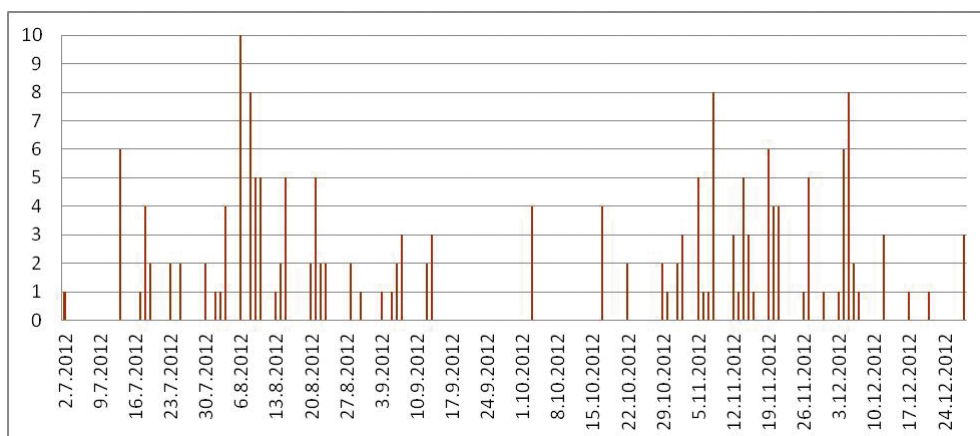
Question	YES [%]	No [%]
1. Do you use a smartphone?	46	54
2. Do you use a tablet?	13	87
3. Do you use any mobile data tariff ?	46	54
4. Are you considering to buy a smartphone or tablet in the next 6 months?	46	54
5. Are you considering to buy a mobile data tariff in the next 6 months?	32	68
6. Would you take the opportunity to communicate with other people using an online transcription app in your tablet?	89	11



[Fig. 1] Illustration of transcription at a bank branch

For the bank computers, secure access was established to our remote server where the web application is operated. When the hearing-impaired person comes to a bank branch the well-trained bank employee starts a simple web application, creating an on-line shared document and initiating a phone call to a transcriber. Then, the monitor is turned towards the hearing impaired and the employee's voice is converted into text on the monitor (which is read by the customer).

We have obtained positive feedback from bank customers as well as from its employees. Over a two-month period, more than a hundred transcriptions were executed. Mean duration over all the transcriptions was measured to be 9 minutes and 50 seconds.



[Fig. 2] Number of commercial transcription provided from 2. 7. 2012

5 Transkript – Social Enterprise

In October 2012, the social enterprise Transkript online Ltd was established as a spin-off company. Cofounders were recruited from core developers in RDC laboratory and CUD representatives. This partnership ensures close cooperation with FEE CTU and CUD. The mission of Transkript is to help reducing communication barriers of their clients. The main activity of the company is to provide a professional online transcription services.

As part of its commercial activities, Transkript focuses primarily on corporate clients with a large number of customers; among them are also people with hearing impairment. Past experience has shown that online transcript significantly shortens the operation time, prevents misunderstandings and increases satisfaction with deaf clients. All these benefits result in decreasing total costs on serving deaf clients. Professional online transcription also significantly increases the attractiveness of brands in the Deaf community.

Currently, Transkript offers professional online transcription at 85 (see Fig. 3) contact points in the Czech republic; 73 of them are branches of Era Poštovní spořitelna and 12 of them are selected Vodafone shops.

6 Conclusion

Online transcription centre at Transkript using a mobile device such as a tablet or smartphone is still being under development to match in the best way the requirements of our potential clients and to provide the best performance in a user satisfaction. We are conducting negotiations with several corporations about a similar pilot project to extend the range of services available to the hearing-impaired people. Also, we are trying to address the public authorities. In the future we plan to provide our services at public culture events like sightseeing tours. We also intend to focus at its application at medical or assistance centers etc.



[Fig. 3] Contact points with professional online transcription

Education of new transcribers in project Expln helps to improve number of transcribers, quality and demand for services from clients. In the year 2013 has started a common project of Czech Union of the Deaf, Career Counseling Agency for Deaf and Hard of Hearing People (APPN) and Transkript online. This project is led by company 365 o.p.s. and its goal is to transfer know-how of well established company VerbaVoice GmbH, which provides professional online transcription and online sign language interpretation services in Germany. This project is supported by ESF grant.

All these concepts of simultaneous transcription will make better life for deaf and hard of hearing people in the Czech Republic and give them correct and clear information.

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Effects of SZKIT in the Designing Software Lecture for Hearing Impaired Students

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Keywords: Hearing impaired students, Support of practice, Graphic design software, Evaluating comprehension, SZKIT

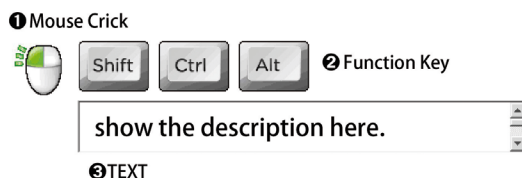
1 Introduction

Our university is only for visually impaired and hearing impaired students. In the lecture class for hearing impaired students, we use several teaching methods with sign language. The methods are projecting Power Point file or captured image to the screen, writing explanation texts to the white board on the table, using summary writing services, playing subtitled video materials, etc. [1][2]. These methods are really useful for the hearing impaired students and produce educational effects in the lecture. However, even supporting with these useful methods, it is difficult to teach in the field of computer operation, especially about designing software. For example, teaching how to operate graphical designing software like Adobe Illustrator or Photoshop is hard task for the teacher. Though many video materials and e-learning system were prepared to teach such kind of software, some students could not acquire exactly how to use such complicate software. We think one of the reasons is that it is difficult to understand real time operation for these hearing impaired students. Showing real time operation is quite effective to the “hearing students” in the normal case, because hearing students can acquire additional oral explanation in the same time. They would not be able to understand the operation if there was not the explanation. On the other hand, hearing impaired students cannot hear such oral information at all. Even though there is sign language translator or subtitling service for the real time operation, the hearing impaired students cannot see both of them simultaneously. Addition to it, these translation services has slight delay in general case. Such time-lag makes the information useless in the case of computer operation.

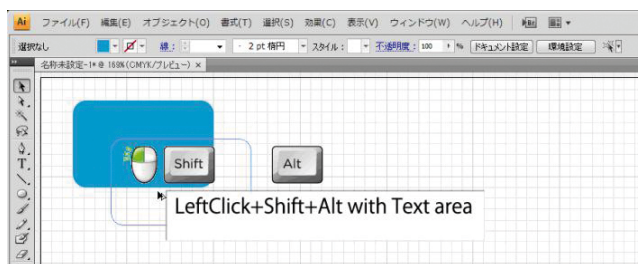
2 Overview of Synchronized Key points Indication Tool: SZKIT

To solve the problem explained above, we developed support software named “Synchronized Key points Indication Tool: SZKIT [3]–[6].” The overview of it is shown in Figure 1. This software is composed of several icons and an instruction text area. The mouse shaped icon appears when the teacher clicks mouse button and the key icons appear when he/she presses real keyboard. The figure shows most of icons to explain how it looks like, but they are hided at first and each icon appears just after teacher’s actions and they will be gradually disappeared after the key is released. Addition to the modifier keys, icons of alphabetical keys are prepared. For example, the teacher presses combination of

“Ctrl-C,” the “Ctrl” icon and “C” icon appears at the same moment. Under these icons area, there is an instruction text area. It is a space for showing text which is for explanation how to operate the designing software. Basically the instruction texts should be prepared in advance by the teacher and he/she can control a changing timing by using hotkey. Figure 2 shows an example of how SZKIT works in the real teaching situation. In this case, teacher is dragging a mouse with pressing Alt-key and Shift-key in the same time. Hearing impaired students can understand what kind of operation is done in real time with these icons and they can also get text information without moving visual axis. The SZKIT is already used in the practical lecture in our university.



[Fig. 1] Interface of SZKIT



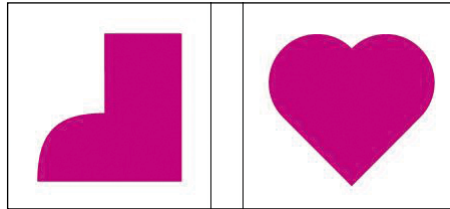
[Fig. 2] Look of teaching with SZKIT

3 Experimental lecture to hearing impaired students for evaluation of SZKIT

To evaluate an effect of the SZKIT, experimental lecture sessions of Adobe Illustrator were conducted to our hearing impaired students. The number of students who participated in the experimental lecture was 11. They were divided by four groups, and each group took different combination of the lectures as described below. We prepared two types of lectures in which the teacher taught different tasks depends on difficulty. A more difficult task was named as Task A and an easy one was named as Task B. Task A is making a drawing of a boot shape with Bezier curve, and Task B is making a drawing of a simple heart shape with combination of two circles and a square. The shapes of these tasks are shown in Figure 3.

Both lectures had two conditions, which were doing lecture with SZKIT and without SZKIT. Therefore the number of conditions of the experimental lecture was four by mixing of them. The lengths of all types of lecture were controlled to keep 20 minutes and to avoid an effect of the order, the order of these lectures were shuffled and two of them

were assigned to four groups respectively. The precise assignments of the conditions and the number of students were shown in Table 1. After these experimental lectures, there were examination sessions where every student was required to make drawings of each shape within eight minutes. The results of the drawing tasks were scored on 100-point scale in which precise scoring strategy defined in advance. The precise scoring strategy is shown in Table 2. After the examination session, all students were required to answer a questionnaire sheet consists of several questions.



[Fig. 3] The shapes of Task A(left) and of Task B(right)

[Table 1] Orders of lectures and number of students assigned to each group

groups	Order of lectures	number of students
group A	Teaching Task A with SZKIT – Teaching Task B w/o SZKIT	2
group B	Teaching Task B w/o SZKIT – Teaching Task A with SZKIT	3
group C	Teaching Task B with SZKIT – Teaching Task A w/o SZKIT	3
group D	Teaching Task A w/o SZKIT – Teaching Task B with SZKIT	3

[Table 2] Required standards of scoring strategy for each task

	Required standards	scores
Task A	Path of the shape is correctly closed.	10
	Color is correct.	5
	Number of anchor points is correct.	25
	There are not unnecessary anchor points.	–5 for each if there is
	States of direction lines are correct.	30 × 2 positions
	There are not unnecessary direction lines.	–10 for each if there is

	Required standards	scores
Task B	Square is not rectangle, circles are not ellipses.	10
	Color is correct.	10
	Height of the square and diameter of the circle is same.	30
	Circles are correctly duplicated.	10
	Crossing position between circles and square is correct.	10 for each position
	Using path finder function or not.	20

The first part of the questions was as follows:

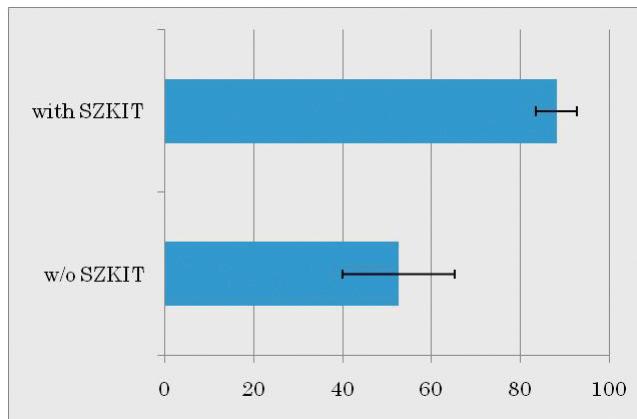
- Do you think the function of showing modifier keys is useful for learning computer operation?
- Do you think the function of showing alphabetical keys is useful for learning computer operation?
- Do you think the function of showing mouse click icon is useful for learning computer operation?
- Do you think the function of showing instruction texts is useful for leaning computer operation?

Answers of the first questionnaire part were required to use 5-level Lickert scale. After that, free writing style questions followed. The questions were;

- Please write advantage or disadvantage of displaying information around the mouse cursor.
- When did you feel SZKIT is useful? (if you thought it was useful)
- The last question was also required to answer using 5-level Lickert scale.
- Do you think SZKIT should be used in other computer based lecture?
- Students read these printed questions and answered them by themselves.

4 Results and discussions

As a result, the average score of making Task A after taking the lecture with SZKIT was 88 and the score of Task B was also 88. On the other hand, the average score of Task A after taking the lecture without SZKIT was 45 and Task B was 62. The reason why Task B marked high score is it was easy task. Applying t-test to the average score of all task “with SZKIT” and “without SZKIT” shows statistically significant ($p < 0.01$). Even only between easy tasks (Task B), statistically significant is also observed. The result is shown in Figure 4.

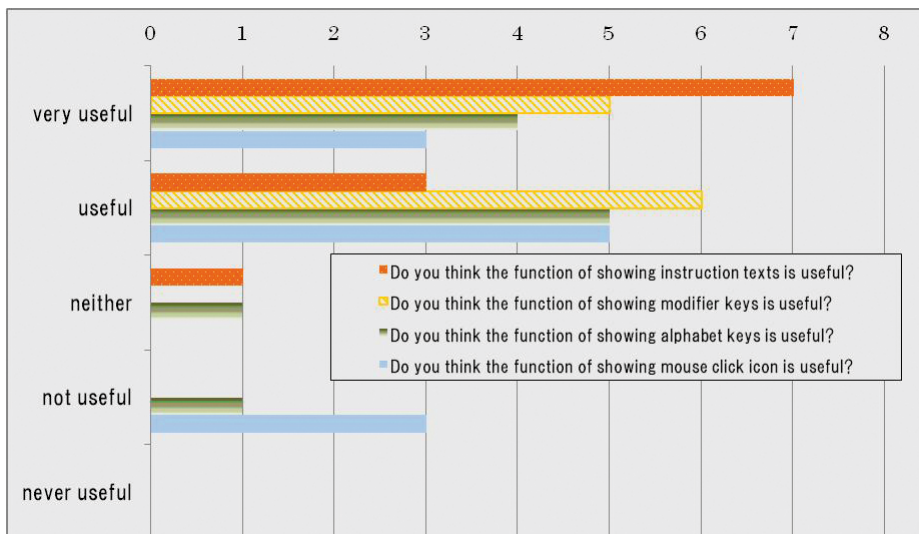


[Fig. 4] The results of scores between tasks with SZKIT and without SZKIT

Addition to it, the number of mistakes and the time of completion is also less and shorter in tasks after a lecture with SZKIT than after a lecture without SZKIT. In the task results after lecture without SZKIT, there are several cases that the shape overview was seemed to be correct though, mistakes are observed frequently. For example:

- Circle shapes are not the same. It means that the student did not use copy function.
- Square is rectangle, Circles are ellipses. It means the student did not use shift key when he/she make these objects.
- Crossing position of square and circles is not correct. It means the student did not check the anchor position using remark messages of the software when he/she make or move these objects.

We think these mistakes causes by lacks of knowledge, and results shows SZKIT could tell such kind of knowledge to the students with good timing.



[Fig. 5] The answers to the first part of questionnaire

Figure 5 shows the answer to the first part of the questionnaire. From this result, it is clear that most of students felt the function of showing instruction text and showing modifier keys were useful. On the other hand, a few students thought the functions of showing alphabet and mouse click icon as not useful. About alphabet icons, we think that the reason is simple. There were not so many opportunities using them in the experimental lectures. However, about mouse clicking, of course we had many opportunities to use it. We think the reason why they feel the function of showing mouse click icon was not useful is that clearly difference appears on the screen when teacher clicks mouse button in case of using designing software. Therefore students might not need signals by SZKIT in this case.

On the contrary, students could not understand what kind of modifier keys were pressed without SZKIT, and the timing of pressing them is important in the operation of designing software. Instruction text area is also available to inform how to use such modifier keys. Because of such situation, students might answer that the functions of showing instruction text and modifier keys were more useful. Furthermore, several answers of free writing comments described that SZKIT was useful on the timing in which teacher uses modifier keys, and advantages of instruction text area and icons of modifier keys. We can say that students were seemed to have trend to think function of showing instruction texts and modifier keys as important.

About advantage of showing information around the mouse cursor, several students answered it was good because they could synchronize their action and teacher's action. We think this effect cannot be established using another support like sign language translator or summary writing services.

To the last question, seven students answered "please use it (level 5)" and remained four students answered "it is better to use it (level 4)." No one answered under "neither (level 3)." We think we could confirm the effectiveness of SZKIT by these results.

5 Conclusion

Experimental lectures of teaching how to draw a boot shape and a heart shape were conducted to estimate an effect of using SZKIT. The scores of examination between after lecture with SZKIT and without SZKIT made statistical significant difference. Besides it, answers of questionnaire showed effectiveness of SZKIT. It was clear that students think functions of showing instruction text and modifier keys are useful. It is considered as quantitative results corroborated qualitative results. As a next step, we plan to conduct experiment which compares SZKIT and other support methods in the future.

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Willingness to Communicate in English as a Foreign Language of the Deaf and Hard of Hearing University Students

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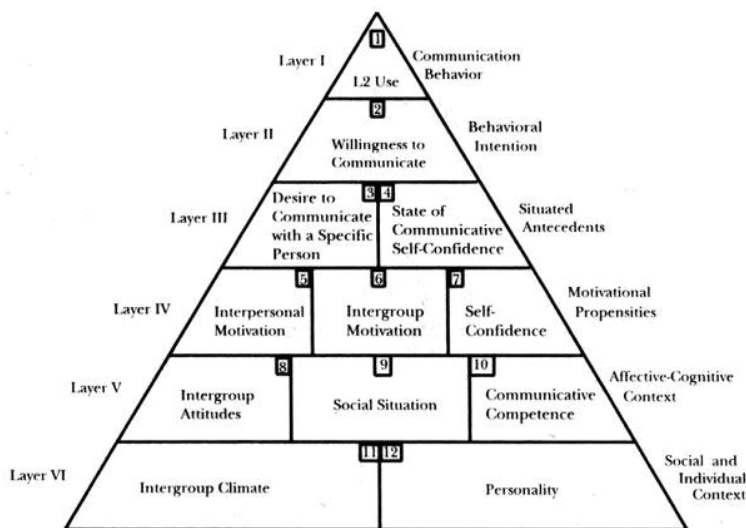
1 Introduction

Research on deaf and hard of hearing students learning and using foreign languages has started not so long ago – in the first years of the 21st century. So far the main topics of it revolved mainly around issues of grammar and vocabulary, reading, writing and speaking acquisition, difficulties experienced by students during this process and strategies of overcoming the possible problems. Some of the personality characteristics, like motivation and learning style were also investigated. In the background of each of these research a conclusion might be visible that a foreign language is best acquired within the context of interaction. It implies the fact that greater attention of both scientists and practitioners should be devoted to active usage of the target language, be it in class or in the more naturalistic setting. The key factor guaranteeing a success is the students' willingness to start and maintain a conversation in a foreign language.

Willingness to communicate (WTC) is by some of the researchers understood as the main goal of language instruction and defined as “the probability of engaging in communication when free to choose to do so” (McCroskey & Baer, 1985) or learner's “readiness to enter into discourse at a particular time with a specific person or persons, using a L2” (MacIntyre et al., 1998, p. 547). Thus, it can be treated as a psychological readiness to use a second language and understood as something different from objective linguistic competence. Formally speaking, willingness to communicate is observed as a certain type of communication behavior, but this act can be described as a multi-layered one. It is implied by the intention to perform a certain behavior, usually in a specified interpersonal and situational context. WTC might be even conceptualized as a primary goal of foreign language instruction. So far it was language competency that was meant to be the ultimate goal of foreign language instruction. However, as many research showed, a person might be competent in a foreign language but at the same time not eager to use it in real communication. This results from motivational, affective and cognitive propensities, such as self confidence, interpersonal motivation, group motivation, attitudes, communication competence, intergroup climate and personality (cf. J. R. MacDonald, R. Clément, P. D. MacIntyre 2012). It seems that age also plays a role in this process and usually the older the learner, the more hesitant to start learning a foreign language and eager to communicate in it.

MacIntyre (1994) proposed that a model of WTC should consist of two variables: communication competence and communication anxiety. It was presumed that a high level of communication competence and low levels of anxiety would result in a more frequent communication in a foreign language. Later on the same author together with a group of researchers proposed a more detailed model of WTC (MacIntyre et al. 1998). It takes a form of a model consisting of: 1. Stable influences (like personality traits) and

situation specific influences (e.g. the interlocutor's characteristics that motivate to or distracts from communication). Further research on the concept of WTC disclosed that it depends on a wide range of factors, such as the degree of acquaintance between communicators, the number of people present, the formality of the situation, and the topic of discussion (MacIntyre et al. 1998, comp. Fig.1). It was also observed that willingness to communicate is hindered in situations when a learner observes that an interlocutor is more fluent in using the language (Kang 2005) and negative attitude towards the classroom tasks Dörnyei and Kormos (2002).



[Fig. 1] Heuristic model of variables influencing WTC (Macintyre, Clément, Dörnyei, & Noels, 1998, p. 547)

MacIntyre (2007) points also at a fact that in measuring WTC rigorous conditions should be met and the factors should be clearly described, as the factors might be connected with different aspects of the communication situation e.g. anxiety might be connected with the situation variables or with some personal traits of the learner or the interlocutor.

The constellation of the variables is dynamic in its nature. Apart from measuring WTC the teachers and researchers should concentrate also on pedagogical interventions: it is not only important to diagnose the situation but also to change the variables that can be changed in order to support the learner's communication willingness.

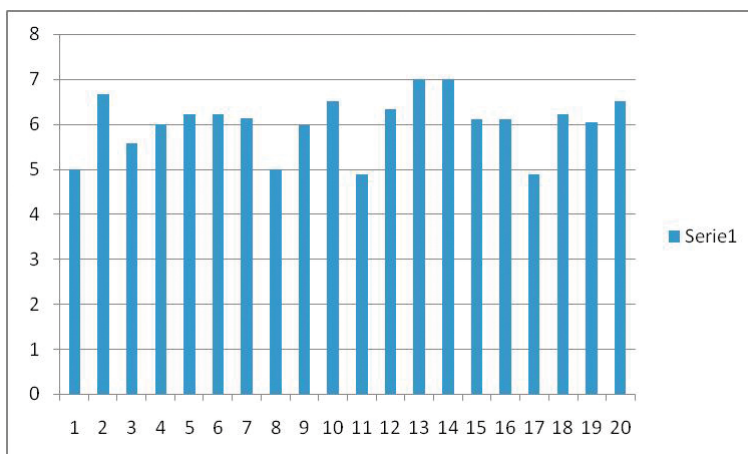
2 Research

The issue of willingness to communicate is of an utmost importance in forming and assessing linguistic competence in a foreign language of the deaf and hard of hearing English as a second language students. It happens more than often that even if they master English grammar and vocabulary, they feel very much reluctant to use a foreign language as a means of communication. It is probably connected with some personality features, lack of self confidence and unfavorable social attitudes and prejudices.

In the present paper the results of research on the deaf and hard of hearing university students willingness to communicate will be presented and analyzed. The research group consisted of 15 deaf and hard of hearing Polish and Czech participants of a workshop *English as a tool of international communication*, conducted at Centre of Education of the Deaf and Hard of Hearing of KUL university in Lublin within the program *Network of Expert Centers Providing Inclusion in Tertiary Education – ExpIn*. The control groups consisted of 15 hearing students who did not participated in the workshop but represented the demographical characteristics similar to the research group. The mean time of learning English was 9,3 years for the hearing students and 6,7 for the deaf and hard of hearing ones. The method included a questionnaire checking their willingness to communicate. The results were analyzed statistically, showing high level of willingness to communicate among the research group of students

The research group participated in a workshop *English as a tool of international communication*, that gathered together 20 student with hearing impairment from universities in Lublin, Brno and Poznan. They spent together 5 days, participating in a series of courses, events and games: regular classes on grammar, reading and communication, e-learning class, Cued Speech classes, a city game (Lublin's quest) and three cultural events: a visit to a museum (the main Lublin's museum, The Nazi Concentration Camp in Majdanek, a tour of Polish capital city, Warsaw and intercultural evening prepared by all the participants. Each group of students prepared also a presentations about their town and their university. The main impact during all the classes and events was on communication and students were encouraged both by the teachers and by the conditions prepared to exchange ideas and communicate within a group, either in writing (all students were equipped with a notebook and a set of pens, they also have tablets during the classes and their personal mobiles) or in speech – if possible.

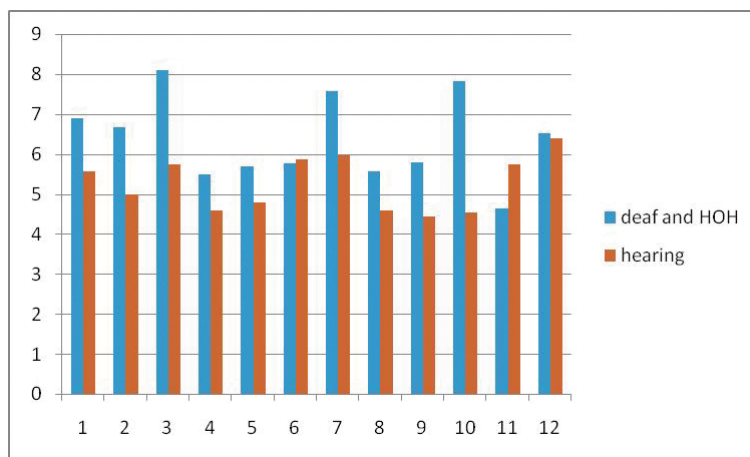
The evaluation of the workshop was very positive (fig. 2). The participants valued mostly the cultural events (visit to a museum, tour to Warsaw and intercultural evening), some of the regular classes: introductory session, grammar classes and e-learning class and also their own presentations.



[Fig. 2] Workshop evaluation

After the workshop the students were asked to complete a questionnaire on willingness to communicate (Willingness to Communicate Scale, McCroskey, 1992). Their task was to assess to what extent they feel they are able to conduct a certain language behavior, with the support of writing or PP presentation: to have a small group conversation, to give a presentation in English, to use English in small groups or in large meetings (comp. Appendix). The same questionnaire was completed by a control group of hearing students.

The results are outstanding. The group of the deaf and hard of hearing student presented in the research a bigger willingness to communicate than the group of the hearing students. The research group felt sure that they could be able to give a presentation in English to a group of friends or acquaintances, or even strangers. They also felt they will be competent to have a conversation in English with friends or in a small group (fig. 3.).



[Fig. 3] Comparison of deaf and hard of hearing and hearing students willingness to communicate

3 Conclusion

Willingness to communicate should be treated as one of major factors facilitating the process of teaching and learning English as a foreign language for the deaf and hard of hearing subjects. Both the language teachers and administrators should pay more attention to develop this characteristics among the students and organize supporting communication environment for students to practice their language competence.

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Appendix

Willingness to Communicate Scale (McCroskey, 1992)

Write using per cents

[0 % – *I cannot do it at all*, 100 % – *I can do it well*]

I can do it, using writing or Power Point presentation if necessary:

- _____ 1. I can have a small-group conversation in English with acquaintances.
- _____ 2. I can give a presentation in English to a group of strangers.
- _____ 3. I can give a presentation in English to a group of friends.
- _____ 4. I can use English in a large meeting among strangers.
- _____ 5. I can have a small-group conversation in English with strangers.
- _____ 6. I can use English in a large meeting among friends.
- _____ 7. I can use English with my friends.
- _____ 8. I can use English in a large meeting with acquaintances.
- _____ 9. I can talk in English to acquaintances.
- _____ 10. I can give a presentation in English to a group of acquaintances.
- _____ 11. I can talk in English to a stranger.
- _____ 12. I can talk in English to a small group of friends.

SECTION 3

Universal Design of Electronic Documents and Public Electronic Libraries for Purposes of Tertiary Education

Organising Student Support Using Accessible Electronic Documents, e-Books and Audiobooks: an Overview

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Keywords: student support, accessible documents, design for all

1 Overview

In this presentation, I will discuss several technological and pedagogical items related to university level teaching for students with a functional limitation (or an impairment). It is well known that many universities (and other schools) pay a lot of attention to making their education as accessible as possible, also to students that need special support or extra help.

In a first part, I will discuss the different types of limitations that students might have as well as some existing technical solutions adapted to their specific limitation.

In the next part, I will give a critical overview of the possible support techniques, based on my experience in international project work and local actions.

Finally, I will resume what I learned from my contacts with the many other universities that invest in real support for the group of students we have in mind.

A small list of good advices can be found at the end of this contribution.

2 Overview of major functional limitations and how to cope with them as a university level student

2.1 Deafness and hard of hearing

As most of the course materials are still in a printed form, they are readily accessible for this group of students. However one must be aware that for many of them, sign language is their mother tongue and the written language (that is not just a pure transcription of the signs) is often their second language.

This group evidently has serious problems in following lectures. Although several systems for automatic speech recognition (IBM's Liberated Learning Consortium¹ is the best known example) have been tried out, results are still mediocre for most languages except for English.

Depending on the level of state and university funding, these students can often call in the help of sign language interpreters. Automatic sign language generation is still far from a reality although quite a lot of research is going into this problem's solution².

In part 4 we will elaborate a bit more on the advantages of recorded course material (including automatic subtitling/closed captioning).

1 Liberated Learning Consortium: <http://liberatedlearning.com/>

2 IBM SiSi: <http://www-03.ibm.com/press/us/en/pressrelease/22316.wss>

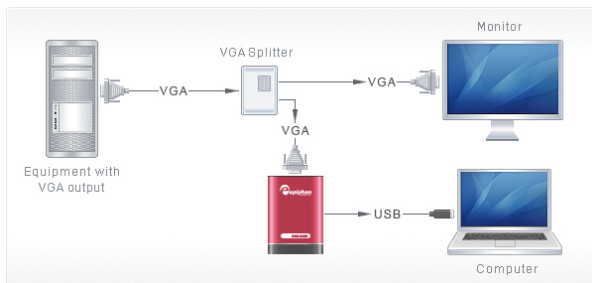
The studying situation is a bit easier for students that are only hard of hearing. Quite often, it suffices to connect a lecture room's public address audio system to a special receiver worn by the student.

2.2 Low vision

Students with some rest vision can use enlargement systems (optical and/or computerized) to get access to course texts. Here the problems arise during lectures and are often related to viewing the explanations written on the white- or blackboard. Special cameras and software do exist. E.g. a computer screen is split in two: the blackboard can be seen in the upper half of the screen, the course material in the lower part.



[Fig. 1] Blackboard camera



[Fig. 2] Epiphan video splitter (VGA to USB)

Big improvements are possible through the use of computerized teaching boards (although not yet widely used in university level education). Their screen information can easily be transmitted to a visually impaired student's portable computer, where it can be enlarged and can be recorded. Especially video-to-usb devices from EPIPHAN³ are quite popular in this respect.

2.3 Blind students

Students without any rest vision need to have their written materials converted into another modality: audio (talking computer) or Braille (on paper or on temporary Braille reading devices). Some of this conversion work can be done by specialized centres, some of it is part of the student's task.

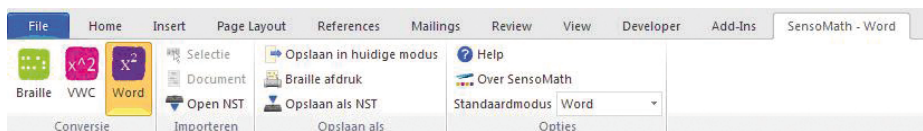
Main challenges here are:

- What kind of document formats is accessible, adaptable and cost effective for transformation? Furthermore can they be realized in the usually short time span that is available for course material conversion? I have extensively discussed these challenges in my ULD/ICCHP 2012 presentation on this subject [Engelen, 2012]. Preferred formats are: pure text, HTML, wordprocessing formats such as **.odt** (Open or Libre Office text files) and **.doc/docx** (MS Office), and tagged PDF/UA (but **not** the general PDF format!). If an audio output is requested, one could use a word processor add-on (Save-as-Daisy or odt2daisy) to produce Daisy format audio books⁴.

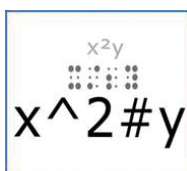
3 Epiphan: <http://www.epiphan.com/>

4 Daisy consortium: <http://www.daisy.org>. Production of Daisy books: <http://www.daisy.org/projects/save-as-daisy>

- There are no global solutions for mathematics' access and no solutions at all for making most graphical materials accessible. For high level mathematics often the use of L^AT_EX is promoted. But L^AT_EX is very verbose and understanding a linearised formula in L^AT_EX can be challenging for a student's memory. A somewhat simpler (but very seldomly) used format is MathML⁵. Specialists in several European countries have therefore developed their own mathematical codes for blind and partially sighted students. A particularly smooth approach is taken by SensoMath⁶: this software (running within MS Word) transforms all mathematical formula on the fly between a graphical, two-dimensional representation, linearized (VWC-code) and Mathematical Braille. Typing in changes (e.g. calculations) can be done at will in one of these three languages as well.



[Fig. 3] The SensoMath ribbon: clicking on one of the three left options transforms the formulae in the document into the chosen format



[Fig. 4] Example of the three mathematical representations (same formula) handled by SensoMath

2.4 Students with dyslexia

Dyslexia is a neural complication in the brain that results in an increased difficulty for understanding written material. Therefore very often those students choose to turn written texts into audio. This can be done with special software packages, usually capable to read and handle PDF (and other types of) documents. Two well-known packages are Kurzweil⁷ and Jabbla⁸.

3 Role of e-books and audiobooks

E-books and audiobooks are a relatively new phenomenon that had a very slow take-up for many years now. More recently e-book reading started booming, mainly due to internet based distribution systems and the widespread use of tablet computers.

⁵ MathML: <http://www.w3.org/TR/MathML3/>

⁶ Sensomath: <http://www.sensotec.be/News/Detail.aspx?ID=366>

⁷ Kurzweil: <http://www.kurzweiled.com/default.html>

⁸ Jabbla: <http://www.jabbla.com/index.asp?lng=EN>

In our experience very little use of this material is made in university level education. The large attention paid nowadays to iPad (or other tablet) use in education might change this but e-books with course material are still very rare. This will change when the e-book standard EPUB3 becomes more widely spread (heavily promoted by the International Digital Publishing Forum⁹). This standard has the extra benefit that EPUB3 books can easily be turned into audiobooks usable for blind persons (Daisy¹⁰).



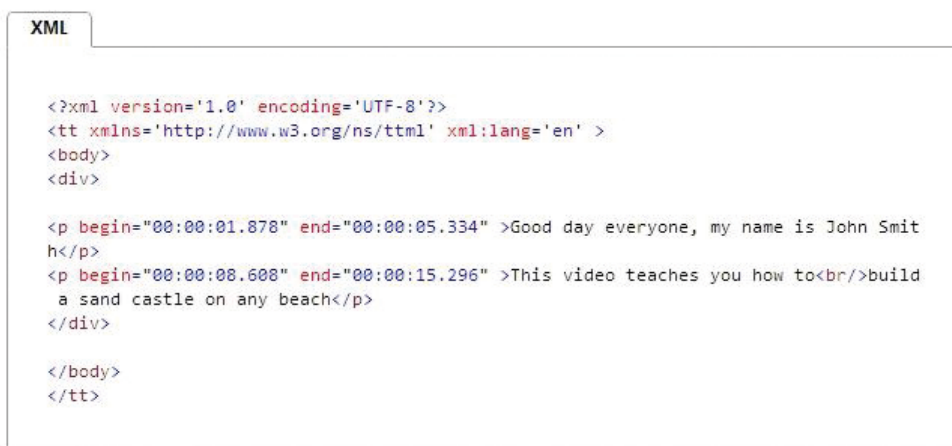
[Fig. 5]

4 Video techniques for course material distribution

A rather new and very effective support system for all kinds of students can be created by using video recording techniques augmented by several types of extra information. The basic idea is then to make a recording of a lecture (video, audio, slides) and to add more information afterwards.

4.1 The YouTube approach

YouTube videos are well known. Several years ago the maximum duration of an upload was dropped (it used to be 10 minutes before). Since 2009 it is possible to add subtitles to the videos (In the US this process is known as Closed Captioning). One can upload now a text file with timing codes and the text of the subtitles to be shown.



[Fig. 6] Example of a TTML subtitling file: a combination of time codes and the text to be shown¹¹

⁹ Link: <http://idpf.org>

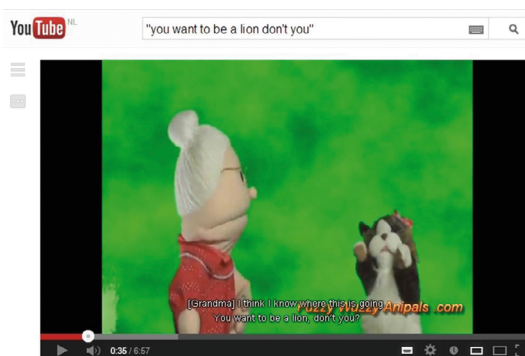
¹⁰ Daisy consortium: <http://www.daisy.org>

¹¹ TTML is a W3C standard. It can be found at: <http://www.w3.org/TR/2013/WD-ttp1-dfxp-20130131/>

This can be done for several languages (the language of the subtitles is chosen by the person viewing the videos later on).

YouTube even allows a registered user to generate the subtitles more or less automatically by Google speech recognition techniques.

A lesser known aspect of this subtitling possibility is the fact that the YouTube search engine will also search within the text of the subtitling.



[Fig. 7] YouTube: Searching within subtitled videos

4.2 The KU Leuven Videolab approach

At KU Leuven University, a huge video recording project of many lectures was started several years ago. This fitted in the ubiquitous trend to provide on-line teaching material outside of the normal campus.

In the initial Videolab approach¹² a single video file is made of the lecture in which the teacher and part of the students in the lecture hall is shown and listened to. The right part of that video shows the slides or the video fragments shown at every moment in time.



[Fig. 8] Videolab layout: simultaneously showing the teacher and the slides used

A next step was the addition of subtitles to such a lecture. As manual transcription is extremely time consuming, attempts for generating automatic subtitles (through speech recognition) were made. Within a couple of research projects the speech recognition engine was trained with the specific terms and words used in the lecture. In practice this was done by analyzing the vocabulary of the college notes of the teacher. This addition is

¹² Source: private communication by Mart Achten, KU Leuven – DoEL (January 2013)

extremely useful for students with a hearing impairment (but also for those that cannot routinely understand the teaching language).

Currently the video files in Videolab can be linked with the subtitle files but also with a special audio file that contains extra spoken information to make the video understandable to blind persons. This process is known as audio description. In many European countries public TV broadcasters even have to provide this service for a certain percentage of their transmissions.



[Fig. 9] Videolab: showing the extra possibilities of subtitling and of audiodescription

5 Student support organisation

My own university, KU Leuven started accepting students with a motor handicap since the late seventies. In that period a small group of volunteer fellow-students was recruited for each person with an impairment and they provided all daily support. This scheme, unique in Europe, got the EU Helios award in 1995.

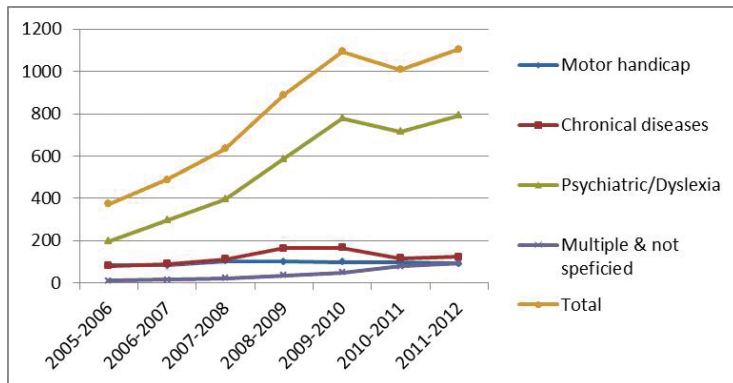
KU Leuven is co-organisator (together with the University of New Orleans) of the International Conference on Higher Education and Disability (Innsbruck, Austria)¹³. More details of KU Leuven's approach will be given at this year's conference [Dewicke, 2013].

But over the last decades, especially the last one, accessibility became a much wider concept. As all teaching and organizing at the university is now done through computer access, eAccessibility became a prime factor in the teaching process for the group of reading impaired students (low vision, blind, severe motor handicap, dyslexia). The same is evidently true at other universities.

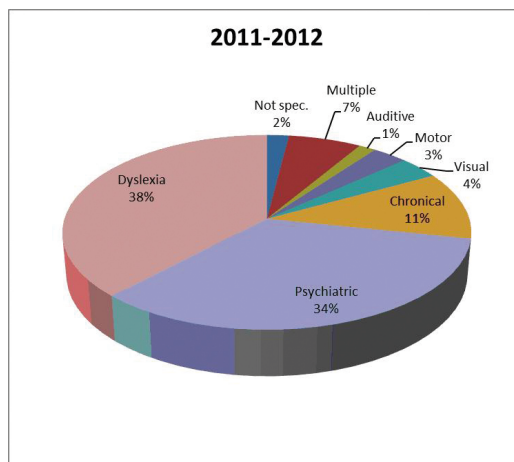
The fact that university level education is made accessible for all students has caused an enormous inflow of students with an impairment at KU Leuven over the last couple of

13 Link: <http://www.trac.uno.edu/conf/>

years. Overview graphs of the evolution in time and the splitting over different kinds of impairments are given below¹⁴.



[Fig. 10] Students with a limitation as registered at KU Leuven (Belgium)



[Fig. 11] Types of students with an impairment at KU Leuven (2011–2012)

6 Some closing remarks

- Be aware that electronic accessibility of a university education is essential for students with an impairment but providing technical solutions only is not sufficient. A University has to provide several other services in a coherent fashion.
- Every occasion to convince professors and other teachers to make their course notes and exams accessible should be grasped. Be prepared for a lot of arguing...
- There is not such a thing as an “accessible book”. The context of use and requirements specific to a person’s reading capabilities determine what type of documents should be made available.

¹⁴ Source: private communication by Ann Dewicke, co-ordinator of KU Leuven’s support services for students with a functional limitation (January 2013)

- Be aware that a University with a serious support for students with an impairment will be very attractive. Sometimes neighbouring Universities or High Schools judge it more convenient for them to point the students to a University where accessibility is taken seriously.
- The technology for student support is changing very rapidly. Only a support service that invests in training its advisers, especially in relation to evolving technological solutions, can guarantee a stable, up to date, continuous and long term guidance of the student population with an impairment.

7 Acknowledgements

This contribution is based on information collected over the years in many research and support projects.

Especially the support of the KU Leuven Educational Service (DOeL: Dienst Onderwijs en Leren) and the CSFB group (Support service for students with an impairment) at the same university is greatly appreciated.

The Open Source software odt2daisy (and also odt2braille) were developed in the framework of the European FP7 Project AEGIS [Strobbe, 2010]. EU support is gratefully acknowledged.

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Accessible Video as a Support for Teaching in Higher Education

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Keywords: video, accessibility, multimedia

Abstract

This paper presents a joint project of the University of Lleida (UdL) (Spain) and University of Barcelona (UB) (Spain) for the development of a specific programme dedicated to define, exemplify and promote the process of accessible video creation and editing in higher education. The main aim of the project is to disseminate best practices through examples tested by a pilot study in order to facilitate the introduction of accessible video as a learning support for on-site courses and blended courses. The nature predominantly applied of the project has fostered the creation of several products and demonstration readily available to the educational community. These materials gather information about different key issues to consider in designing audiovisual materials, different useful tools are recommended to make the user capable to create accessible audiovisual content autonomously with basic skills or to add accessible features to an existing video in the most common formats.

1 Introduction to the project

This paper presents the results of a program dedicated to define, exemplify and promote the process of usable and accessible video creation and editing in higher education. The project is a joint project of the University of Lleida (UdL) and University of Barcelona (UB) – both from Spain – performed by a multidisciplinary group of academics (pedagogues, librarians and computer and multimedia technicians) by experimentation and piloting. The aim of the project is to disseminate best practices through examples tested by a pilot study to facilitate the introduction of accessible video as a learning support for on-site courses and blended courses, i.e. a combination of **classroom** and online activities. The project focuses on the application of Universal Design and Accessibility concepts in teaching.

The main objectives of the project are the following:

- To collect and apply a set of widely accepted accessibility criteria to video editing.
- To create and disseminate a collection of guides on how to design and edit accessible videos for teaching in higher education.

These objectives will be put into practice with a pilot video used as well to disseminate the philosophical principles behind the project. This video will be planned, subtitled, audiodescribed and published with accessible technologies.

The tools used were selected taking into account their widespread use and low cost, to address a wide range of stakeholders, especially education professionals, technicians and professors.

2 Rationale of the project

Universities in Catalonia in recent years have seen a remarkable increase of students with disabilities, calculated in 215 % over the past 7 years according to the report of the Consell Interuniversitari de Catalunya (2009). These conditions urge the need of useful and affordable answers in the use of digital resources for all people in higher education and especially for those that require specific adaptations.

At the same time, video is a format increasingly used in communication on the Web (Maaden 2007, Purcell 2010; Moore 2011) and many universities systematically record classes and redistribute video for web and mobile platforms. Several Spanish and international universities offer selected teaching contents in video format on popular platforms like iTunes (<http://www.apple.com/es/education/itunes-u/what-is.html>) or Youtube (<http://www.youtube.com/education?b=400>), or on their own channel. It is worth noting that distance learning universities also record teaching content in video format in order to enrich the content of their courses and offer it to the students in their intranet. Other universities with blended learning use video as a tool to recreate part of the “richness” usually offered in the classroom learning experience.

According to education ethical principles and to the Declaration of Human Rights, it is stated that “everyone has the right to education” and “higher education shall be equally accessible to all” on the basis of merit. In addition, in 2006 the United Nations Convention on the Rights of the Persons with Disabilities ruled on the responsibility of State parties to take appropriate measures “to enable persons with disabilities to live independently and participate fully in all aspects of life”. In this sense, university education should be accessible to everyone and should not create new digital barriers. The current local law in Spain, as in many other countries, supports these principles forcing public websites to adhere to accessibility regulations (R.D. 1494/2007).

Professors using audiovisual resources in their classroom should learn their pedagogical uses and their accessibility requirements. Since the first aspect, concerning the educational use of video, has been extensively studied in other studies (Dale, 1969; Bruner, 1997; Ferrés, 1997; Sancho, 1994), this project focuses on video content accessibility. Unfortunately, accessibility issues related to teaching have been seldom discussed in the literature and their inclusion in audiovisual content offered in university courses is currently very low. It is very common to come across video lessons hard to access because of the lack of subtitles, video players not supporting accessibility features, or other limitations caused by the lack of knowledge of better options.

In a scenario where the universities increasingly invest efforts to provide their expertise in digital video format, we consider the benefits this format can offer to students with disabilities as, more often than wished, they may have difficulties to attend regular

classroom activities. The opportunity to access specific lessons in video format, anytime and anywhere, increases the teaching quality for students in general and for students with special needs in particular. Paradoxically, the video format may present specific barriers for the access to the content by people with hearing and visual impairment if it is not correctly created. In order to allow universal access to the audiovisual contents, several factors should be taken into account: captions and audio description should be integrated, an accessible player should be used, images should be clear... The mutual connection of these factors is what is known as “the accessibility chain of audiovisual contents on the Web” (Moreno et al., 2007), and includes three main principles: “The video must be accessible itself”, “once the web page includes the video, it must still be accessible” and “the interaction with the user must be accessible”.

3 Outcomes of the project

The following list shows the outcomes of the project:

1. A short video (5–10 minutes) focused on raising awareness of accessibility in multimedia, and in particular of the importance and benefits of subtitles, audio description and accessible players (<http://www.youtube.com/watch?v=d-IUOW-iGsa4>). The video fulfils two basic functions: first, it supports the dissemination of the activities of the project and, secondly, it is used as a pilot for all the tools in the project.
2. A PowerPoint presentation, parallel to the video, was also created to demonstrate its conversion to an animated audiovisual with integrated accessibility.



[Fig. 1] Example of a slide from the Power Point presentation

3. An audio track with audio description of the video and subtitle files in Catalan and Spanish in SRT and Timed Text format.

4. A set of guides designed to give step by step information on how to create, edit and upload accessible videos with practical recommendations for immediate implementation. We delivered these guidelines with Creative Commons licence in order to allow their dissemination and growing. As an illustration, Figure 2 shows an example from a guide on how to include subtitles and audio description in a video.



[Fig. 2] Example of a page from the guide of CapScribe.

The guides have been created to support mainly professors in higher education, but they are expected to be useful for a broader audience. The guides are:

- Guide on how to plan and prepare accessible videos. The guide includes contents related to principles and techniques for making an accessible video, rights and licenses of use. At the same time, it describes the process of preparation and creation of a script taking into account the accessibility requirements.
- Guide on how to create accessible subtitles with different tools:
 - Caption Tube, Universal Subtitles and VSync for the creation of subtitles within Youtube or in any other platform online;
 - Subtitle Workshop, a free tool for the creation of subtitles locally (for Windows);

Showing the benefits of subtitles for retrieving information and internationalisation, as well as giving guidelines to convert the subtitles to timed text format, the only with positioning and styles for different types of information and characters.

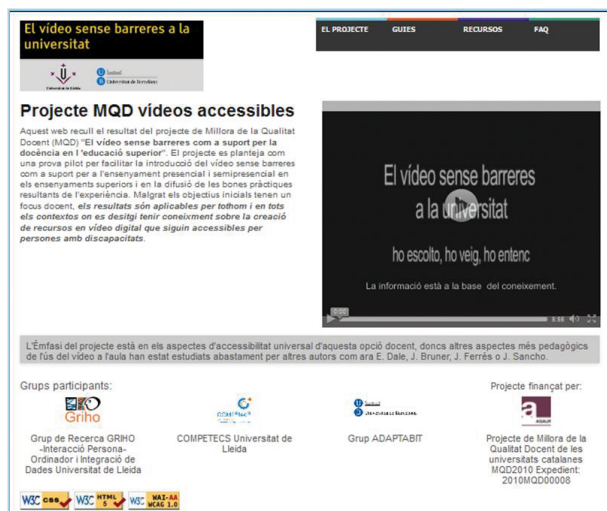
- Guide on how to create an audio description with CapScribe, an free tool for the creation of subtitles and audio description for digital video (for Mac).

- Guide on how to create an accessible player with different tools:
 - HTML5
 - CCPlayer
 - JFLV Player

Showing the requirements of keyboard access, labelling of controls, ...

- Guide on how to convert a slide presentation to a video with subtitles and a narration with Camtasia Studio, a commercial tool extensively used by staff in higher education.
- A guide on using automatic speech recognition for creating the initial script with Dragon Naturally Speaking and Audacity tools, which cover many more languages than other Internet tools.
- A guide to create a SCORM package from a video resource with accessibility information included for its use as a learning resource in a LMS, such as Moodle, Sakai etc.

All the guides were demonstrated with the pilot video and pilot PowerPoint slides and another outcome of the project was a set of files which can be download from <http://www.videoaccessible.udl.cat>.



[Fig. 3] Screenshot of the homepage of the project's web.

4 Conclusions

The technology transfer is one of the main purposes of the project and its predominantly applied nature allows the products to be available to the educational community. We therefore present different materials for raising awareness on the need to incorporate accessibility in video production, such as a multimedia presentation, a short video and also step-by-step guides for the creation and production of accessible audiovisual material with affordable technologies. The project reports briefly the possible barriers to universal

access some platforms may have and it recommends the most affordable publishing options to avoid them and guarantee the accessibility to the content.

Different useful tools are recommended to empower university staff to create accessible audiovisual content with basic knowledge and skills or to add accessible features to an existing video in the most common formats.

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UNE 153010 Subtitulado para personas sordas y personas con discapacidad auditiva. 2012.

Accessibility Issues in Digital Mathematical Libraries

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Keywords: accessibility of mathematics, canonicalization of mathematics, searchability of mathematics, digital mathematical libraries, MathML, Czech Braille

Abstract

The growing number of digital libraries does not serve only metadata of scientific or educational documents, but also the full-text data themselves. This brings new possibilities but also accessibility issues to cope with when designing user interfaces for exploratory search and accessing and reading the full-texts that are usually provided only in some version of PDF format.

We have participated in the design and solutions for the European Digital Mathematics Library (EuDML) and also participated in the preparation of primary data of the Czech Digital Mathematics Library (DML-CZ). In the paper we describe the developed technologies addressing Braille output of document content including mathematical formulae, document preprocessing and enhancement that increase accessibility, readability and exploration qualities (similarity of mathematical documents) of the documents in digital libraries of texts for tertiary education and research in STEM domain.

1 Introduction

The amount of digitally available and processable scientific texts and data grow at the unprecedented pace. Even small part of the scientific output that is peer reviewed and published in a controlled way (journals, proceedings, books) to be used for research and (tertiary) education is big and steadily growing. The chance that at least negligible amounts of this valuable scientific output are processed manually to be accessible for people with disabilities is very low. Ensuring accessibility of wide range of scientific document types produced by wide range of the ICT-Information and Communications Technologies (EIT) is limited to small isles of literature used for educational purposes enforced by the Law enacting Section 508 in the USA. This does not cover research literature, blogs or Linked data, a must in today's research communities at universities. The remedy might be that publishing work-flows are adapted so that information is processed in as rich and as semantic forms as possible. Specifically challenging in this respect is the Science, Technology, Engineering, and Mathematics (STEM) domain full of mathematical formulae, diagrams and other two-dimensional structures appearing in STEM literature.

Validated publications and data are stored in the digital libraries. The growing number of digital libraries does not serve only metadata of scientific or educational documents but also the full-text data themselves. This brings new possibilities but also accessibility issues to cope with when designing user interfaces for exploratory search and for accessing and reading the full-texts that are usually provided only in some version of PDF format.

1.1 Accessibility in Digital Mathematical Libraries

We have participated in the design and solutions for the European Digital Mathematics Library (EuDML, <https://eudml.org/>) [18] and also participated in the preparation of primary data of the Czech Digital Mathematics Library (DML-CZ, <http://dml.cz/>) [4]. In both projects we have addresses several accessibility issues and designed the workflow so that available literature is as accessible, searchable and explorable as possible. In this paper we describe the developed technologies addressing Braille output of document content including mathematical formulae, document preprocessing and enhancement that increase accessibility, readability and exploration qualities (similarity of mathematical documents) of the documents in digital libraries of texts for tertiary education and research in STEM domain.

In the next section we briefly introduce mathematics processing in EuDML and necessity of canonicalization of math formulae. Section 3 refers about accessible formats and developed tools used in the EuDML workflow. Paper closes by conclusion and summary Section 4.

2 Mathematics Processing in EuDML

The EuDML is a Digital Mathematics Library that collects published scientific literature in a ‘one stop shop’ for math students and researchers. Metadata of related published items are collected via OAI-PMH protocol and most items are ingested including their full-texts in various formats as agreed with project data providers. There are papers that have more formulae than plain text, even in the metadata (titles, abstracts), and even leading edge NLP and machine learning tools are not designed to cope with this gracefully. Full texts are processed internally and enhanced [15] so that added value information could be computed by carefully designed automated workflow and presented to the users of EuDML portal.

2.1 Workflow

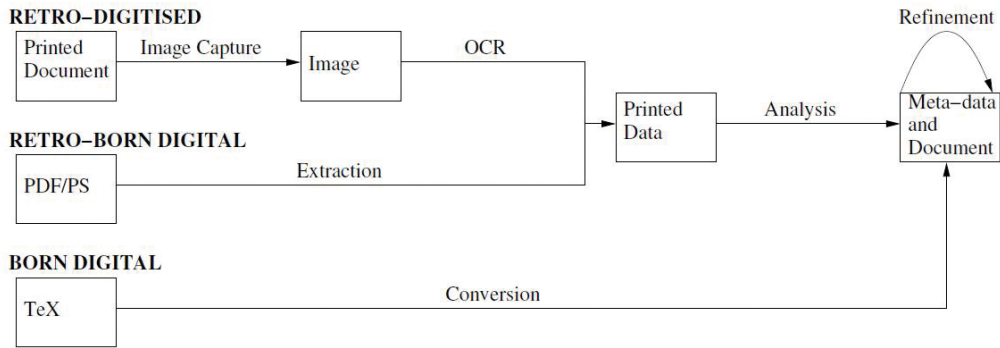
Top-level workflow is depicted on Figure 1. Ingested items are of various origin – some were digitized and available as scanned bitmaps and need Optical Character Recognition (OCR), some were created digitally by different publishing tools and provided in various forms of PDF, PostScript or even [X]HTML and need extraction. Some are in the primary (L^AT_EX) format and need conversion. Workflow tries to create all available data in one homogeneous format. Namely plain text with math formulae in W3C standard MathML: *plain math-text*.

To get plain math-text for further enhancements two frameworks are used:

- **Maxtract** for conversion of born-digital PDF to plain math-text. [3]
- **InfyReader** for OCR of other documents (usually rendered to series of page TIFFs or bitmapped PDF) to plain math-text. [17]

(For further information see Section 3 on page 92.)

Plain math-texts are generated from rich internal document representation that both tools create by sophisticated layout analysis algorithms. As this primary information is visual it is really hard to convert and disambiguate it into useful semantic markup (Content MathML [2]).



[Fig. 1] EuDML enhancement workflow

2.2 Canonicalization

Widely used language for encoding of mathematical content in digital mathematics libraries is MathML. [2] MathML encoding exists in two forms – Presentation and Content. In contrast to Content MathML encoding which grabs the meaning of formulae, Presentation MathML encodes appearance of the formulae. Thus, there is a lot of different possible encodings of mathematical statements with the same meaning using Presentation MathML. As Presentation MathML is widely used in the real world documents we have to cope with, this encoding has been primarily supported in our math-aware search engine [14]. The ambiguities that Presentation MathML bring, however, are issues not only for mathaware search engines but also for accessibility of mathematical documents. The same looking formulae may describe different mathematical notions, different content. For our processing, we have to pick up some canonical representation of formulae which should be as disambiguated as possible.

Our first attempt was use of UMCL (Universal Maths Conversion Library)¹. [1] The main purpose of the UMCL toolset is the transcription of the MathML formulae to Braille national codes. However, part of the translation process is also canonicalization of input MathML intended to eliminate ambiguity of inputs and thus making it easier to translate it to the Braille national codes. The canonicalization module was implemented as a set of XSL transformations. These XSLT stylesheets were extracted from the UMCL toolset and we tried to use them for canonicalization of MathML inputs of our math-aware search engine.

Unfortunately, the use of the UMCL canonicalization module appeared to have severe deficiencies. Firstly, use of XSLT was not fast enough for processing of large amounts of data that are necessary for routine operation of math-aware search engine in digital mathematics library as large as EuDML. Secondly, and more importantly, the implementation of the UMCL module proved to change semantics of input formula during the transformation (see Listing 1).

¹ <http://inova.ufr-info-p6.jussieu.fr/math/umcl>


```

<math xmlns="http://www.w3.org/1998/Math/MathML">
  <mfenced>
    <mrow>
      <mi> a </mi>
      <mo> + </mo>
      <mi> b </mi>
    </mrow>
  </mfenced>
</math>

<math xmlns="http://www.w3.org/1998/Math/MathML" id="formula0:1">
  <mrow id="formula0:2">
    <mrow id="formula0:3">
      <mi id="formula0:4">a</mi>
      <mo id="formula0:5">+</mo>
      <mi id="formula0:6">b</mi>
    </mrow>
    <mrow id="formula0:7">
      <mo id="formula0:8">+</mo>
      <mi id="formula0:9">b</mi>
    </mrow>
    <mi id="formula0:10">b</mi>
  </mrow>
</math>

```

[Listing 1] UMCL inputs MathML encoded formula $(a + b)$ but outputs MathML encoded formula $a + b + bb$.

Taking into the account insufficient speed of the XSLT and complexity of the original solution we decide to abandon this solution and implement our own MathML normalization tool. [6] Canonicalization is going to deal with both Presentation and Content MathML. Almost all visual markup is deleted as it is not bearing semantic information. Also, different notations are unified into a canonical one. As outlined in [13] future version of the canonicalizer should take various *semantic annotations* in the context of formulae to disambiguate terms in a formulae² or even convert Presentation MathML to a Content one.

3 Accessibility Formats in EuDML

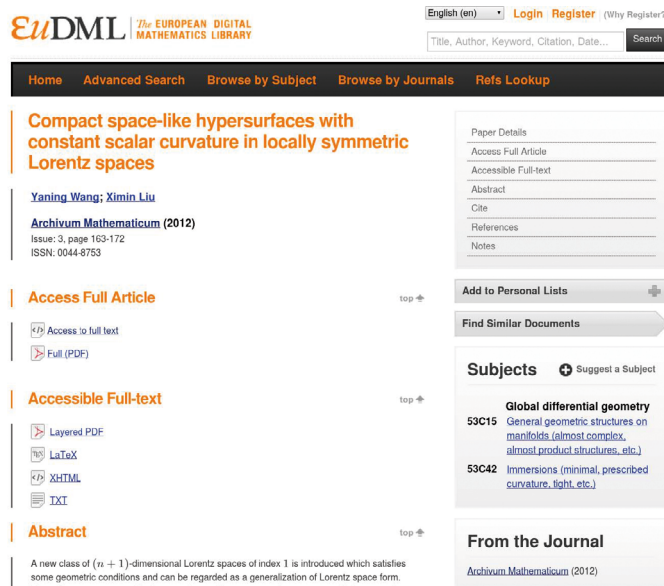
When evaluating accessibility options for EuDML, in addition to the plain text with math read as text, several math accessibility formats were identified [16, Section 3.1]: Braille with Math, DAISY XML, canonical MathML by UMCL and HRTeX (Human Readable TeX) by InfyReader. We have opted for supporting as many formats as possible given the process to create them is *fully automated* during internal enhancement processes [15].

² Is f variable, function or functional?

Maxtract³ is capable of preparation of different output formats:

- \LaTeX for use with Tralics (a \LaTeX to XHTML+MathML converter⁴) [8, 5].
- \LaTeX for layered PDF with \LaTeX and text layers.
- \LaTeX for annotated PDF with \LaTeX annotations.
- A simple text file.
- A text file with math in \LaTeX .

These results are consequently available for internal purposes and for transformation to accessible formats (Layered PDF, \LaTeX , XHTML, or TXT) for the EuDML users (see Figure 2).



[Fig. 2] Available accessible formats in EuDML item <https://eudml.org/doc/247009>

In the layered PDF the reader can switch between several copy & paste textual representations stored as separate plates in the PDF documents.

For successful analysis by Maxtract the PDF file must make sole use of Type 1 fonts with embedded encodings. This is not the case for the part of born-digital PDF documents in the digital library as well as for none of the scanned retro-digitized documents. In this case, InfyReader⁵ OCR software can be used as this program has the unique feature of recognition of mathematical expressions in scanned documents. InfyReader accepts various bitmap image formats on the input (TIFF, BMP, GIF, PNG, PDF) and transforms them to \LaTeX , XHTML+MathML and various XML formats. If the quality and resolution of input scans is sufficient, InfyReader produces reasonably good outputs that can be successfully used for preparation of accessible documents.

The widest possible use have text-based formats thanks to simplicity and support in screen-readers.

3 <http://www.cs.bham.ac.uk/research/groupings/reasoning/sdag/maxtract.php>

4 <http://www-sop.inria.fr/marelle/tralics/>

5 <http://www.infyproject.org/>

3.1 CopyMath

pdfT_EX users can enhance their PDF documents with various hidden text information. For this purpose, we can use the ability of pdfT_EX to put into the output PDF document raw PDF commands. Including `/ActualText` to the code of the PDF enables us to provide users with different visual and text information.

```
\documentclass{article}
\begin{document}

Standard text.
\pdfliteral{/Span << /ActualText<\pdfescapehex{\detokenize{Copya-
  ble text.}}>> >> BDC}
Printed text.
\pdfliteral{EMC}
Another standard text.

\end{document}
```

[Listing 2] Minimal example of use of ActualText PDF command use.

For example, PDF documents produced by pdfL_AT_EX from the source code shown in Listing 2 visually presents the following text:

Standard text. Printed text. Another standard text.

However, following text is provided to the use by a PDF viewer when the copy&paste function is used or text search though the document is performed:

Standard text. Copyable text. Another standard text.

To allow users to use this technique as easily as possible for improvement of accessibility of mathematical contents of scientific documents we are experimenting with the CopyMath L_AT_EX macro package. That package should allow user-friendly creation of layered PDF such that mathematical equations could be copy-pasted as original textual L_AT_EX source representation. For details of the approach see [11].

3.2 Textual Output – Reading Formulae Aloud

We have developed MathML-to-text application⁶ that processes XML files that contain one or more MathML blocks (plain math-texts) and converts each such block into plain text to be read aloud. This format can be useful as an input for speech synthesizer software, for computing similar articles [10] or for indexing and searching.

Input file is parsed using streaming API for XML. MathML block is then transformed into simplified DOM model. Based on MathML type, Presentation or Content, slightly different method is used. If both types are present Content MathML takes precedence as Presentation MathML can be ambiguous and unclear. Either way final result will be more or less the same.

Conversion mechanism is able to process most arithmetic operations, trigonometric functions, logical, set, and comparison operations. Many specific operations, for example

⁶ <https://code.google.com/p/mathml-converter/>

limit, summation, product, integral, etc., are also implemented. The same holds for well known mathematical constants, as well as widely used symbols. Based on input parameters, conversion of numbers is also possible. So far only output to English language is supported. Other languages may come in the future. Output file is a valid XML file with all occurrences of MathML substituted with converted plain text.

3.3 Braille Output

There is no simple language independent encoding of math in Braille – there are different versions for English, German, French or Czech. We have decided to support Czech version of Braille [7] by the development of the tool converting canonical MathML to Czech Braille [9]. The tool is implemented as one of the UMCL output drivers.

4 Conclusions, Future Work

We have presented our approaches and tools to increase the accessibility of mathematical texts in digital libraries. Our workflow adds math handling to the processing pipe and our tools are able to automate the Braille output generation, production of PDF suitable for copy&paste including math, . . . We hope that this work finds followers to the benefit of students and researchers in STEM domains.

Acknowledgement

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Mathematical Algorithms and their Modication for Blind Students

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1 Support Centre for Students with Special Needs (Teiresias Centre)

The Support Centre for Students with Special Needs provides services for all students of Masaryk University with sensory and other disabilities. Its mission is to guarantee accessibility of all study programmes at Masaryk University [1]. Currently, there are 94 students with visual impairment studying at Masaryk University, 44 of them are blind. As far as students who have taken or will take a course focused on mathematics, informatics or statistics are concerned, there are 13 blind or partially sighted persons (based on information from 31 October 2012).

2 The problem introduction

Formal and physical sciences such as mathematics, statistics, physics etc. are very visual in their nature. We observe several objects concurrently and put them into suitable positions in space or a plane, which helps us understand the relationship between them better and enables us to work with them more effectively. Many mathematical algorithms are based on visual manipulation with objects, e.g. graph theory, linear algebra, and calculus. How can blind students use a given mathematical algorithm in view of the fact that they work in linear way, which means that they can only follow a very limited amount of information at the same time? It is certainly possible for a blind student to proceed the algorithm in the same or similar manner as his sighted peers do but very often he/she is not sufficiently effective. For people with low vision, it is not easy to find and then work with objects in space: this requires much more time and energy in comparison with the sighted. A suitable adaptation of the algorithm which respects the linear way of processing the information can often be helpful.

In Chapter 4 we start with two well-known mathematical algorithms (polynomial division and matrix multiplication) based on visual manipulation with objects. We introduce several methods of their adaptation and discuss their pros and cons.

3 Principles of mathematical algorithm's adaptation for the blind

When giving instruction, we often face the following task: how to adapt a given mathematical algorithm for a blind student. Our experience indicates several principles which

should be taken into consideration. We will introduce them at first and then explain their meaning:

1. Respecting the blind people's manner of work;
2. Eventual change of the arrangement of objects used during the computation;
3. Effective processing of the algorithm with minimal time and memory requirements;
4. Choosing suitable tools for manipulation with data and objects of the algorithm;
5. The procedure and the result of the computation should be clear to the person who is responsible for assessing the work.

A blind person perceives the information in a different manner than people who can fully use their sight. When following a given mathematical algorithm or text we usually prefer a suitable spatial arrangement of objects to

1. represent relations between them,
2. find them more easily and
3. examine their details promptly.

By contrast, for blind people such an arrangement often entails a barrier. When looking for a specific piece of information they spend a lot of time by following other objects and their details which are not important at that moment. They do not have the opportunity to work with objects generally without concentrating on their specific values or properties. With respect to the blind person's manner of processing the information we have to ensure easy and quick access to the objects we actually work with during the computation. Therefore, in many cases, it is not useful to respect their traditional arrangement, although it can help the blind to understand single steps of the computation more deeply when getting to know the algorithm.

Besides choosing the method of adaptation we should also consider which (computer) tools are suitable for manipulation with data and the computation itself. Sometimes, it is enough to open a single file in the standard text editor. Alternatively, a blind student can use a spreadsheet which enables to organize data in rows and columns. In addition, one can work with more than one sheet located in one file. Naturally, this application is suitable for manipulation with matrices. There are other options – to mention just one, the special mathematical editor Lambda supports the speech and braille output and features useful accessibility functions for blind users which help them handle complex and structured expressions more easily.

Finally, it is necessary to ensure that the whole procedure of computation is clear also to the people who supervise and evaluate the work of the blind student. As mentioned above, the adaptation need not respect the original arrangement of objects: the blind student's solution is therefore not understandable to people who are used to the standard procedure of the algorithm. It is thus necessary to explain in advance any deviations from the standard procedure.

4 Examples of two mathematical algorithms' adaptations

In this chapter we introduce two mathematical algorithms and then their adaptations for a blind student. We explain:

1. the polynomial division,
2. matrix multiplication.

The first algorithm is well-known to students in high schools, while the second one usually appears at the first time in the study material aimed for introductory course of mathematics in university.

We shared the proposals of adaptations for both algorithms with participants of the workshop "Typical Mathematical Problems in University Studies", which we gave at the ICCHP Summer University 2012 in Linz, Austria. We received valuable remarks which are also mentioned and commented on in this chapter.

4.1 Polynomial division

4.1.1 Original procedure of the algorithm

If we divide two polynomials f, g of one variable, we arrange them in the same way as two integers we want to divide.

1. We put the dividend f and the divisor g next to each other.
2. We find the terms of both polynomials with the largest degree and divide them.
3. We put the result q_1 of the division next to the divisor g and then multiply $p = q_1 \cdot g$.
4. We put the semi-result p below the dividend f while respecting the vertical alignment of the terms of the same degree.
5. We subtract $f_1 = f - p$ and put the polynomial f_1 below the expression p , again with respect to the vertical alignment of the terms of the same degree.
6. We repeat the procedure with the polynomials f_1, g and receive polynomials f_2, f_3, \dots, f_n , and q_2, q_3, \dots, q_n respectively. The algorithm is finished when the polynomial f_{n+1} is of a lower degree than the divisor g .
7. The sum $q = q_1 + q_2 + q_3 + \dots + q_n$ is the result of the division $f : g$ (so called quotient) with the remainder f_{n+1} .

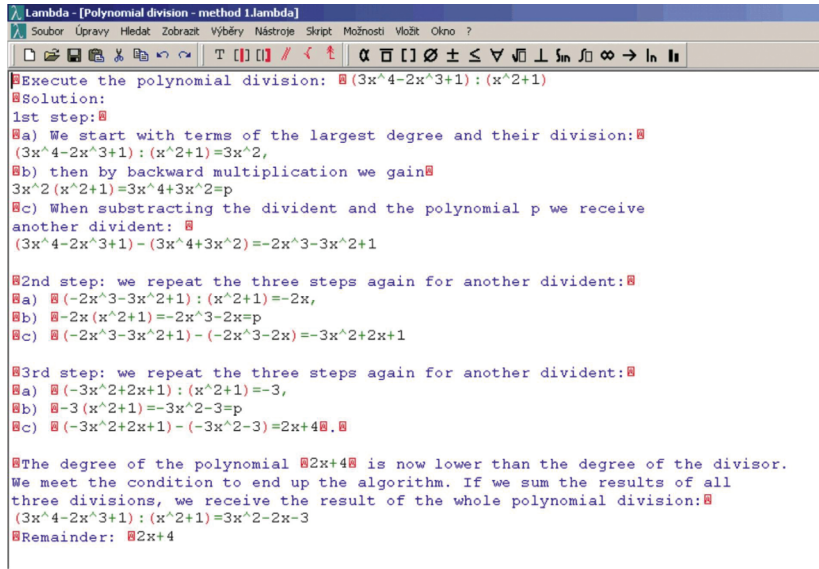
We add one specific example – division of two polynomials:

$$\begin{array}{rcl}
 & (3x^4 - 2x^3 & + 1) : (x^2 + 1) = \overbrace{3x^2}^{q_1} \overbrace{-2x}^{q_2} \overbrace{-3}^{q_3} \\
 f_1 : & \begin{array}{r}
 (3x^4 - 2x^3 & + 1) \\
 - (3x^4 & + 3x^2) \\
 \hline
 -2x^3 - 3x^2 & + 1 \\
 - (-2x^3 & - 2x) \\
 \hline
 -3x^2 + 2x & + 1 \\
 - (-3x^2 & - 3) \\
 \hline
 2x + 4
 \end{array}
 \end{array}$$

4.1.2 Proposals of adaptation

1. Consistent copying of all the expressions which occur during the computation: linear production of polynomials including a short description of each semi-result.

See the example in the Lambda editor:



[Fig. 1] An example of computation in Lambda editor

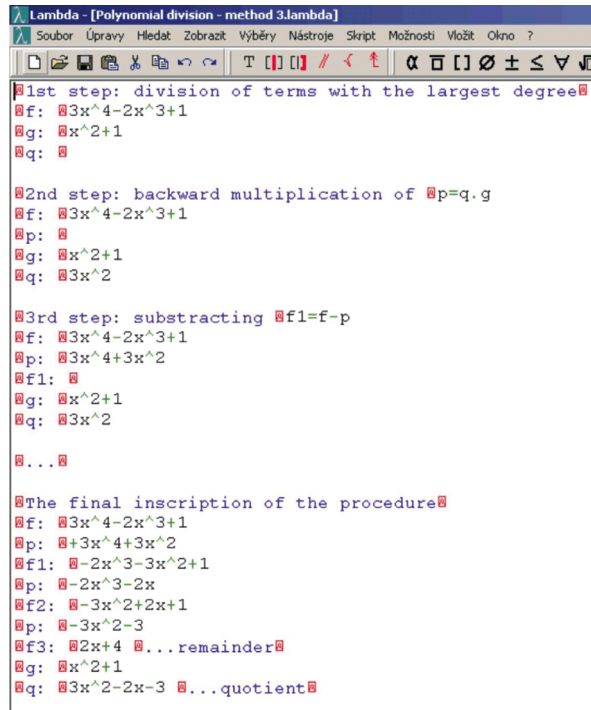
2. Entering the polynomials into a Spreadsheet using only their coefficients: the first row is reserved for the powers of the dividend, the divisor and the quotient, followed from left to right, each two polynomials are separated by an empty column. Other rows are determined for writing down the coefficients which should be located in the same columns as the power of the specific term. We put the polynomials $f_1, f_2, \dots, f_n, f_{n+1}$ below the dividend. See the example of the computation in MS Excel:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	f: x^4	f: x^3	f: x^2	f: x^1	f: x^0		g: x^2	g: x^1	g: x^0		q: x^2	q: x^1	q: x^0	
2		3	-2	0	0	1		1	0	1		3		
3		-3		-3										
4		0	-2	-3	0	1		1	0	1			-2	
5			2		2									
6		0	0	-3	2	1		1	0	1				-3
7				3		3								
8		f3:		0	2	4								
9														
10	Description:													
11	q ... result of the polynomial division													
12	a4 ... remainder after division													
13														

[Fig. 2] An example of computation in MS Excel

3. Entering all the polynomials into one (text) file, one below the other: the method is based on the following fact: In every step of the algorithm, the blind student only works with two input polynomials. He executes a single operation with them and receives the

third polynomial. Therefore, the idea of the adaptation is simple: the student should keep these polynomials together on three following lines. Then he can easily move between them using the keys down arrow or up arrow only once or twice. See the example of the procedure in the Lambda editor:



```

Lambda - [Polynomial division - method 3.lambda]
Soubor Úpravy Hledat Zobrazit Výběry Nástroje Skript Možnosti Vložit Okno ?

1st step: division of terms with the largest degree
f: 3x^4-2x^3+1
g: x^2+1
q:

2nd step: backward multiplication of p=q.g
f: 3x^4-2x^3+1
p:
g: x^2+1
q: 3x^2

3rd step: subtracting f1=f-p
f: 3x^4-2x^3+1
p: 3x^4+3x^2
f1:
g: x^2+1
q: 3x^2

...

The final inscription of the procedure
f: 3x^4-2x^3+1
p: 3x^4+3x^2
f1: -2x^3-3x^2+1
p: -2x^3-2x
f2: -3x^2+2x+1
p: -3x^2-3
f3: 2x+4 ...remainder
g: x^2+1
q: 3x^2-2x-3 ...quotient

```

[Fig. 3] An other example of computation in Lambda editor

4. All the polynomials are organised in three files or sheets of a spreadsheet:

1. We place the dividend and the polynomials $f_1, f_2, \dots, f_n, f_{n+1}$ into the rows of the first file so that we respect their original arrangement set up according to the standard algorithm. If we use the spreadsheet we may describe all the polynomials only with their coefficients as it was done in the second method.
2. We put the divisor into the second file (or sheet).
3. In the third file (or sheet) there are the polynomials q_1, q_2, \dots, q_n which give us the quotient $q = q_1 + q_2 + q_3 + \dots + q_n$.
4. During computation we can switch between these files (or sheets) by pressing the key combination Alt+Tab (or Ctrl+PgUp, Ctrl+PgDown) and modify them all except the divisor, whose value remains constant.

4.1.3 Discussion of pros and cons including the remarks of the workshop participants

We summarize the pros and cons of all the four methods of the polynomial division's adaptation.

The first method meets the requirement stated in the last principle (see Chapter 3). The whole procedure is understandable to the person responsible for supervising or evaluating the work of the blind person – there is no need for additional explanation. Unfortunately, it is not very economic – the computation takes a lot of time and memory of the student. He works with the divisor very often, so he/she has to keep it in his memory or search for it in the previous text – which is very time-consuming. Even when preparing the final result he/she has to go through the whole text and pick up all the particular terms q_1, q_2, \dots, q_n .

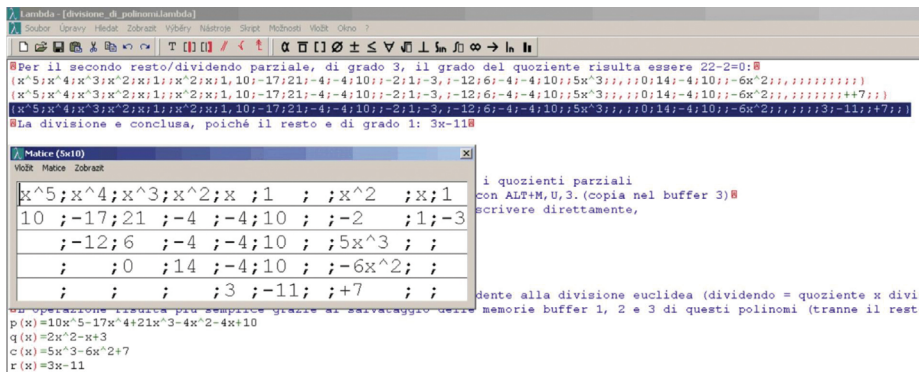
The second method respects the original arrangement of the polynomials which is used when a sighted person performs the algorithm in the standard manner. So the procedure is understandable to the supervisor although he can be confused because only coefficients are used instead of the whole terms of the polynomials. However, the workshop participants discovered several disadvantages:

1. Accessibility of the coefficients is not easy – blind students spend a lot of time moving between three objects and do not have an option to ignore specific values of the polynomials.
2. Additionally, orientation is very difficult – the blind have to make sure very often which power corresponds to the coefficient they have actually reached.
3. If they want to save some time, they are constantly occupied by holding semi-results in their memory as they are looking for a position where to insert them.

One of the workshop participants proposed a possible solution of the problem described in item 2: “If the blind user could immediately get to know the power related to the actual coefficient, it would help him to orientate in the table, for example a simple script or macro which would substitute a lot of keystrokes when moving cursor to the first row and back.”

José Enrique Fernández del Campo offered an adaptation very similar to our second method [4]. His approach is more simple: blind students work only with two groups of coefficients. Prof. del Campo built his method on the fact that the divisor does not change during the computation so we can put the terms (not only coefficients) of the quotient below the powers of the divisor. This approach partially solves the problem described in item 1. The student follows only two groups of coefficients – the objects’ accessibility during computation is easier. We provide an example of del Campo’s method in the Lambda editor. To work with polynomials he uses the tool for matrix manipulation (see fig. 4).

Let’s mention Cristian Bernareggi’s article called “Non-sequential Mathematical Notations in the LAMBDA System” [5], in which he also deals with the adaptation of polynomial division. His proposal is nearly the same as that of Prof. del Campo. The only difference can be recognised in the manner of writing polynomials. Bernareggi uses coefficients only for the dividend and the polynomials $f_1, f_2, \dots, f_n, f_{n+1}$, which are located one below the other. The divisor and the terms of the quotient are placed as whole expressions, not only represented by coefficients.



[Fig. 4] An example of matrix manipulation in Lambda editor

The participants of the workshop evaluated the third method as the most convenient. There is no question of the optimal access to objects we work with during the procedure. In every step of the computation we perform a certain mathematical operation with two polynomials and insert its result into a given position. Therefore it is good to have them as close as possible. At first, the blind student creates an empty line for inserting the result of the operation. Then he moves between two input polynomials by pressing only one key. He performs the operation very easily without occupying his memory too much and then saves the result above or below two actually processed polynomials. This approach also provides an easy access to objects which we will process in the following steps of the computation. The final inscription of the computation is not immediately understandable to the supervisor because it does not respect the original arrangement of objects we work with during the standard procedure of the algorithm. But if the student is consistent in writing all the polynomials including their names in front, then a short explanation at the beginning of the computation should be sufficient.

Finally the forth method offers the same advantage as the third one, that is the easy access to polynomials we actually work with. It is not very useful when the blind student wants to present the inscription of his/her computation to the supervisor. All the polynomials are divided into three files (or sheets), therefore the teacher evaluating the work of the blind student has to continuously switch between them, which is not comfortable for any sighted person. For this reason, the student should help his teacher and put the content of these three files (or sheets) into a single document after the whole computation has been done.

4.2 Matrix multiplication

4.2.1 Original procedure of the algorithm

To multiply two matrices A , B (in the order as they are listed), it is necessary to meet the following requirement: the number of columns of the first matrix must be the same as the number of rows of the second matrix. If this condition is fulfilled, we usually write both matrices A , B one beside the other and leave some space on the right for the third resulting matrix $C = A \cdot B$. Computing the value of the matrix C in the row i and the column j , we follow the row i of the matrix A and the column j of the matrix B . We mul-

tively relevant values and add these semi-results afterwards. The result of the addition is inserted into the given position of the matrix C .

We provide an example to make the algorithm more comprehensible:

$$\begin{pmatrix} 7 & 6 & 2 \\ -2 & 5 & 4 \end{pmatrix} \cdot \begin{pmatrix} 1 & 2 & 3 & 4 \\ 5 & -1 & 0 & -2 \\ 0 & 3 & 7 & 6 \end{pmatrix} = \begin{pmatrix} 37 & 14 & 35 & 28 \\ 23 & 3 & -2 \cdot 3 + 5 \cdot 0 + 4 \cdot 7 & 6 \end{pmatrix}$$

4.2.2 Proposals of adaptation

1. **Input matrices are printed in braille:** the blind student works with a tactile print where both matrices A , B are written in braille, beside or above each other. He uses a text editor or spreadsheet to put down the values of the resulting matrix $C = A \cdot B$.
2. **All three matrices are inserted in one digital file:** the blind student works with a standard text editor or spreadsheet in which the matrices are listed in one sheet, beside or below each other.
3. **Each matrix is located in one separate file (or sheet):** the blind student can switch between the files (or sheets of a spreadsheet) by pressing the key combination Alt+Tab (or Ctrl+PgUp, Ctrl+PgDown).
4. **The matrices are processed in the Lambda editor:** as already mentioned, the Lambda editor provides users with a special tool for manipulation with matrices which works in a similar way as spreadsheets. The blind student can switch between matrices very quickly by pressing the keys PgUp, PgDown. Additionally he can also insert complex expressions combined from powers, square roots, fractions, Greek letters, etc., which, unlike standard text editors or spreadsheets, are reproduced by a screenreader or a refreshable braille display in the correct way according to the authorized national 8-dot rules.

4.2.3 Discussion of pros and cons including the remarks of the workshop participants

We summarize the pros and cons of all the four methods of the matrix multiplication adaptation.

The first method is useful for students who begin working with matrices. One of the workshop participants confirmed that: “I think that the braille print is optimal to use during the introductory lessons about matrices. The teacher could demonstrate the basic properties of the matrix more easily. Thanks to the braille print a student has a better idea about the arrangement of values in the matrix.”

We also discussed the question of whether a blind person is able to read information in the braille print located at different positions at the same time, and whether he/she prefers the matrices arranged one beside the other or one below the other. The workshop participants declared they did not have a problem with simultaneous reading of two sources of information at different positions. What is more, they do not distinguish between the two types of arrangement of matrices mentioned above. Rather, they confirmed the following

fact: “If values of the matrix are complex, then they cannot be aligned vertically because of their different length; that’s why it is not possible to follow them in columns.”

Therefore they all agree that it is suitable for blind students studying matrices for the first time to use a tactile print as it helps them imagine their structure and arrangement of values in rows and columns better. For those who work with complex values in matrices it is necessary to use the editor Lambda or a spreadsheet.

The workshop participants validated our assumption concerning the accessibility of objects we work with during the computation. Manipulation with three matrices in one digital file (the second method) is too time-consuming and inefficient. One spends a lot of time moving between both input matrices A , B because he has to read through all the values in previous rows and columns. To speed up the computation he can remember the particular row’s values of the first matrix which he multiplies with numbers or expressions located in the given column of the second matrix. At the same time he/she adds up these semi-results. It is absolutely clear that although this approach saves time, it also causes overloading of memory and therefore it can lead to mistakes during the computation.

If blind students manipulate matrices only on a computer, the third or fourth method is optimal. They can access the particular row or column very easily. Additionally, when they leave the matrix located in the particular file (or sheet) and move to the other one, the cursor stays on the position where it was the last time. Therefore if they return to the matrix they do not have to look for the relevant row or column again.

There was a question whether the workshop participants distinguish between 1. distributing all three matrices to separate files or 2. using sheets of only one spreadsheet document. They were not able to recognize any substantial difference between these two approaches, therefore they consider the first option as redundant.

They also appreciated the Lambda tool for matrix manipulation. Expressions including complicated mathematical symbols (powers and square roots, fractions, Greek letters, etc.) are correctly reproduced to the blind user whether by a screenreader or a refreshable braille¹. Standard spreadsheets do not provide users with this kind of service. Finally, the workshop participants suggested the following idea. “It would be useful if the blind person could ask the application to read the content of one single cell, row, or column of the matrix without having to go through all the previous values”. This is a reasonable requirement. For example, if the student intends to analyze the fourth column of matrix B , he/she has to pass first three cells of the first row, which slows down the process of looking for the information.

5 Plans for the future

As mentioned above, we led the workshop “Typical Mathematical Problems in University Studies” presented at the ICCHP Summer University on Maths, Science and Statistics for Blind and Partially Sighted Students held in 2012 (Linz, Austria). Apart from polynomial division and matrix multiplication, we discussed another algorithm (the process) – the function graph analysis. We primarily focused on adapting the task of sketching a graph of the function.

¹ According to the relevant national 8-dot rules.

The ICCHP Summer University 2013 will be held in Karlsruhe (Germany) and organized by the Study Centre for the Visually Impaired Students at the Karlsruhe Institute of Technology. We plan to hold a similar workshop there. It will be focused on basic problems of graph theory, which, however, can also be observed in other parts of mathematics. One of our long-term goals is to find teachers of mathematics or other people interested in the didactics of mathematics for blind students. We would like to share our experience with them and discuss possible solutions and adaptations of specific mathematical problems.

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Evaluating Solutions to Process, View and Listen Mathematical Formula within an Accessible Context

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1 Introduction

Project “Recursos docentes accesibles” – accessible teaching documents – is an action within the Teaching Improvement and Innovation Program at University of Barcelona, whose broad objective is providing templates for the creation of most widespread teaching documents, and easy procedures to create alternate versions of them. Those alternate versions will include changes in colour, fonts or other presentational attributes and also conversions to different digital formats, thus promoting inclusive education in the university by the integration of alternative formats in everyday contents.

Within the mathematics context, this broad objective imposes specific requirements for mathematical notation/formulae. Most word processors process mathematical notation/formulae through a proprietary codification system or, even, through graphical formats procedures, so they are not suitable for assistive technologies like screen readers or screen magnifiers (JAWS). This situation imposes a severe barrier for blind and low vision students when using learning resources within mathematics area. People with dyslexia or ADHD could also benefit from screen readers or changes in presentation when reading mathematical notation/formulae in order to understand them better – even when, for those groups, this solution is not essential.

For a long time, solutions oriented to generate Braille formats have been considered the most convenient for visually impaired students to access the mathematical content, and, specifically, the mathematical expressions (Pontelli & Palmer 2004, and surveys of Jayant in 2006, and Karshmer, Gupta & Pontelli in 2007 which have not been formally published yet). Lately, these solutions have been questioned, as in (Sources & Ferres 2012), which consider them “an expensive and/or slow technology”. Alternative solutions help produce rendered audio of electronic documents. For low vision students, most effective solutions focus on expression magnifiers.

2 Methodology

A testbed was designed with two main components:

- A selection of 139 different formulae, with a good coverage of symbols and expressions, based on the formulas offered by LibreOffice Math 3.3.2, which distinguishes 11 different sets of formulae.

- A selection of three text processors with specific capabilities for processing mathematical notation: MS Word 2007 (12.0.6661.5000) SP3 MSO (12.0.6662.5000) and LibreOffice Math 3.3.2, for office documents; and L^AT_EX MiK_TE_X 2.9 T_EXnicCentre 1.0, for L^AT_EX documents. The selection was based on the results of a survey on the tools commonly used by faculty members in the Department of Mathematics of University of Barcelona.

All the formulae were processed within the editors, in order to obtain evidences of capability and quality on viewing them and listening to them. In the case of MS Word 2007, formulae were tested both on a regular version of the editor, and on an empowered version with MathType 6.0c., from Design Science, a formula editor that allows the creation of mathematical notation for inclusion in desktop and web applications.

Once all the formulae were processed with the three editors, results were converted into MathML, in order to view and listen to them on different internet browsers. All converted formulas were tested on Firefox (on Windows), Opera (on Windows) and Safari (on MAC), which have native support for MathML. After this first test, LibreOffice was discarded as an option. Further tests were done with MS Word and L^AT_EX on IE with MathPlayer plugin.

The test was performed during November 2012, when presentational results were gathered and, in the case of MathPlayer, also results of listening. The evaluation of results involved two different indicators: quality of displays for user visualization and quality of reading for user audition. For the first indicator, values were: not acceptable display; acceptable display; and best display. For the second indicator, values were: MathPlayer doesn't read the formula; MathPlayer reads the formula partially; MathPlayer reads the formula correctly. In this second indicator, the listening was carried out by choosing Spanish language and "reading for the blind" setup option. We have also conducted tests in other languages (e.g. English) and for different settings (e.g. low vision and dyslexia), which are not reflected in the final results.

Results of the tests have been consolidated in an Excel table. Values for indicators are represented both through textual expressions and chromatic codes.

3 Results

Results show that MS Word empowered with MathType is the best solution in terms of number of symbols correctly interpreted; quality of displays for visualization; and quality of readings for audition.

Even when 6 of the selected mathematical expressions were not covered by MSWord+MathType, this last solution provides better displays than LibreOffice. It's worth noting the high quality in visualization of big operators (\sum , \prod , \coprod ...) and resizable delimiters.

L^AT_EX MiK_TE_X 2.9 can't process 11 of the selected mathematical expressions. By default L^AT_EX exports formulas in a nonstandard typography which hinders understanding in viewing and in Mathplayer listening, but this can be corrected in the conversion process.

As for browsers, visualization on IE+MathPlayer of expressions processed by MSWord+MathType is the best solution, although Firefox alone gives better results in comparison with any other browser without plugins.

Opera shows the worst results in recognizing expressions which have been processed by Math LibreOffice 3.3.2 and MS Word 2007, and also in rendering symbols, especially in the cases of accents and delimiters. Only for expressions processed by \LaTeX MiKTeX 2.9, the results obtained with Opera are better than those obtained with Firefox.

Results in viewing with Safari are quite good, as only 13 expressions processed with MS Word 2007+MathType generate not acceptable displays, and 9 expressions processed with LibreOffice-Math generate not acceptable displays. The overall negative aspect that should be noted is that expression accents are too distant from letters, and they don't resize when it's needed.

Concerning the quality of reading for user audition, tests on MS Word 2007+MathType and \LaTeX MiKTeX 2.9 (both on IE+MathPlayer) give the results shown in the following table.

[Table 1] Results of tests on reading for user audition

	Formulas not supported by the editor	MathPlayer doesn't read the formula	MathPlayer reads the formula partially	MathPlayer reads the formula correctly
MS Word 2007 + MathType	6	6	11	116
\LaTeX MiKTeX 2.9	11	66	33	29

As you can see, results are far better for the combination MS Word 2007 + MathType. Dysfunctions focus on expressions that include small fractions (e.g., a/b $4/3$...) and expressions that include symbols $|$ $\{$ $\}$ as delimiters.

4 Further works

Test results will allow us to deliver evidence-based advice to the University professors (and, specially, to the Department of Mathematics) on best options for accessible mathematical formulas within teaching resources. Also, we will advise blind or low vision students about the best options for optimum viewing and listening resources containing mathematical formulas. In addition, some models devoted to mathematical formulae will be included in the catalogue of accessible materials for teachers within the University and advice on how to convert Latex formulas and how to create formulas with MathType will be disseminated.

Next steps in our project envisage developing solutions to make mathematics manipulation processes accessible, further than processing, viewing and reading of mathematical expressions, in inclusive education contexts (Tsonos et al. 2009) (Alajarmeh et al. 2011).

A final point is that we are planning to provide access to result data for external querying and operating.

5 Acknowledgements

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Accessible QTI-Questions

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Keywords: accessibility, QTI, dynamic response, WAI-ARIA

1 Preamble

Learning Management Systems (LMS) are used for supporting teaching in schools and universities and are getting more important. These LMS offer many advantages for learners and teachers. Learners can access teaching material time- and location-independent. Afterwards they can test their learning success. Therefore the LMS supports different kind of answer-techniques, e.g. single and multiple choice, ordering elements by Drag'n'Drop. Some of these techniques use visual interaction like Drag'n'Drop and pairing elements which may cause barriers for users with special needs.

In addition the teachers will be relieved. There exist some editors for creating tests and the LMS checks the completed tests and evaluates the answers automatically. Different standards and programs exist for creating online tests. Current standards for the description of content of learning are Sharable Content Object Reference Model (SCORM) and IMS Question & Test Interoperability (QTI).

Besides commercial systems also OpenSource-LMS are available. Their accessibility and usability is important when selecting a LMS. The accessibility of QTI questions types has been repeatedly evaluated [STROBBE], [LUEPHATTANASUK, SUCHATO & PUNYABUK-KANA]. But interactive question types such as sorting or ordering elements by Drag'n'Drop were not considered. This has considerable impact for impaired and non-impaired users.

2 LMS

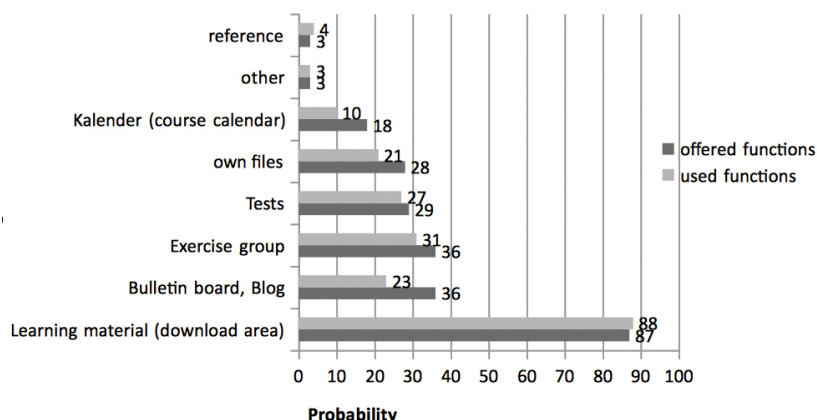
In which way a LMS is used depends on the teacher. A study of the Saxonian Online Platform for academical Teaching and Learning (OPAL)¹ shows that the most often used activity was downloading content like lectures and exercises (see Figure 1). For improving the usage of collaborative functions like bulletin board, shared calendars and online tests our team had evaluated this system with visual impaired persons and worked together with the provider for the realization of our recommendations in later updates.

Our team is also running a LMS called Moodle². The advantages of Moodle are:

- is OpenSource
- tested with visual impaired and blind users (see (PRESCHER))
- modified for enhancing the accessibility
- blind and visual impaired students use our LMS

1 more information <https://bildungsportal.sachsen.de/opal/dmz/>

2 <https://moodle.org/>



[Fig. 1] Usage of the supported function in Opal (N = 2572) [BERGER et al.]

We offer our students tests for their exam preparation and bulletin boards for news, discussions and questions. Both, online tests and bulletin boards are used during the terms and for testing the knowledge of different topics. In another finished project our team has evaluated the accessibility of OPAL³, but the accessibility of presentation and interaction with QTI-Tests was not evaluated.

2.1 QTI

QTI is a xml-based standard format for the representation of assessment content and results. QTI offers different interactions for answering a question (see [IMS Global Learning Consortium]). These interactions are single-Choice and Multiple-Choice (simple), input fields (textbased) and Drag'n'Drop or order/sort elements (graphical) and miscellaneous interactions like sliders.

The format defines new tags and attributes for the description of tests and test-relevant informations like points, the amount needed for passing and duration of the test. In addition some tags and their attributes from XHTML are used in QTI. For example <hx> for headings, <table> for tables and for images. Regarding to the WCAG 1.0 the used XHTML-tags support the accessibility. So the images can be accessible, if the attribute *alt* contains an alternative description.

For the creation (editors) and presentation of QTI-Tests exist different tools. These editing tools affect the generated QTI-file. Some editors do not support alternative information for pictures. It is necessary to add them with another xml-editor manually.

The QTI standard supports additional information like description of pictures in its specification. Furthermore there is no definition in which way the assessment content will be rendered and presented to its user. But often HTML and JavaScript is used for this. And this is the main problem, because the interactive responses are not accessible for assistive technologies.

³ The finish report is available in [Arbeitskreis E-Learning] page 127–145.

2.2 QTI-Player

In our current project it is the main goal to enhance the accessibility of interactive responses in QTI-Test. Therefore different existing QTI-Player were evaluated:

- the qti-player⁴
- jqti and the QTIEngine⁵
- the integrated player in OPAL (Onyx⁶ Webplayer)⁷

The *Onyx Webplayer* is a commercial solution and for the *qti-Player* no documentation of the implementation is available. *QTIEngine* is openSource and its source code is available. So we can enhance the existing QTIEngine. Another advantage is that MathML can be represented. Also the engine validates the QTI-files and shows errors if something is wrong or missing, e.g. no alt-attribute is available for pictures.

The *QTIEngine* transforms the QTI-Tests via XSL to HTML and JavaScript is used for the mouse interaction. But the main problem is that the accessibility was not considered during the development. Therefore we have chosen the QTIEngine.

3 Accessible interactive responses

Different studies show that interactive response can be accessible, if they fulfill current guidelines and specifications like WCAG 2.0, WAI-ARIA and HTML5. Responses like Drag'n'Drop and sort elements can be accessible. Therefore just HTML5, ARIA, CSS and JavaScript is required.

3.1 Moused-based quizz techniques accessible for visual impaired people

Based on QTI, HTML5, CSS and WAI-ARIA different kind of interactions are developed and tested with blind and visual impaired users. During the pretest blind users were asked what kind of interaction they prefer when asked to sort a list of multiple items. The result are two kind of interactions: *select'n'move* and *select'n'paste*. In addition a concept Drag'n'Drop is developed and tested.

3.1.1 Select'n'move

Select'n'move is performed by selecting/grabbing an element and moving it via the arrow keys to the current position. During this interaction the user gets the auditive feedback like "Item 5 is insert between element 4 and element 6". If the selected item is moved to the first or the last position of the list. The feedback is "The selected element is first/last element of the list".

3.1.2 Select'n'paste

Select'n'paste is performed by selecting an element and moving the focus. With second selection the selected element is pasted at the focussed position. The selected element

⁴ <http://code.google.com/p/qti-player/>

⁵ <http://www.qtitools.org/landingPages/QTIEngine/>

⁶ The Onyx Testsuite contains an editor, a player, a converter and reporter more information are available at <http://www.bps-system.de/cms/en/products/onyx-testsuite/>.

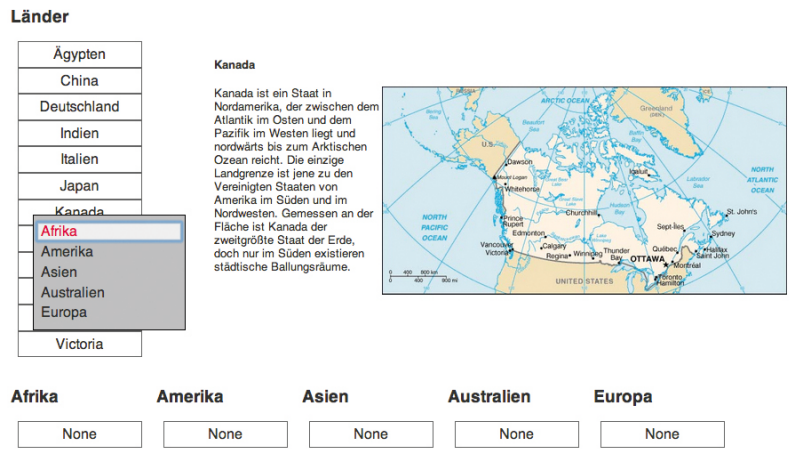
⁷ The Onyx Webplayer can be tested at <https://demo.bps-system.de/onyx/>.

is pasted between the selected and the following element. This is nearly like *copy’n’paste* with keyboard in many programs. The difference is that the selected element is not copied to another position. Because each element is unique and duplicates are not allowed.

During the interaction the focussed element is spoken by the screen reader. The problem with the interaction is to handle the first and the last elements of a list, because the old element has to be moved up or down in the order of the list. So the first element has moved to the second position if it is replaced by focussed element. And vice versa for the last element. The auditive feedback is the same like for *select’n’move*, but the user just heard it after pasting the element.

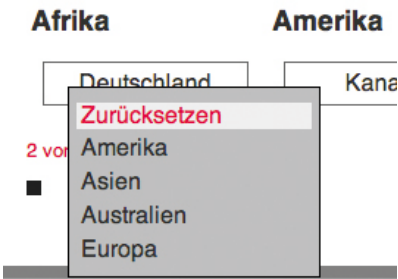
3.1.3 Drag’n’Drop

A accessible Drag’n’Drop was evaluated in [HEIMER]. This concept is using a pop-up menu for selecting the drop target (see Figure 2). The user can focus the draggable element by using the arrow keys. If the user selects an item by pressing space a popup menu is shown where all drop targets are listed. In figure 2 the countries should be sorted to the correct continent. In a hidden live-region the visual changes are verbalized. For this Drag’n’Drop the text is “Canada has moved to America.”



[Fig. 2] Accessible Drag’n’Drop via a pop-up menu [HEIMER]

The reversibility of a mapping can also be changed with the pop-up menu (see Figure 3).



[Fig. 3] Pop-up menu of a dropped element

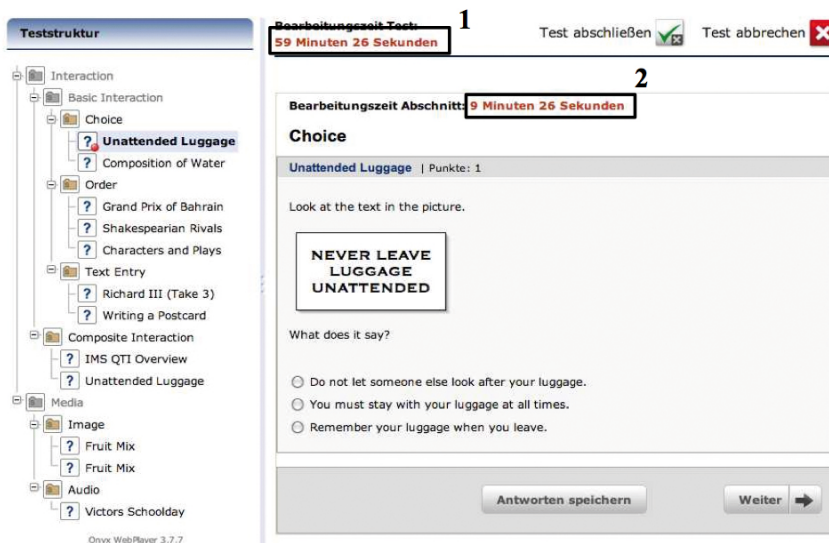
3.2 Pre-Evaluation

These concepts were tested with a small group of blind users (n=2). After a short time of training the subjects had to order the countries to the correct continent. Firefox and the screen reader Non Visual Desktop Access (NVDA) were used for our test. The latest version of Jaws (Version 13) was not used for the tests til now. Tests with more users are planned.

4 Accessible interactive Responses

In 2.1 is explained why we have chosen the QTIEngine. We are developing a solution based on the latest standards HTML, JavaScript, WAI-ARIA. The main goal is that all visual interactions and changes of the content are accessible and usable for visual impaired users. Therefore we have to enhance the QTIEngine and develop the accessible dynamic interactions.

The new user front-end of the test presentation has to be customisable to the special needs of each user. For example the tests also have time limits for different questions and/or for the whole test. In Figure 4 the red text above shows the time for the whole test and the second red text the time for the current section. Also the progress of the test has to be readable by the assistive technologies, like watched, answered or not watched task (tree view on the left side).



[Fig. 4] Presentation in the Onyx-Webplayer

In our solution⁸ the user will be able to customize the live-regions for their needs. For example the time is just read every minute for the section (frame 2 in Figure 4) and for the whole test (frame 1 in Figure 4) only on a defined keypress. The developed solution will be also openSource and the accessible implementation of the dynamic interactive responses can be imported and used on other websites.

⁸ The implementation has just begun and is in an earlier stage.

5 Conclusion

The standard QTI supports the accessible delivery of tests by using the XHTML-tags. So alternative information can be added and tags for structuring the content are defined. By using technologies like HTML, WAI-ARIA, CSS and JavaScript dynamic web pages and particular Drag'n'Drop are accessible for assistive technologies. All three proposed accessible interaction techniques are subject to preferences of an individual user. Besides it is necessary that the users can select a interaction technique and ARIA-attributes live-regions like timer or scores have to be adaptable.

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Automated Process to Create XML Based Non-Fiction Books from Scratch Making them Accessible for Blind Students on Devices like Tablets

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Keywords: DAISY, XML, structured document, work flow

Abstract

There are different ways to make fiction and non-fiction books accessible, whether as Braille, large print or DAISY audio books. For this structured sources are needed. Structuring a document manually consumes much time.

This document introduces a production software tool kit developed at the German Central Library for the Blind (DZB) in Leipzig. It aims to support structuring complex books both automatically and manually. The goal is to cover 95 % of recognition fully automatically leaving the rest for manual improvement. Other aims are accessible tools, OCR improvement, easy editing, media specific labeling, generation of different media and embedment into work flows.

As an example the tools allow to produce HTML pages that can be presented on tablet computers and used in lessons. It is possible to create a fast and comfortable access to non-fiction books at the level of modern means of communication.

1 Introduction

Traditionally DZB Leipzig focused on providing educational materials for visually impaired persons. Throughout several decades the production has been reduced more and more to fiction books whose production is less time consuming, complicated and expensive. In this situation DZB decided to refocus on non-fictional books that have to be produced with uttermost expense. To grant access to those books which are desperately needed for educational and professional purposes, DZB established the project Leibniz which shall simplify the production of these books.

When analyzing production techniques, several groups can be described:

1. One technique is to use simple OCR software, mostly focusing on “simple” books without much structure like fiction books. DZB for example has been using Finereader¹ and HBS² to produce fiction books for many years.

1 Finereader (2011)

2 HBS (2011)

2. Another technique is to use highly structured (“perfect”) outcomes from publishers which are entered via XSLT scripts into an XML-process like DAISY-Pipeline regarding to both fiction and non-fiction books³. In fact at the moment not the many books have accessible XML sources. This will change in future.

Beside it, different software recognizes content from scratch accepting that publishers’ outcomes are not perfectly structured. Especially those can be of different generality and usability. The InfyReader⁴ which internally uses Finereader for example focuses on mathematical texts while the TGA⁵ software focuses on graphics.

Between September 2009 and December 2012 DZB has been working on the project Leibniz which has been supported by the German Federal Ministry for Labor and Social Affairs. It had been announced on DAISY 2009 in Leipzig⁶ and presented on Braille 21 in Leipzig⁷. Three additional software developers and the project coordination have been financed by the project. With the help of DZB’s internal software developers and several student works, four main problem areas of producing non-fiction books have been addressed:

1. Automated recognition and structuring of scanned sheets (*core* part for of the project)
2. Editing of structured documents with respect to the needs of a publisher of media for visually impaired (*LEdit* part of the project)
3. Tools to provide an export to HBS (Braille) and HTML
4. Embedding the tools into working processes

Why don’t we just use commercial software for production? The reason is that commercial tools for sighted people have some disadvantages:

1. They focus on what a person can see, but this is mostly layout information. For that reason the quality of the data isn’t sufficient.
2. Editing XML documents in fact *means to edit XML* which is quite complex for Braille transcribers, most of whom have never had contact with it. Furthermore, it is often quite confusing, as there is a mix of tags and attributes, which can contain real content or just be labels. Furthermore those tools can be called non accessible if accessibility includes effective work for visually impaired persons.
3. The description of media specific aspects like special definitions of Braille symbols, printing colors or articulation of a word, is of utmost importance and must be supported.

2 Accomplishment

The following components will help to reach a semi-automatic production of media for visually impaired: automated recognition tools (*core*), editing tools (*LEdit*), translation

3 Egli (2009)

4 InfyReader (2003)

5 TGA (2007)

6 Kahlisch (2009)

7 Leopold (2011)

tools and workflow processes as mentioned in the introduction. Those tools should be as flexible and open as possible to be able to fit them to different workflows and environments. This means that the different components must be as independent from each other as possible. This is enabled by the definition of interfaces between the different components and concepts as well as by reducing their complexity.

2.1 Input Document Sources into the System

To input scanned images into a work flow is quite complicated when thinking in working processes. Problems arise like those of versioning, description, preparation (for example color reduction to save space), scheduling (of which ones should be processed next). DZB Leipzig organizes its data and processes within a data base called *media data base* developed at DZB Leipzig. Leibniz workflows have been connected to it without insisting on it.

2.2 Automated Structuring of Document Sources using core

Sources of scientific books could be printed books as well as electronic documents from publishers. While DZB once focused on both scanned images and getting PDF documents into the work flows we now only prefer scanned images which by the way can be easily produced from PDF.

The reason why we don't read content from PDF but from images is that: Printing PDF to images produces best quality sources that nearly never occur any kind of problems with OCR, or color normalization. On the opposite reading out the content using interfaces like PDFBox⁸ offer a load of unforeseen problems like obscure glyph encoding, curious accent drawings, exotic color models or hidden content. In fact they are not well supported by common PDF interfaces.

Next steps are automated processes. Firstly image quality is bettered by straightening, color normalization etc. Afterwards the pages are segmented. Each segment is assigned a base property: text, area, image, line or garbage. Text segments are further analyzed: recognize tables or paragraphs, multi column set etc. Different methods improve the text segments before OCR is started. As OCR software commercial software like FineReader or Omnipage⁹ can be used as well as free software like tesseract¹⁰ or cuneiform¹¹. After analyzing different engines DZB found out that Omnipage is the best software for our purposes¹². All these steps are working page wise.

Now the data of all pages are concatenated to one document. Colors and font sizes are normalized; front and back matter are separated (because their setting can substantially differ from the actual book). Each segment of the book is described by their formal properties like color, indentations, locations, text contents etc. Those are the base for tagging the segments with substantive meanings like *section title* or *page number*. Thereby segments having similar formal qualities are assigned the same meaning following the

8 PDFBox (2012)

9 Omnipage (2011)

10 Tesseract (2011)

11 Cuneiform (2011)

12 Kanitz (2010)

assumption that the underlying book has been well set. To describe the relation between different meanings, the document is fit into a document tree which describes the document. Meanwhile, complex relations are linearised to preserve the correct reading order.

The process described above is designed to work fully automatically on a server which we call core. The input is scanned book pages as well as PDF documents which we print to images. The output of the core is a highly structured electronic document which is called LeibniX package. Input and output are well defined. That reason for the core can easily be embedded into different workflows.

2.3 LeibniX Package and LeibniXML Data Format

The LeibniX package contains a structured LeibniXML document and further information like images etc.

The most time consuming work is to correct and enrich the output of the core. Therefore all tools, data formats, controls, workflows, definitions etc. are designed with respect to it. A proper LeibniXML has been developed to support extensibility, a simple usage (which means easy to edit) and a consistent control. LeibniXML is embedded into the LeibniX package mentioned above, which is the interface between the core and the editing tool LEdit. The LeibniX package contains miscellaneous that support the transcriber's work, too. Those are thumbnails, images, paths to source files, special character information etc.

LeibniXML concentrates on production. For distribution it should be transformed to other formats like DAISY.

The first main idea of LeibniXML is to describe all contents by tags and all forms by attributes. Contents influence the target media while attributes do not. This allows the transcribers to concentrate only on tags while formal aspects (attributes) are hidden. Furthermore LeibniXML is extensible to new contents like math or music notation without having to adapt LEdit or core.

The second main idea of LeibniXML is only to define hierarchical relations neglecting aspects like sequential relations or quantities.

The third main idea of LeibniXML is not to mix tags and text.

When extending the underlying LeibniXML schema these rules must always be considered.

This concept makes editing an XML document very easy, as it supports relations of real importance like hierarchies that cannot be ignored by the transcriber. It should be clarified that aspects like sequential and quantitative dependences are over all delimited by the book itself. If those aspects are ignored, the book can be recognized as miss-structured beside any definition of any schema or dtd. For example if the bodymatter is before the frontmatter then this is not mainly a question of whether a schema is fulfilled or not, but a fundamental mistake with respect to the underlying book. By the way, there is a special view within LEdit highlighting those mistakes.

2.4 Manual Post Processing of Automatically Structured Documents Using LEdit

LEdit is a special editor to work on LeibniX packages. LEdit is not designed to be used to generate structured documents from scratch. It focuses on editing and improving the

LeibniX package. LEdit prevents from producing erroneous documents without limiting the transcriber too much. This is done by a combination of assistance commands, restrictions and liberties.

2.4.1 Leibnix Language

The LeibniXML file is quite complex. To advance the usability to the user the presentation is done using a special notation called Leibnix which is quite similar to L^AT_EX notation. The document itself is always fully represented as LeibniXML, while the user's view reduces the document to its content showing the tags as Leibnix elements. For example all attributes of LeibniXML are hidden from the user. A Leibnix element can have two different forms: whether

```
\cmd[content]
```

which is used for most commands and alternatively

```
\begin{cmd}
content
\end{cmd}
```

which aims to be used with elements having long ranges like title levels. It can be configured for each element which of both forms shall be used.

A special notation of Leibnix' elements are those which are media specific. For instance elements that are restricted to Braille output are notated via

```
\braille:cmd[content]
```

respectively

```
\begin{braille:cmd}
content
\end{braille:cmd}
```

As an example: while one LeibniXML file has a size of 1.3 MByte the corresponding Leibnix only needs 250 kByte.

2.4.2 Basic functionality for editing

LEdit provides a set of basic functions on elements. During editing basic functions can be combined to more complex working steps which are the base for the editing workflows.

Basic functions are:

1. copy (restricted to text), cut, paste
2. create, replace
3. delete, delete keeping the content
4. split, merge
5. shorten and extend range (restricted to inline elements)
6. switching neighbouring elements (not on inline elements)
7. raise or lower global titles (restricted to level elements)

All commands can be reverted. They all work context sensitive. Some are limited to a special element class like block elements or level elements.

During editing basic functions can be combined to more complex working steps which are the base for the editing workflows.

2.4.3 Views

Views are bound to a couple to tabs which are located normally to the right of the document. They provide different tools. These are:

1. Document view
2. Figure view
3. Source view
4. Selection mask
5. Help view
6. Visualizations

The **document view** offers a look onto the document which is represented by normalized pages. Elements and their classes (level elements, block elements, etc.) are indicated by colors and frames. When clicking in one of both windows the other one is synchronized. The **figure view** allows managing figures which are embedded in the document. They are the base for producing large print. The **source view** can be used to display the scan pages. It is equally good to the book. A special feature is the **selection mask** which offers a specific view on the document.

Restrictions are:

1. Leibnix element names (paragraphs, figures, figures and tables, ...)
2. Formal parameters (green backgrounds, large letters, ...)
3. General similarity of elements
4. Text content

With the help of the selection mask, e.g. all italic texts on blue areas or numeral texts in the upper left corner can be found and selected. When using a mapping command like replacing or inner tagging on a selection the document can be structured book wide at once.

Further restrictions are planned: for example element locations could be restricted. For example all page numbers that look like images could be selected (and altered) when combining image element selection and location selection.

2.4.4 Visualizations

Visualizations are additional tabs within the view. The LeibniXML document is transformed by command shell scripts or XSLT scripts to an HTML document which is displayed. Examples are HTML output, HBS output for Braille production and a hint view that points to mistakes and errors in the document. New visualizations can be easily added by configuration without having to modify LEdit at all. All visualizations are fully synchronized with the LeibniXML document which means when clicking into one then the other is synchronized.

2.4.5 External macros

External macros are very similar to the visualizations. They are XSLT or command shell scripts which are executed on the LeibniXML document. The result of the transformation is LeibniXML again overwriting the actual document.

2.4.6 Export

Export scripts (XSLT or command shell scripts) work similar to the macros and the visualizations. The result of the transformation (HTML, HBS) is stored to a file.

2.4.7 OCR Checking and Character Modification

OCR recognition processes produce a special class of mistakes differing much from spelling ones. Typical spelling mistakes such as turns of two letters, two capital letters at the beginning of a word, mismatching neighboring letters like “e” and “r” hardly ever occur when running an OCR on a textual graphic. On the other hand, OCR mistakes won’t occur when typing a text. Those could be mismatching “l” and “I” or “rn” and “m”, which is caused by their optical similarity. LEdit concentrates on typical OCR mistakes allowing highlighting “candidates” and offering a tool to get rid of them.

2.4.8 Extensions

Beside the qualities and possibilities of LEdit, there are always special data formats and editing tools whose reimplementation or replication is not useful or suitable. Those formats could be MathML or SVG for graphics representation. Those data can be embedded or linked into LeibniXML, e.g. by defining a svg-tag to which an external graphics editor¹³ can be bound by configuration.

2.4.9 Configuration

The configuration distinguishes between two different modes. The first one is user specific and allows configuring aspects like colors, scripts, presented visualizations, etc. The second one aims at an overall “transcriber administrator” who is allowed to modify the behavior of LeibniX language, adding and removing visualizations and external macros, assigning context sensitive help files, defining short cuts, extending LeibniXML schema etc. The administrator’s changes affect all LEdits within the editor’s group.

2.5 *Generating Different Media for Visually Impaired*

To generate media from the LeibniX package, it has to be exported to formats such as DAISY, HBS or others. Using standard XML converting tools like XSLT, this is easily done with respect to speed and reliability. Generating different formats from a LeibniX package is not a task of the LEdit editor but of a superior data handler managing the LeibniX packages.

13 Tangram: The Tangram project has been initiated by TU Dresden, Germany under the management of Prof. Weber to support the creation/translation of graphics.

3 State of the Art

The tools are still in development and will be durable extended and supported. The focus is not that much on recognizing everything perfectly, but on generating a LeibniX package output which can easily be edited via LEdit by transcribers. Especially the usability and extendibility of the editor is of utmost importance for workflows to come.

There have been several in house usability tests that have shown, that the underlying concepts are useful and highly welcome for future workflows at DZB. Especially the extension of LeibniXML is strongly tied with the production of real books. Meanwhile visualization and export scripts are adapted and bettered.

One commercial usability test has been realized by HTWK Leipzig (Leipzig University of Applied Sciences, <http://www.htwk-leipzig.de/en>) in February 2012. The results include videos, presentation slides, suggestions for improvement and a summary report all in German language that have shown that the underlying concepts are sustainable. A second usability test at HTWK Leipzig will be made in second half of 2013.

During spring and summer 2012 LEdit had been checked by students within a lecture on usability at HTWK Leipzig offering a lot of suggestions for improvement which have been realized when useful.

A presentation to different German media producers in November 2012 has proved that Leibniz and their concepts are highly welcome for other institutions that produce media for schools and studies.

The first part of the software is planned to be finished until the end of 2012. Next steps will be the takeover into production, different extensions and improvements. At the moment first complete books are produced. Planned extensions are interfaces like Daisy 4 export and making LEdit a production tool that can be effectively used by blind and partially sighted people.

The most time consuming part was the development of the concepts and infrastructures. Build on them, the project's development makes great efforts.

4 Applying Leibniz for tablet computers

The tools developed by Leibniz will help to produce non-fiction books for visually impaired people in different media formats. Focuses are adapting the tools with respect to special needs as well as changing requirements. The underlying architecture is designed to be very robust and adaptable to those developments.

The bbs nürnberg, a school and competence-system for pupils and young adults with low vision and blindness in Bavaria/Germany started 2011 a new project which uses tablet computers like the iPad for vocational training.

Uninformed people could have the impression that the iPad cannot be used without sight, but the integrated software "VoiceOver" generates a direct Bluetooth connection to different Braille devices. Also it designs the screen especially for people with low vision (contrasts, font size ...)

After half a year of use the iPad proved to provide access to books and information in a fast and very impressive way. The teachers started to give their information via e-books by placing them in the "kiosk". With it the books can be quickly accessed. Therefore the pupils use the iPads like a book – carrying it always with them.

Here is the very interesting connection between “Leibniz” and the bbs nürnberg. There exists a very big gap to have access to text books on vocational training like office communications which is educated at bbs nürnberg. By using Leibniz tools this gap can be closed in a fast, secure and easy way.

5 Summary and Discussion

The Leibniz project aims on producing production software that allows creating non fiction books for the blind and visual impaired. During the last three years automated (core) and manual (LEdit) tools have been developed and integrated. Tests, discussions and usability tests have shown that the concepts are on the right way. But there is still a lot to do.

In 2013 DZB will concentrate on improving OCR using a new Omnipage engine and on improving LEdit.

The work with students has shown different results. There can be good impulses as well as busy work.

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SECTION 4

Compensation Tools for the Specific Learning Disorders and Other Types of Diversity in Tertiary Education

Dyslexia Friendly Education – An Overview

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The Dyslexia Friendly Quality Mark for Higher Education organisations is a whole organisation approach. The British Dyslexia Association (BDA) has set criteria covering policies, teaching and learning, and partnerships with students as part of the BDA Dyslexia Friendly Quality Mark. It also involves effective identification, intervention and support, including reasonable adjustments, access arrangements for examinations and effective use of assistive technology. Around 10 per cent of the population has some degree of dyslexia difficulty so all educational establishments must be able to differentiate for their needs. This is to the benefit of students, the success rates of the colleges and society in general. The British Dyslexia Association aims to create a dyslexia friendly society and works across all age ranges and sectors (www.bdadyslexia.org.uk).

The British Dyslexia Association (BDA) is a charity which is now 40 years old. It arose originally mainly from parents trying to get recognition and provision for their dyslexic children, and teachers who were pioneers in trying to understand how to help these children. The BDA has 58 affiliated local associations across the UK.

The BDA aims to bring about a Dyslexia Friendly Society. The following main goals have been identified:

1. Early identification of dyslexic difficulties for all in society.
2. Availability of effective and appropriate teaching provision for all dyslexic children and adults.
3. Availability of appropriate assessments for all dyslexic children and adults.
4. Reasonable adjustments for dyslexic individuals within all sectors of society (including education, employment, training and the criminal justice services).
5. Information should be available for dyslexic individuals across the age ranges and sectors, and for those who support them, about effective strategies to help overcome dyslexia related difficulties, and how to maximise the strengths of those with dyslexia.

The activities of the BDA contribute to the achievement of these key goals.

The BDA sets the course criteria for the training of Dyslexia/Specific Learning Difficulties specialist trained teachers. These courses are run by 32 universities across the UK and increasingly, through the work of the BDA International Accreditation Board, also across the world. They are for teachers with at least 2 years teaching experience and are at 2 levels. The first level (ATS – Approved Teacher Status) enables teachers to be able to set, deliver and monitor progress on dyslexia specialist teaching intervention programmes and work with class teachers on dyslexia friendly class room practice. Teaching Assistants (who are not usually qualified as teachers) can also do the ATS courses and they can then be awarded APS – Approved Practitioner Status. In some Initial Teacher Training

Universities, a version of the ATS course, known as ATS ITT (Approved Teacher Status – Initial Teacher Training), is offered as an integral part of the general teacher training courses.

The further level (AMBDA – Associate Member of the British Dyslexia Association) covers the same area as ATS but also trains teachers to be able to carry out diagnostic assessments for Dyslexia/Specific Learning Difficulties (SpLD). Educational Psychologists also carry out diagnostic assessments in the UK. In England the government recently carried out a large research study, a review of international literature and government expert committee, culminating in the Rose Review report (2009). As a result of the recommendations for this report, which recognised the positive impact of specialist trained dyslexia teachers on the progress made by pupils, the English government funded the training of 3,200 more dyslexia specialist teachers on BDA accredited courses. These teachers often work in schools as Special Educational Needs Co-ordinators (SENCOs). Every school is required to have a SENCO (but they do not have to be dyslexia qualified and there are not enough trained currently to resource this). AMBDA qualified teachers also often work within a Local Education Authority across a region, advising schools, assessing, setting programmes and monitoring progress. Specialist teachers also work in the Learning Support departments for Further and Higher Education organisations. For both ATS and AMBDA specialist teacher qualifications, there are particular courses geared to working in the Further Education (FE) and Higher Education (HE) sectors (ATS FE/HE and AMBDA FE/HE).

For many years, the BDA has also run a Dyslexia Friendly Schools Quality Mark scheme. The BDA sets the criteria for those things that a school should be doing, if it is to be considered Dyslexia Friendly. If the school demonstrates that it is fulfilling these criteria, it can be awarded the BDA Dyslexia Friendly Quality Mark. One of the key concepts behind this, which is shown to be the case in practice, is that changing policy to accommodate individuals with dyslexia will result in good practice for everyone. Many Local Education Authorities run Dyslexia Friendly Schools schemes across their regions. The BDA scheme provides a template of good practice and helps organisations to meet the legislative requirements of the Equality Act 2010 in England.

BDA Dyslexia Friendly Quality Mark Initiative has developed sets of standards for each of the following sectors: Individual Schools, Post 16 Educational and Training Providers, Further Education, Commercial Organisations, Children's and Young Peoples Local Authority Services, and Universities and Institutes of Higher Education (Departments and Schools of Learning).

The BDA criteria for Dyslexia Friendly Universities/Higher Education (HE) Institutes (Departments and Schools of Learning) cover the following key areas:

- Effectiveness of Management Structure.
- Identification of Dyslexia/SpLD.
- Effectiveness of Resources (Physical Environment, Teaching and Learning).
- Continuing Professional Development.
- Partnership with Students, Parents/Carers and External Agencies.

The process is that the University/HE organisation registers with the BDA to undertake the Dyslexia Friendly Quality Mark. They identify a lead member of staff, but also the

senior management team must be on board with the scheme. They conduct a self-audit against the listed BDA criteria. They make an Action Plan to put in place any criteria that they are not currently satisfying. It can take around 18 months to work through this action plan. They note what evidence they then have that they are then satisfying all of the criteria. The British Dyslexia Association then carries out a Verification Visit, conducting interviews (with senior managers, learning support staff, lecturers and students) and lesson observations. They also ask to see a random sample of the evidence against the BDA set criteria.

If the organisation has been able to demonstrate that they meet the criteria, they are awarded the BDA Dyslexia Friendly Quality Mark. They are presented with a certificate and allowed to use the copyrighted BDA Dyslexia Friendly Quality Mark logo on their website and headed paper. The award lasts for 3 years, during which time they are expected to embed good practice. There will then be a further Verification Visit. The British Dyslexia Association offers consultancy support, including a mock verification, for participants going through the Dyslexia Friendly Quality Mark process, as an additional service.

The Standards for the BDA Dyslexia Friendly Quality Mark for Universities/Higher Education can be found here: www.bdadyslexia.org.uk/files/qm_universities.pdf.

The Dyslexia Friendly Quality Mark criteria include a number of key points, including that the organisation should have effective identification systems, effective intervention programmes, allow appropriate access arrangements for examinations, all lecturers should be aware of key dyslexic difficulties and potential strengths and of how to teach in a dyslexia friendly way, there should be regard to dyslexia friendly learning environment factors, support services, positive role models and ways to enhance the self-esteem of dyslexic students, particularly with regard to their learning skills.

The BDA recently completed an EU funded project working with partners in Italy, Romania, Bulgaria and Hungary, adapting the Dyslexia Friendly Quality Mark to the education system in those countries, for use with Vocational, Education and Training organisations (see <http://www.dyslexia-veto.eu>). Appropriate changes to both the criteria and the assessment protocol were made, in line with the needs and situations in those countries. The Dyslexia Friendly Quality Mark scheme has, therefore, been shown to be highly adaptable and to bring benefits across nations.

In the Higher Education system in England there is also a government funded scheme called “Disabled Students’ Allowance” (DSA). This arises from the Equalities Act 2010. It is available to dyslexic students in Higher Education (full-time, part-time and post-graduate). The application from the student has to be supported by post 16 years of age diagnostic assessment (from a suitably qualified dyslexia specialist teacher or psychologist). Provision can include assistive software, study skills training, proof reading and allowances for books and photocopying. These are paid for by the government.

Typical reasonable adjustments include: an appropriate computer, headset etc., assistive Technology software (eg. text read back, dictation software), training in the use of the software, 1:1 coaching in personal organisation, managing their learning, getting assignments in on time, approaching revision and exams. Maximum DSA allowances are £5610 for equipment and ‘non-medical support worker’ costs of £20,520. The majority of

dyslexic students would typically get most of the equipment allowance and a proportion of the non-medical support worker allowances.

Within the Dyslexia Friendly Quality Mark criteria there is a requirement to make access arrangements for dyslexic individuals undertaking examinations. The access arrangements given in any one case depends on the precise learning difficulties of the individual concerned. Access arrangements can include: a reader, a scribe, extra time, rest breaks, marking for content and not being marked down for errors of spelling, punctuation and grammar.

Other criteria relate to appropriate use of computer technology and assistive technology, including the use of hardware and software to allow assist with recording for note-taking, text to speech, speech to text, concept mapping, spell checking, organisational skills, time management, reminder, reading and handwriting recording pens, cameras for photographing text to use with text to speech software, e-learning platforms and web-based assistance including early posting of lecture notes, coursework requirements and submission dates, alternative learning and recording/presentation/assessment modes (eg. using video material, iphone recordings, role play, demonstrations, etc.). The British Dyslexia Association New Technologies Committee webpages have a good deal of helpful information about technology that is useful for dyslexic students (see <http://www.bdatech.org> and www.bdastore.org.uk).

For those students going on to employment, there is also a government funded scheme, called 'Access to Work'. Under the Equalities Act 2010, when a new employee discloses dyslexic difficulties (or other disability) reasonable adjustments should be implemented. Access to Work provides access to work assessments and funding for necessary 'reasonable adjustments'. Adjustments can include assistive technology, coping strategy training and support workers to help with proof reading, organisational skills, etc.

The BDA has a number of helpful publications covering many aspects relating to Dyslexia, including co-occurring difficulties, dyscalculia and learning difficulties, languages and multilingualism, tips for teachers and dyslexic adults, parents, music and performing arts, early identification, code of practice for the criminal justice system and code of practice for employers, as well as an annual Dyslexia Handbook covering an update on a range of topics and Wiley's 'Dyslexia' academic journal (see www.bdastore.org.uk).

The BDA has been working in recent years with other organisations as part of the Dyslexia-SpLD Trust in England, with government funding. The Dyslexia-SpLD Trust has developed a web based Professional Development Framework for dyslexia/Specific Learning Difficulties/Literacy Difficulty professionals. This has 6 strands:

- Language and literacy
- Theories of dyslexia
- Identifying and assessing
- Supporting and teaching
- Communication and working with others
- Professional development

The framework defines additional knowledge skills and understanding required to support SpLD learners. It also allows professionals to think strategically on Continuing Professional Development (www.thedyslexia-spldtrust.org.uk/4/resources/).

Summary

The Dyslexia Friendly Education approach provides a road map to creating an environment where dyslexic individuals are enabled to fulfil their potential, with positive benefits for the individual, the educational organisation and society. This approach helps to develop a dyslexia friendly society.

For further details about the **BDA Dyslexia Friendly Quality Mark**:

www.bdadyslexia.org.uk, Quality Mark tab.

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Tel: Joanne Gregory: 07786 071 020 (England)

BDA Helpline: 0845 251 9002 (England)

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For further information on these publications see: www.bdastore.org.uk.

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The Thematic Networks eAccess+ and ETNA: Spreading the Word and Enhancing the Take-Up of eAccessibility in Europe

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1 Introduction: Two Different Approaches Conquering the Low Take-Up of eAccessibility

Over the last decades the eAccessibility field has established a solid body of knowledge, including guidelines, methodologies, techniques, training and reference materials and examples how to implement eAccessibility in Information Society products, systems and services (e.g. [1, 2]). This consolidated body of knowledge is intended to be applied to mainstream design as an integral part of systems and services in society.

However, eAccessibility seems to stay confined to its domain of origin. This is despite the fact that a) Awareness and acceptance of eAccessibility as a fundamental human right is growing, as can be seen in the UN Convention on the Rights of People with Disabilities [3] and in many EU directives, and in national and international legislation; b) eAccessibility is a key business concern due to the considerable and still growing number of citizens who are dependent on or benefiting from eAccessibility; c) eAccessibility is crucial in dealing with the growing pressure on social systems due to an aging population, correlating with increasing occurrence of disabilities. Finally, the ongoing investment in many initiatives, programs and projects all demonstrate the need, the feasibility and the viability of eAccessibility.

Yet, although key mainstream players are involved in these programs, application in day to day practice is scarce. Furthermore, the situation even appears worse when we compare these gradual and step by step improvements in the uptake of eAccessibility in the light of the exploding application of ICT in society. This is true for areas which have received much attention over the last years, such as Web Accessibility (e.g. [4]), but it is even worse in other eAccessibility domains [5].

Another important issue in this field and crucial for everyday work in support centers for people with disabilities as well as for the peer group (or their carers) itself can be identified as information on already existing assistive solutions. Most often, people working in the field of providing assistive technologies or assistive solutions to people with disabilities or their carers have problems in staying up to date – as they are in most cases not involved in research and development after getting basic education in this field. A Europe – wide unified, accessible, comprehensive and usable portal (database) on assistive solutions could fill this gap and raise the level of proficiency on all fronts, from researchers/developers over providers and support centers to (end) users and their carers.

Safe and up-to date information, combined with the community web 2.0 based style of such a portal, where all involved key players are able to review and evaluate the pro-

posed solution and its aptitude for different user groups would help raising both, quality and quantity of flexible, user centered and efficient assistive solutions.

The thematic network project ETNA (EU funded within the framework ICT-PSP) dedicated its 3 year work to this topic and built up – in cohesion with two other projects in this field (EASTIN and ATIS4all) a portal for exactly this issue and is able to foster – in addition to eAccess+ and its work the future uptake of eAccessibility.

2 eAccess+: Supporting the Implementation of eAccessibility

European institutions reacted to the situation outlined above with actions such as the EC Communication 2008 “Towards an accessible information society” [6] and related feedback such as that from the European Council [7], aiming at improving the situation and calling for related activities. [8]. One of these related activities has been the founding of the eAccess+ network. eAccess+ (www.eaccessplus.eu) has established and is systematically developing a cooperative platform for co-ordinating, supporting and improving the implementation of eAccessibility throughout Europe by involving all stakeholder groups in the associated value chains; analyzing the present state in order to identify the obstacles or missing links hindering a wider uptake of eAccessibility. The network first identifies and consults relevant stakeholder groups, analyses and discusses with them the state of the art, supports stakeholders in adopting eAccessibility and disseminates experiences and knowledge all over Europe. Finally a roadmap is being drawn up to find appropriate future actions.

Out of the wide range of topics related to eAccessibility, eAccess+ focuses particularly on fostering the implementation of:

- Web accessibility: Here the network focuses on disseminating and increased uptake of the internationally recognized W3C/WAI web accessibility standards, techniques and technical solutions, in particular WCAG 2.0 and Rich Internet Applications, on harmonizing the evaluation methodologies and tools; on web accessibility monitoring; as well as approaches to accessibility statements on a web system.
- Accessible communication and audio-visual systems and accessible documents: The switch to digital television and recent technology (ASR, gesture control, smart remote controls and second screens) and applications developments (social media, home care, tele-medicine, etc.) originating either directly from manufacturers or from European research projects alongside standardization activities such as HbbTV (<http://www.hbbtv.org/>), have greatly facilitated the move towards a truly accessible Web TV experience. eAccess+ supports the relevant stakeholder groups in achieving greater strategic coherence at a technological, economic and political level.
- Self-service terminals (SSTs) and related devices for banking and financial services, public transport, tourism and cultural heritage, e-government: The proliferation of these services and newer hybrid self service technologies (such as e-boarding cards delivered to smart phones) are capable of making our everyday lives easier. They can offer 24 hour service, consistency in service, greater distribution of services, etc. However some human mediated services are being phased out and replaced

with self services. This means that there is no alternative for those who are unable to use SSTs, due to sensory cognitive, or mobility and dexterity limitations. eAccess+ is communicating actively with suppliers and deployers of such services to make them more aware of the problems and the need to implement eAccessibility.

eAccess+ is driven by 25 core members, coming from all over Europe. Their main task is outreach to stakeholders, – in particular those who are typically responsible for implementing eAccessibility, – and to expand the network. A clear focus is given to contacting those stakeholders able to act as “ambassadors” or opinion leaders, following the dissemination of innovation theories of Rogers [9]. A web based management system supports this process of involving stakeholders. In addition, eAccess+ is present at key mainstream events to advocate for eAccessibility.

2.1 The eAccessibility HUB: Guided Access to eAccessibility

As a core methodology and main tool, eAccess+ is establishing the “eAccessibility HUB” (http://hub.eaccessplus.eu/wiki/Main_Page) which allows guided access to existing resources by adding semantic enrichment and cross-linking (resources are not mirrored). The HUB addresses a very practical problem, namely that people often do not find the right source of information they need in a certain situation. eAccessibility is without doubt a complex issue and the body of knowledge mentioned is vast, diverse and interdisciplinary. Different stakeholders need different “views” to get what they need in practice. eAccess+ identified the problem of interested parties becoming disoriented – and their difficulties to find the appropriate piece of information; example; method; tool; and/or competent expertise; – as one of the main issues that discourages stakeholders. Such stakeholders, although interested and motivated, may become hesitant and frustrated and eventually withdraw from efforts to implement Accessibility [15].

Thus, by systematically analyzing the existing body of knowledge, the eAccessibility HUB offers better access and sophisticated search functionalities to support better orientation in the large amount of resources available.

In doing so, the HUB allows for an evidence based discussion of the state of the art and on obstacles to take up. As a media tool, it supports feeding facts; ideas; recommendations; and concepts into appropriate end-user; political; technical; industrial and research channels.

The use of a network as a tool; the creation of the HUB; and the concentration on three implementation areas, all support eAccess+ to act as a facilitator and coordinator for a better implementation of eAccessibility in practice. In addition, it can be used to plan the future of the next steps at national and European level with regard to standards; policy; guidelines; and tools. Due to the crowd sourcing approach and the involvement of well established networks and associations, we see the eAccessibility HUB as an approach and a tool that is eminently sustainable.

3 The Thematic Network ETNA: Guided Access to Accessibility through a Web 2.0 Enriched Information Portal on Assistive Solutions

Starting with a study, carried out to detect the information needs of the various stakeholders involved, such as end-users of assistive technologies, professionals in health, social services and education, manufacturers and developers, policy makers and academic/

researchers the network ETNA identified thirty “search profiles”, each related to a specific reason why information may be sought in response to a specific information need that people may encounter at given times. In turn, each profile involves a specific body of information. This study provided a detailed insight in the audience’s expectations, that is guiding the design of the future Portal. The Portal stems by the existing Portal of the European Assistive Technology Information Network (EASTIN), enriched by the contributions brought by the ETNA project and its “sister” ATIS4All Thematic Network.

The success of the Portal will depend on how far it will meet the various actors’ information needs. This calls for a detailed understanding of the specific topics to be covered, as well as of the type, depth and format of the information to be provided. An investigation was carried out leading to the identification of four sub-domains [10]:

- Stand-alone products
- Non stand-alone products
- Resources for development
- e-Services

Within each sub-domain, a distinction was made whether mainstream technologies or assistive technologies are considered [11].

The term assistive refers to a product/service/technology used by, or aimed at, people with disability to improve functioning in activities that might otherwise be difficult or impossible; while the term mainstream refers to products/services/technologies designed for the general public. Assistive, as opposed to mainstream, reflects the concept of design-for-need (for meeting specific disability-related problems); while mainstream reflects the concept of design-for-all (for everybody, thus including also persons with disabilities and elderly people) [12].

A still-open discussion point is the extent to which accessible mainstream products should be considered by the Portal. While assistive products can be easily identified as such, in that they have been purposely designed to meet disability-related needs, the extent to which a mainstream product can be considered “worth mentioning” is questionable. In an ideal world, all mainstream products should be accessible, thus there would be no need of a specific information system to find them; however, in the real world the border between “accessible” and “inaccessible” is often blurred or depending on the way the product is configured and used. Depending on the accessibility regulations, a product considered “revolutionary good design” in one Country may be considered uninteresting in another which has more advanced regulations and much better products. Today, most existing information resources (e.g. public national databases on disability issues) tend to be very comprehensive in relation to assistive products, and to mention just a few numbers of mainstream products, selected as “best practice examples” of how a product should be designed. This criterion sounds reasonable: However, in case it is going to be followed also in the Thematic Network Portal, indicators of what is meant for “good practice” should be agreed.

The domain of ICT / AT and e-Accessibility also reveals several other challenges needing to be seriously taken into account in the development of the Portal: the fast ongoing evolution of social attitudes towards technology; the growing pervasiveness of ICTs in every aspect of daily life; the different approach of the young “digitally native”

generation versus the “non-digitally-natives”; the taking off of e-Marketing and many more issues [13].

Rather than being a pure “search engine” or an “integrator of databases and repositories”, the Portal should be a “virtual space” that facilitates these processes. Therefore not only data should be available, but also opinions, articles, case studies, ideas, competence centers that can be contacted, resources that can be directly downloaded, thus offering various opportunities that help the individual to structure his/her own path according to his/her main needs and preferences.

Following this, mapping the information needs of different users’ profiles doesn’t mean categorizing the stakeholders and their demands in fixed and static groups. Whenever accessing the Portal [14], a person will recognize himself/herself in the search profile that is best appropriate in that moment and to this specific use case and framework.

Acknowledgements

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A Case Study of Applying Card-sorting as an Initial Step in the Design of the LITERACY – Portal for People with Dyslexia

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Keywords: card-sorting, human-centered design, users with special needs, dyslexia

Abstract

There is an increasing awareness of the fact that early user involvement in the development of web-based applications is a key success factor. The human-centered design process suggests a number of useful interventions that guide the process of including users. One of them is the card-sorting technique.

In this paper we aim to share our experiences in applying card-sorting in an early phase of developing a web-portal for supporting users with reading difficulties, most prominently dyslexia. The paper characterizes the card-sorting technique and describes the preparation, design decisions, data collection, data analysis and results we achieved while applying the technique with a sample of dyslexic users. Moreover, the meaning of the results is discussed along with the special learning and adaptations necessary for applying card-sorting with users with special needs. Readers will also get acquainted with the EU-Project LITERACY that forms the context of the study.

1 Introduction

“I don’t read. I simply never could.”

“Grammar in my emails is never correct and it cost me my job.”

“I’m even ashamed to write an illness note to my kid’s teacher.”

These three are only a few examples of problems in people’s daily lives in today’s world overloaded with textual information. All three have one factor in common – dyslexia. They were shared with us in interviews and stories such as these were part of the motivation behind the project LITERACY.

This project aims to support adults and teenagers with dyslexia (or limited reading literacy) and enable their better inclusion in society. We aim to provide an ICT solution which will enable dyslexic youth and adults to acquire learning skills, accommodation strategies and methods for functioning at literacy related tasks at work and at home. The ICT solution, an internet portal, will enable users with dyslexia to operate independently online, by providing three interactive services:

- Comprehensive analysis of one’s strengths and weaknesses and based on it;
- Personalized e-learning tools and assistive technology and

- a Community Zone with a specialized human-computer interface – helping users to socialize in ways they find meaningful.

In the development of a web-based tool such as this, there is an increasing awareness of the fact that early user involvement is a key success factor. Taking this into account, the so-called “human-centered design” process, which suggests a number of useful interventions that guide the process of including users (one of them being the card-sorting technique), was chosen for the project.

In this paper we characterize the card-sorting technique in the context of human-centered design and describe the preparation, design decisions, data collection, data analysis and results we achieved while applying the technique with a sample of dyslexic users. Moreover, the meaning of the results is discussed along with the special learning and adaptations necessary for applying card-sorting with users with special needs.

2 Human-centered design

The basic philosophy behind human-centered (or often also “user-centered”) design is that “the user shouldn’t suit the product, the product should suit the user”. To achieve this goal, it is necessary to know the user and his needs and interests deeply. This necessity formed human-centered design into a process that consists of short incremental development phases, prototyping, and collection of feedback of real future users already at the early stages of design. More details about human-centered design can be found in the dissertation thesis of Simone Kriglstein (Kriglstein, 2011) and it is thoroughly advocated in Donald Norman’s “Design of everyday things” (Norman, 2002).

As for the LITERACY project specifically, the design process has comprised various (also user-involving) techniques. We started with preparatory research and persona¹ creation, then conducted semi-structured interviews with people with dyslexia and continued with menu structure poll and card-sorting, the last one being the focal point of this article. The process will continue with steps such as creation of clickable prototypes and task-based testing², taking all preceding results into account.

3 Card-sorting

Spencer and Warfel say that “Card-sorting is a user-centered design method for increasing a system’s findability. The process involves sorting a series of cards, each labeled with a piece of content or functionality, into groups that make sense to users or participants.” (Spencer and Warfel, 2013)

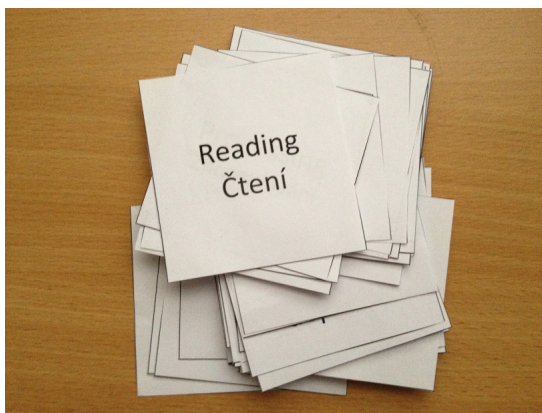
Card-sorting is a highly adjustable technique, it can be prepared, executed, processed and evaluated on PC only, it is possible to conduct it with paper cards and hybrid methods are also used. The simplicity of this technique makes it a cheap and rather fast way how to “generate an overall structure for your information, as well as suggestions for navigation, menus, and possible taxonomies.” (Spencer and Warfel, 2013)

1 Persona is a user profile symbolized by a comprehensively described fictional person.

2 In task-based design, a respondent is given a task such as “Change the colour of the background” and his activity is observed and recorded, with the possibility of him or her thinking aloud.

4 Card-sorting method for the LITERACY project

We used this technique as it is defined, choosing to combine the processing power of computer and simplicity of the paper. A large offer of content and functions was assembled during various meetings and workshops in our project consortium and from this offer 65 possible menu items were singled out, each represented by one printed card (you can find the complete list in Appendix).



[Fig. 1] A set of cards

A brief introduction of the Literacy project and card-sorting was given to a participating respondent. Then they were handed the set of cards and asked to go through them to see if they understand all terms and if not, anything unclear was explained to them. Afterwards they discarded the items they did not want to use and sorted the remaining cards into various groups and structures to their taste. They were also instructed to feel free to create their own items (blank cards were provided) and to complain about the names of the items. The motto of our card-sorting was that there is no bad answer. The resulting card structure was photographed and the photographs commented so that the depicted structures and groupings were clear to any reader.

A plan was made by the team of University of Vienna and Psychological and pedagogical counseling center in Brno to do card-sorting with 30 respondents. Firstly, we wanted to cover the previously created 10 personas evenly, but this goal was changed according to our project officer's recommendation to focus more. Our new criterion created on a project meeting was to focus on people, who feel hindered by dyslexia, have basic internet usage competences and want to improve themselves. This move cut down the number of personas to be covered by card-sorting to 5.

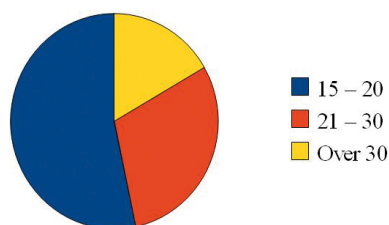
To be able to scale to 30 results in the given time frame and consistently, we created a description sheet with the names of the items and their explanations. All of these materials were translated into Czech and a workshop with employees of the Psychological and pedagogical counseling center in Brno was conducted to teach them how to run card-sorting with our respondents.

5 Respondents

Acquiring people to take part in card-sorting was a challenging process. We tried in various ways:

1. Project was presented in the television with the call to action to take part and help us.
2. Project was presented on seminars for special pedagogists and meetings of dyslexic adults
3. Word of mouth – inviting acquaintances and former clients of our psychologists and also students of our special pedagogues

Altogether 40 of the collected contacts were approached via email or telephone or personally and 30 of them agreed to participate. Following figure shows the gender ratio of people with dyslexia who contributed to our project.

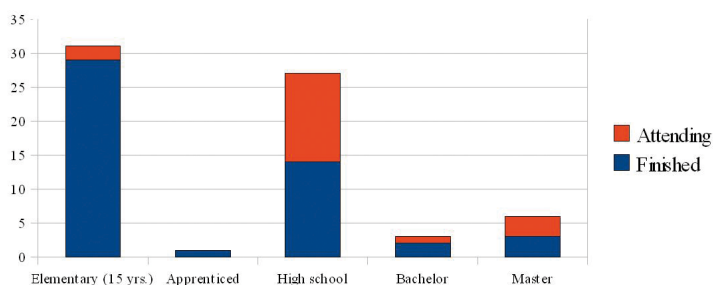


[Fig. 2] Gender distribution of card-sorting participants

Most of our respondents have already finished elementary schools. All of them have continued with high school. 36 % have finished it, too, and are currently working, studying at a university and 2 respondents are on a maternity leave. Of all respondents, 7 % have a bachelor degree, mostly continuing with master studies (See Fig. 3).

These figures show us that we achieved a rather balanced ratio of adolescents and adults. Specifically, 52 % have not finished their high school studies yet and the rest is adults, who are:

- still studying
- already employed
- done with studies and unemployed
- on a maternity leave, but without a job to return to



[Fig. 3] Education of card-sorting participants

6 Results achieved

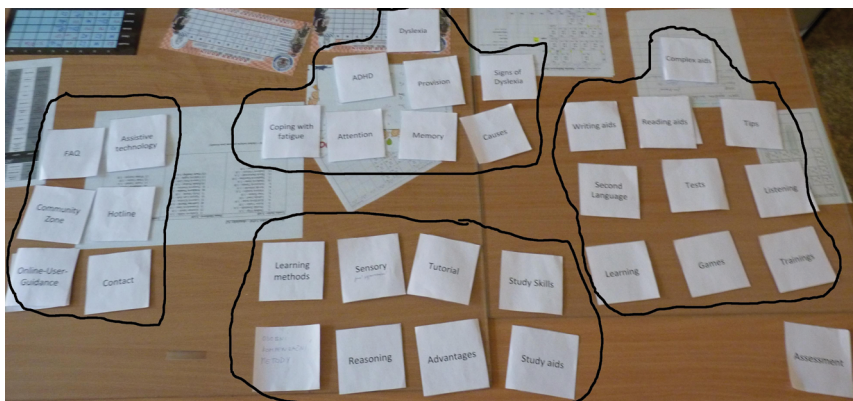
Commented photos of the how our respondents sorted cards were the last step of data collection and the first step of evaluation. Following pictures show some of the results:



[Fig. 4] Photo of a sorted set of cards

This sorting (Fig. 4) represents not only groups of words but a hierarchy as well. The first column on the left is a main menu and 7 of its items contain sub-menus (rows), of which one is going another level deeper.

However, not all of the processed card-sortings were so comprehensible and unambiguous. To enable communication in our team spread over Vienna, Brno and Prague, photos had to be well edited and commented. An example is available on the next picture (Fig. 5).



[Fig. 5] An edited and commented photo of a sorted set of cards

For unambiguous records and a quick overview, all of the sorting was stored in an Excel table. The complete list of cards and how often they were chosen is shown in Appendix.

6.1 Computerized analysis

Our next move was transferring the results of the manual card-sorting into a digital tool. For this purpose, we used xSort, a free and easy software to create, conduct and analyze card-sortings. With xSort we were able to create a distance table that included all the different cards we used and also a table containing items that were used rarely, which gave us a first idea of how well the items are connected.

In the next step xSort allowed us to create a cluster tree based on the complete linkage clustering method, which uncovered small groups of items. Following graphic displays a small branch of this cluster tree. It shows the connections and distances between different items:



[Fig. 6] Part of the cluster tree from the analysis of the card-sorting results

The closer to zero a connection is the better connected they are, which means they were picked together often. In this case the items Dyslexia and Signs of Dyslexia have a very close connection whereas the card Causes has a comparatively bad connection to the other items.

As a cluster tree with that many items quickly becomes complicated and hard to comprehend so we created a visualization to display the most closely connected items with boxes. The graphic that follows (Fig. 7) shows that we were able to identify 8 main clusters which all represent different activities or possibilities on our web-portal.

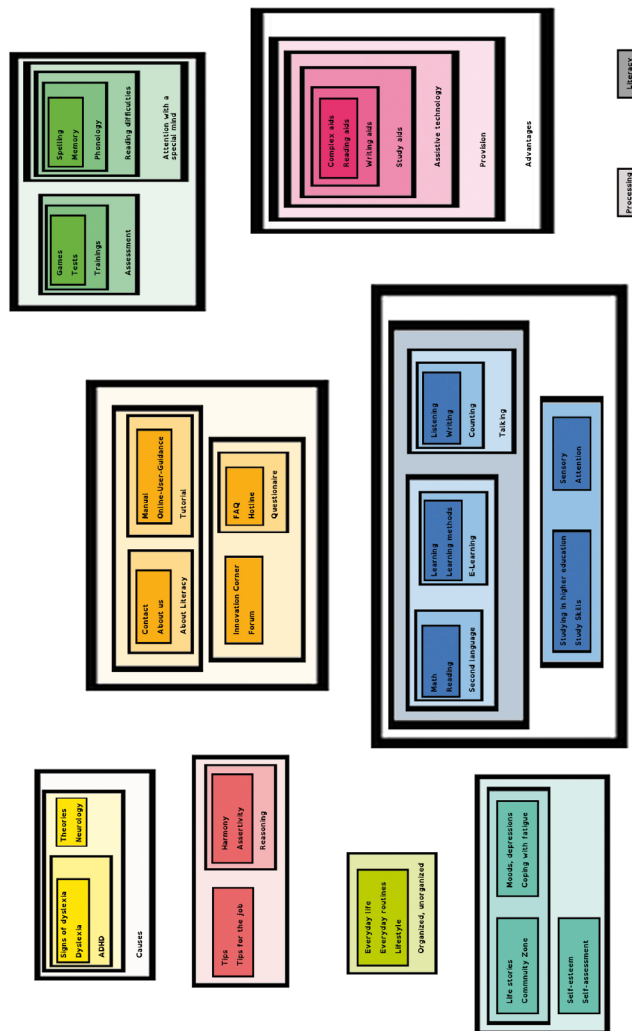
The first small (yellow) cluster includes cards about dyslexia, its causes and the theoretical background. It represents an informative and theoretical part of the portal. The second (red) cluster consists of tips on how to succeed as a dyslexic as well the items Harmony, Assertivity and Reasoning. In the next (light green) cluster the participants combined Everyday life, Everyday routines and Lifestyle with Organized, unorganized. The turkey cluster combines the item Life stories with different issues dyslexics might encounter, like moods, depressions, how to cope with fatigue or their self-esteem but also includes the items Self-assessment and Community Zone.

One of the bigger clusters (orange) sums up different ways of getting information about the portal. It includes items like About Us, Forum, Contact and Hotline but also Manual, Tutorial, FAQ and Innovative Corner. The biggest cluster (blue) represents the different possibilities our portal will offer to learn or improve oneself. It contains different areas to improve, like math, reading and writing but also more general items like Attention and Study skills. Furthermore it also includes the items regarding learning, learning methods and studying in higher education.

The green cluster combines the items Games, Tests, Trainings and Assessment with the items like Attention with a special mind, Reading difficulties, Spelling and Memory. As the connection between this two sub-clusters is not very strong it is possible to separate them into independent clusters for the final adaptation. The last big cluster (pink) combines the different aids with the suitable term assistive technology as well as the items Provision and Advantages. This cluster clearly represents the area of our web-portal that will showcase different assistive technologies and helpful software.

The items Processing and Literacy only show very weak connections to other items and therefore do not fit into any of the clusters. We will either need to revisit the terms or discard them completely.

These 8 clusters represent the next step in our iterative process of creating a menu-structure for the web-portal and will heavily influence the next steps in the portal-design.



[Fig. 7]: Visualization of results of card-sorting

7 Implications

There are four main outcomes of the card-sorting. Firstly, we acquired insight into the mental model of the LITERACY portal structure that its possible future users have. Secondly, we received valuable clues about naming of functions and content suggested by us. Thirdly, we were constantly working on improving the process of card-sorting and the last point is what we found out about the number of cards.

7.1 Structure of the portal

As Norman stresses: “The designer must develop a conceptual model that is appropriate for the user, that captures the important parts of the device, and that is understandable by the user.” (Norman, 2005) We plan to achieve this goal by employing results of the card-sorting in the next prototypes of the LITERACY portal. Menu structure formerly suggested by our project consortium will be confronted and adjusted, mainly grouping of the items into categories being influenced.

7.2 Naming

Our respondents commented some of the terms for the items and it turned out that some of our initial suggestions were influenced by our professional knowledge. “Assistive technology” is crystallizing as one of the core components of the LITERACY portal content, yet some of the respondents find this term too complicated or they do not know what to imagine behind it. A woman suggested the term “Helper” and men were more inclined towards “Life hacks”³. This detail might prove to be vital in orientation on the portal and calls for testing in the next phases of design.

7.3 Process improvement

At first, we considered taking existing digital tools for card-sorting and using them as they were, however, taking dependency on electricity, internet and different usability needs of respondents, the simplicity of paper cards won. We chose the hybrid process of executing card-sorting physically and evaluating it in the digital tool, which requires competence with xSort only from our side.

Our process originally included paper forms for recording which cards were used, created and omitted, but after the first run we found out that taking a photo and then processing it into Excel later is more effective. In this way, the interviewer is able to focus on the respondent instead of his paperwork, so we adjusted the card-sorting process accordingly. These process changes call for detailed elaboration and notation, but it is out of scope of this paper.

7.4 Number of cards

As we knew from the preparatory research, dyslexia often manifests with impaired working memory (Beneventi et al., 2010). Our initial expectations had been that this might prove to be a point of failure in our card-sorting efforts. Thus we started to prepare a

3 These are all cases of card-sorting done in Czech. Originally, these suggestions were “Pomocník” (Helper) and “Vychytávky” (Life hacks)

lighter version that would employ only 10 cards our project consortium suggested as the main menu, 3 random cards chosen from the rest of the total of 65 and blanks.

We discussed this issue on a meeting with the Psychological and pedagogical counseling center in Brno and contra-intuitively, our first respondents that have by that time sorted the full set of cards had little problems and were rather enthusiastic about this exercise. This indicates that card-sorting may be a technique of human-centered design that is suitable for people with dyslexia.

8 Discussion

Even in light of this results, some questions arise. One of them is the number of respondents. Is 30 enough? We arrived at it taking the difficulty of acquiring volunteers and our time constraints into account – a card-sorting (usually done together with an interview, which was the preceding step of human-centered design) took approximately 1 hour without processing and evaluation. Had we reached the state of grouping of items that is too variable (if most of the connections in the cluster tree analysis were close to 1), we would have to press for more card-sorting respondents. Or adjusting our process, e.g. approaching additional respondents via internet and online tools, though such a method change would skew the results.

As mentioned in the definition of card-sorting, taxonomies are also one of the influenced factors. Contrary to the case of the previous paragraph, we have not gathered enough data to create a clear hierarchy. Even though the respondents were explicitly told that they can also specify what is a category and what is sub-, they were often inclined just to group items without indicating clearly, what is the name of the group. This failure is not critical, though, because the taxonomy will be suggested by us and tested again in the next phases of design.

The next phases will also gradually include more and more people, with the goal of reaching 150 testers in the last, 3-month portal validation phase. This number consists of 50 people per country where portal is released – Hungary, Czech Republic and Israel. This increase will give more weight and precision to our tests.

9 Conclusion

This case study of applying card-sorting in the design of the LITERACY portal shows how human-centered design techniques can aid developing for users with special needs. The classic problem of a designer considering just his or her mental model as sufficient is exacerbated by the inherently different thinking of people with dyslexia. Employing card-sorting, which approaches creativity, a strength of people with dyslexia, resulted into our deeper understanding of our target audience and into consolidation of our mental models.

We were able to sort our items into 8 groups with the cluster tree analysis and the menu structure in the next prototype will be adjusted accordingly. The incremental and feedback-based nature of human-centered design was reflected in the process itself and we found ways how to conduct card-sorting efficiently. Among the results of our case study is that our expectation of 65 cards probably being overwhelming have not been confirmed and we also gained feedback on some of the terms we used for our items.

Interactive and user-centered activities such as card-sorting also aim to initiate a relationship between the respondent and our portal. We believe that investing one’s time, being listened to and then seeing some of their ideas taken into account already at the beginning of the design phase may support the emergence of a community around the LITERACY portal, which is one of the goals of our project.

The next planned step is the creation of a clickable offline prototype of the LITERACY portal. Our respondents will be invited to participate again and they will do task-based testing with thinking aloud. This will provide us with more feedback on clarity of the information architecture of the portal, on the adjustments made and we will be able to listen directly and watch out for the places on portal where people get lost, confused or irritated (if it happens), improving them and moving to a higher level of usability towards the final solution – an effective portal supporting inclusion of people with dyslexia by making use of ICT in their daily lives and creating a community.

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Appendix: A table of results

A table of all cards, starting with the highest count of being picked. The letters in the first row stand for respondents and each “1” in the box below means that the particular card was picked by the particular participant. The last three cards we created by respondents.

[Table 1] Results of card-sorting processing

Item / Respondent	Total	M	P	R	B	K	H	E	Me	V	J	F	O	Ko	S	Pa
Tests	27	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dyslexia	26	1	1		1	1	1	1	1	1	1	1	1	1	1	1

Item / Respondent	Total	M	P	R	B	K	H	E	Me	V	J	F	O	Ko	S	Pa
Learning methods	26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Signs of Dyslexia	25	1	1		1		1	1	1	1	1	1	1	1	1	1
Reading	25	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
E-Learning	24	1	1		1	1	1	1	1	1	1	1	1	1	1	
Contact	24	1		1	1	1	1	1	1	1		1	1	1	1	1
Games	24	1			1	1	1	1	1	1	1	1	1	1	1	1
Second Language	23	1		1	1	1	1	1	1	1	1	1	1	1		1
Memory	23	1	1	1	1	1	1	1	1	1	1	1	1	1		1
ADHD	23	1	1		1		1	1	1	1	1	1	1	1	1	1
Complex aids	23	1	1		1		1	1	1	1	1	1	1	1	1	1
Tutorial	23	1	1	1	1	1	1		1	1	1	1		1	1	1
Trainings	22	1	1		1	1	1	1	1	1	1	1		1	1	1
Forum	22		1		1	1	1	1	1	1	1	1	1	1	1	
Theories	22	1	1	1	1		1	1	1	1	1		1	1	1	
Learning	22		1	1	1	1	1		1	1	1	1	1	1	1	1
Study aids	22	1	1		1	1	1	1	1	1	1	1	1	1	1	1
Tips	21	1			1		1	1	1	1		1		1	1	1
Coping with fatigue	21		1			1	1	1	1	1	1	1	1	1		1
Studying in higher education	21	1	1	1	1	1	1	1	1	1	1	1		1		
Tips for the job	21	1	1	1	1	1	1	1	1	1	1	1		1		
Assistive technology	21	1	1	1	1	1	1	1	1	1	1	1	1	1		1
Reading aids	21		1		1	1	1	1	1	1	1	1	1	1	1	1
FAQ	21	1	1		1	1	1	1	1	1		1		1	1	1
Hotline	20	1	1	1	1		1		1	1	1	1	1	1	1	1
Writing aids	20		1		1	1	1	1	1	1	1		1	1	1	1
Community zone	20	1		1	1	1	1	1	1	1	1	1		1		1
About us	20	1		1	1	1	1		1	1		1	1	1	1	
Life Stories	20		1	1		1	1	1	1	1	1	1	1	1		
Study Skills	19	1	1		1		1	1	1	1	1	1		1		1
Math	19	1		1	1		1	1	1	1	1	1	1	1		
Assessment	18	1	1		1	1	1	1	1	1		1		1		1
Moods, depressions	18		1			1	1	1	1	1	1	1	1	1		
Online-User-Guidance	18		1			1	1	1	1	1	1	1	1	1		1

Item / Respondent	Total	M	P	R	B	K	H	E	Me	V	J	F	O	Ko	S	Pa
Causes	17	1	1		1		1	1	1	1		1		1		1
Listening	17	1	1	1	1	1	1	1	1			1			1	1
Innovation corner	17	1		1	1	1	1		1	1		1		1		
Reading difficulties	17			1	1		1	1		1	1	1	1	1	1	1
Self-Assessment	16			1		1	1		1	1		1	1	1		
Neurology	16		1				1	1	1	1	1			1	1	
Questionnaire	16		1	1	1		1	1	1	1			1	1	1	
Spelling	16		1		1		1	1	1	1	1	1	1	1		
Reasoning	16			1	1		1			1		1		1	1	1
Every day routines	16		1				1		1	1	1		1	1		
About Literacy	16	1		1	1		1		1	1	1	1	1	1		
Manual	16	1	1				1			1	1	1		1	1	
Every day Life	15	1	1			1	1	1		1	1		1	1		
Writing	15	1	1	1	1	1	1	1	1						1	
Talking	15			1	1	1	1	1	1			1				
Attention	15	1	1	1	1	1	1	1	1			1			1	1
Provision	14	1					1	1	1	1	1	1	1	1		1
Attention with a special mind	14		1		1		1	1	1	1	1			1		
Lifestyle	13		1				1		1	1	1		1	1		
Phonology	13						1	1	1	1	1	1		1	1	
Organized, unorganized	13						1		1	1		1		1		
Advantages	12		1			1	1		1	1		1		1		1
Counting	12			1	1		1	1	1			1			1	
Sensory	11	1	1		1	1	1					1			1	1
Self-Esteem	10		1	1		1	1	1	1			1			1	
Assertivity	9			1		1	1		1			1			1	
Learning	8		1		1	1	1					1			1	
Processing	8	1					1	1	1			1				
Harmony	6						1		1						1	
Reading	1															

Item / Respondent	Total	M	P	R	B	K	H	E	Me	V	J	F	O	Ko	S	Pa
Osobní kompenzační metody						1										
Kompenzace									1							
Argumentace pro a proti (výhody dyslexie)									1							

[Table 2] Results of card-sorting processing – the rest of the respondents

Item / Respondent	Total	Bl	Ja	L	Ž	Mi	Kn	Kr	Hon	DB	JC	T	Mich	KJ	Ka
Tests	27	1		1		1	1	1	1	1	1	1	1	1	1
Dyslexia	26	1		1		1	1	1	1	1	1	1	1	1	1
Learning methods	26	1		1		1	1	1	1	1	1	1	1	1	1
Signs of Dyslexia	25	1		1		1	1	1	1	1	1	1	1	1	1
Reading	25	1		1		1	1		1	1	1	1	1	1	1
E-Learning	24	1		1		1	1	1	1	1	1	1		1	1
Contact	24	1		1		1	1	1	1		1	1	1	1	1
Games	24	1		1		1		1	1	1	1	1	1	1	1
Second Language	23	1		1		1	1	1	1	1	1		1		1
Memory	23	1		1		1	1		1		1	1	1		1
ADHD	23	1		1		1		1	1	1	1		1	1	1
Complex aids	23	1		1		1	1	1	1	1	1	1		1	
Tutorial	23	1		1		1	1	1	1		1	1		1	1
Trainings	22	1		1		1		1		1	1	1	1	1	0
Forum	22	1				1	1	1	1		1	1	1	1	1
Theories	22	1				1	1	1	1	1	1		1	1	1
Learning	22	1		1		1	1			1	1		1	1	1
Study aids	22	1		1		1		1	1	1	1			1	
Tips	21	1		1		1	1	1	1		1	1	1	1	1
Coping with fatigue	21	1		1		1	1	1	1	1	1	1			1
Studying in higher education	21	1		1		1	1	1	1		1		1		1
Tips for the job	21	1		1		1	1	1	1		1		1		1
Assistive technology	21	1		1		1	1		1	1	1				
Reading aids	21	1		1		1		1	1	1	1			1	
FAQ	21	1				1	1	1	1		1	1		1	1
Hotline	20	1				1		1	1		1			1	1

Item / Respondent	Total	Bl	Ja	L	Ž	Mi	Kn	Kr	Hon	DB	JC	T	Mich	KJ	Ka
Writing aids	20	1		1		1		1	1	1	1			1	
Community zone	20	1		1				1	1	1	1	1			1
About us	20	1				1	1	1	1		1	1		1	1
Life Stories	20	1	1	1		1	1	1		1	1				1
Study Skills	19	1		1		1		1		1	1		1		1
Math	19	1	1	1				1	1	1	1				1
Assessment	18	1		1		1			1	1	1				1
Moods, depressions	18	1		1		1	1		1	1	1				1
Online-User-Guid- ance	18	1		1		1	1	1			1		1		
Causes	17	1				1		1	1	1	1		1		
Listening	17			1		1	1	1	1					1	
Innovation corner	17	1		1		1		1	1		1	1			1
Reading difficulties	17	1							1	1	1			1	1
Self-Assessment	16	1		1				1	1	1	1			1	1
Neurology	16	1		1		1	1		1	1			1	1	
Questionnaire	16	1						1	1		1			1	1
Spelling	16	1		1			1		1		1			1	
Reasoning	16	1				1		1	1		1	1		1	1
Every day routines	16	1	1			1	1	1			1	1	1		1
About Literacy	16	1		1		1	1		1		1				
Manual	16	1				1	1	1			1	1		1	1
Every day Life	15	1					1		1	1	1				1
Writing	15					1	1		1				1	1	1
Talking	15		1	1		1	1		1			1		1	1
Attention	15					1		1	1					1	
Provision	14	1						1			1	1			
Attention with a special mind	14	1		1		1					1	1			1
Lifestyle	13	1		1		1			1		1				1
Phonology	13	1					1			1				1	1
Organized, unorganized	13	1				1			1	1	1	1	1		1
Advantages	12	1				1			1		1				

Item / Respondent	Total	Bl	Ja	L	Ž	Mi	Kn	Kr	Hon	DB	JC	T	Mich	KJ	Ka
Counting	12					1	1	1	1					1	
Sensory	11					1						1		1	
Self-Esteem	10								1					1	
Assertivity	9					1			1					1	
Learning	8					1								1	
Processing	8					1	1					1			
Harmony	6					1			1			1			
Reading	1					1									

Introduction of Czech Assessment Battery for Students with Dyslexia in Tertiary Education

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Keywords: dyslexia, tertiary education, assessment battery

Abstract

The paper introduces fundamental principles of a new assessment battery for students with dyslexia in tertiary education. There is an assessment battery for adolescents and adults in the Czech Republic. However, this battery has proved to be rather insufficient in the course of assessment of students in tertiary education. The project ExpIn thus included an adaptation of the battery as one of its goals. The new battery has already been piloted and is prepared for further standardizations. The paper will present the theoretical background of the battery adaptation and the outcomes of the pilot stage.

1 Background

In 2008 a complex assessment battery for adolescents and adults with dyslexia (Cimleřová, Pokorná, Chalupová et al., 2008) was released. This was the first attempt to assess older individuals than children. The battery is divided into eight modules and it covers various areas of dyslexia. Apart from reading and writing tests there are tests on phonological processing, visual discrimination, spatial orientation, verbal skills, concentration, and fine motor skills. The battery certainly proved its importance and is used throughout Czech counselling centres, especially in the course of adolescent assessment.

Since the assessment battery was published, it has also been used by tertiary education counselling centres as this is the only assessment device which may be applicable when a university student asks for dyslexia modifications. Repeated experience from various tertiary education counselling centres showed that the battery was not always suitable for the assessment of university students (e.g. Zelinková, 2012). Among the most frequently mentioned comments was a lack of reading and writing materials. The tests appeared too easy for university students and they did not point to specific needs of university students. Many of them gained similar results as intact population even though they described traditional dyslexia problems.

Thus, a need to create a more precise assessment device which would differentiate among university students with and without dyslexia arose. The aim was to create the assessment approach which would describe one's strengths and weaknesses and it would combine a traditional assessment and a functional assessment. As far as the university study is concerned the assessment for a label does not seem as crucial as the assessment of particular study needs (Goodwin, Thomson, 2010; Smythe, 2010).

1.1 Various assessment devices – inspiration

According to I. Smythe (2010, p. 19) the key areas of dyslexia testing include:

1. literacy skills
2. cognitive skills
3. study skills
4. learner preferences
5. visual stress
6. keyboard skills
7. executive functioning
8. ICT needs
9. word-dependent skills analysis.

The idea to adapt the current assessment battery into a new version suitable for university students did not consider all the above mentioned areas. However, the literacy skills, some of the cognitive abilities as well as executive functioning became the target areas of the assessment. Apart from analysis of already conducted assessment procedures, which emphasized what needed to be changed and what should have been kept in original version, the adaptation of the battery was also inspired by principles of different assessment devices created and used abroad.

The most important inspiration came from different literacy skills tests. The existing test in the battery only requires reproduction of two stories, which an examinee has to read (either aloud or silently). Many foreign tests use various other options to survey comprehension. These also demonstrate the ability to work with information. Especially in case of more talented individuals who are accustomed to reading comprehension and handle this skill on a basic level relatively well, a more in-depth test of literacy skills is necessary. Tests generally contain shorter articles on various topics and use different vocabulary and styles. Follow-up multiple-choice questions are then related to the content (Bartlett, Moody, 2004). One of such examples of a literacy skills test which inspired the adaptation of the battery was Wechsler Individual Achievement Test (2001).

Another source of inspiration was a Comprehensive test of phonological processing (Wagner, Torgesen, Rashotte, 1999). The test measures three areas of phonological processing, which the authors declare as its fundamental parts – i.e. phonemic awareness and processing, auditory short term memory, and rapid naming.

2 New version of the assessment battery

The new version of the assessment battery is being created within a project entitled *Network of Expert Centres Providing Inclusion in Tertiary Education (ExpIn)*. The aim of the project is to create a network of collaborating institutions providing practical services to individuals with special needs in tertiary education (retrieved from: <http://www.teiresias.muni.cz/expin/about-the-project>). The network covers universities throughout the Czech Republic and is led by Teiresiás, Masaryk University, Brno. One of the project objectives is modernization of the dyslexia assessment battery. The team responsible for this modernization includes one of the authors of the existing battery (P. Cimlerová) and

experts from several university counselling centres who deal with students with dyslexia (Masaryk University in Brno, Czech Technical University in Prague, Charles University in Prague, University of West Bohemia in Pilsner). As the starting point members of the team analyzed assessment reports of university students which they had carried out between 2008–2012. The outcomes of this analysis served as one of the sources of information for further adaptation of the assessment battery. In the course of the project new parts of the assessment battery are expected to be created. Furthermore, the battery should be piloted and standardized.

2.1 Literacy tests

Interviews with university students as well as observations of their special study needs revealed the necessity to assess their literacy skills more in-depth. Compared to the assessment battery published in 2008 the adaptation will include nine different texts, each approx. of 500–600 words. One text is fiction; seven other texts are either popular scientific texts or professional scientific texts. They include topics of social sciences, geography, chemistry, and mathematics. The texts were adapted from journals, university textbooks and/or professional publications. The choice of the texts was driven by a demand of rather complicated texts which would include long sentences, combination of scientific expressions and less frequent words as well as expressions which would point to traditional dyslexic reading difficulties.

The ninth text is a non-word text used also as a part of the previous assessment battery. Compared to foreign non-word texts, which usually involve a list of non-words, the Czech version comprises pseudo-sentences. The text appears as a normal coherent text. This text and two other texts require loud reading; the other texts are read silently.

Except the non-word text all the other texts are accompanied by specific tasks on reading comprehension. Seven out of eight texts are followed by nine questions divided into three kinds of questioning: 1) multiple-choice questions linked to the content of the text; 2) true-false statements; 3) sentences to be completed in accordance with the text. One of the texts is followed by the so called auto-dictation. The examinee is asked to rewrite the outline and the plot of the text in one's own words. This test inquires both comprehension and writing skills including note taking.

The unresolved question concerning the literacy part is whether the texts will be all administered in a course of the assessment or particular texts will be individually chosen according to one's university subjects and needs. Even the pilot study did not offer an answer to this question. The sample included students of social sciences, languages, natural sciences and even technical subjects. However, there was no agreement among students whether the texts which were closer to their subjects were also the texts which they processed more easily. Some natural sciences students declared that texts on social sciences and fiction were the easiest. On the contrary, the social sciences and language students repeatedly considered the math and/or chemistry texts exact and easy to comprehend.

Another important part of the assessment which needed revision was the writing part. University students are used to writing rather long and complex texts. They have to be able to take notes during lectures and also write essays and presentations. The assessment should target at all such areas of skills and possible difficulties. The above mentioned

auto-dictation is one of the sources of information. Further tests include traditional dictation, a test of syntactic competence, and a test of morphological competence.

2.2 Phonological processing tests

Another rather large part of the assessment battery included four tests of phonological processing, particularly segmentation, blending, and two tests on manipulation with phonemes. The segmentation and blending tests are both based on non-words, which eliminate previous experience with words. One of the critical comments of the current assessment battery (Zelinková, 2012) was that the segmentation and blending tests included rather long existing words and a lot of examinees complained about not being able to remember the phonemes as opposed to the process of blending and segmenting words. Thus, the tests may actually measure a different variable than is supposed to. Considering this experience the current version of the phonological processing test includes shorter but more complicated words with specific Czech language phenomena which will hopefully primarily observe phonological processing abilities.

According to V. Pokorná (2010) the ability to say meaningful words backwards is the highest ability of phonological manipulation. As the assessment battery is aimed at university students and their abilities are traditionally considered rather high, moreover they are pretty much able to compensate for their difficulties, the battery required several more complicated tests which may map the phonological processing. Therefore a test of phonological manipulation – saying words backwards – was also involved. The last test of phonological manipulation is included from the current battery as the analysis of university students' assessments revealed its validity.

2.3 Semantic versus verbal fluency

The current battery included a traditional test of verbal fluency, which is a part of various neuropsychological tests. Experience of our Swedish colleagues indicates that it is valuable to use two types of fluency tests (Lavesson, Wigforss, 2009). In the first test of semantic fluency examinees are instructed to name in one minute as many words that fall into certain categories (e.g. fruit, animals) as possible. The second test focuses on phonemic fluency and it requires naming a list of words starting with a certain phoneme. Individuals with dyslexia are expected to perform significantly lower in the latter test (Lavesson, Wigforss, 2009). The standardization will prove this assumption.

2.4 Visual perception tests

Two visual perception tests which were involved in the current assessment battery for adolescents and adults both appeared to differentiate rather precisely (Cimlerová, Pokorná, Chalupová et al., 2008). One of the tests had a very high validity; the second one was not standardized as there were too few stimuli to state norms. Both tests were slightly adapted. The first one was made shorter as the analysis of the project team revealed that the current test had never been completed. On the contrary, the second test was made wider as more stimuli were added to a new version. The first test demands visual discrimination of written information which may be the same or may differ in slight details. The second test requires visual-motor perception and it is based on mirror reflections of words. A subject is asked to state which of given words is a mirror reflection of a certain word.

2.5 Memory tests

Memory test were not included in the existing assessment battery. However, short term memory and working memory are considered traditional areas of deficits among individuals with dyslexia (e.g. Bartlett, Moody, 2004; Nicolson, Fawcett, 2008; Reid, 2003). This fact led to the inclusion of memory tests into the new version of the battery. As short term memory tests (especially digit span tests) are a usual part of various tests of cognitive abilities, these test were not involved. However, two tests of working memory based on auditory information processing were created and/or adapted into the assessment battery.

3 Conclusions

In January 2013 the first version of the battery was piloted on twenty-two subjects. The pilot revealed certain inconsistencies in literacy tests. The analysis of answers in text comprehension tests is required to omit questions which may be misleading and/or unclear. Furthermore, writing tests need clarification and certain changes so that they will grant sensitivity to dyslexia matters. Finally, memory tests need further specification and some of the questions have to be changed. All the tests also need to specify proper evaluation procedure. In some cases more than one answer is correct, in other cases (e.g. auto-dictation) the evaluation is not so straightforward and a system of evaluation has to be stated to minimize the risk of misunderstanding and mistakes. However, the complete battery will certainly enrich current assessment possibilities of university students and possibly also other adults with dyslexia.

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