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Preface

The **Universal Learning Design International Conference 2011**, held on 8–11 February 2011 in Brno to celebrate the 10th anniversary of the founding of the **Teiresias Centre at Masaryk University**, provided the first opportunity for a practical presentation of the universal accessibility design of tertiary education and a possibility to share experience with professionals who take care of the practical matters and thus technologically, organizationally, legally, linguistically, psychologically or pedagogically provide for the universal learning design at the university level in Europe as well as other parts of the world.

210 participants took part in the conference, 42 of whom gave a paper or workshop.

The programme of the conference was divided into four thematic tracks and enriched by accompanying events such as thematic workshops and other presentations.

Keynote speakers and chairs of individual sections were:

1. Standards of Universal Learning Design at Universities and Testing of Persons with Special Needs
   - **Alan Hurst**, Skill: National Bureau for Students with Disabilities, London
   - **Joachim Klaus**, Study Centre for the Visually Impaired Students, Karlsruhe Institute of Technology
2. Linguistic Competence of the Hearing Impaired and the Role of Sign Languages in Tertiary Education
   - **Arnfinn Muruvik Vonen**, Department of Special Needs Education, Faculty of Educational Sciences, University of Oslo
3. Universal Design of Electronic Documents and Public Electronic Libraries for Purposes of Tertiary Education
   - **Klaus Miesenberger**, Institute "Integriert Studieren", Johannes Kepler University Linz
4. Specific Learning Disorders and Other Types of Neurodiversity in Tertiary Education and Compensation Devices
   - **Willy Aastrup**, Counselling and Support Centre of the Danish School of Education, University of Aarhus.

The conference offered an opportunity to present partial results of the project Universal Learning Design – Innovation in Interpreting and Communication Services within the Operational Programme "Education for Competitiveness" of the European Social Fund. The conference was therefore partly financed by the European Social Fund.

Masaryk University would like to follow up the first year of the Universal Learning Design conference and to organize other events of this type in the following years. The first opportunity will be the **13th ICCHP conference at Johannes Kepler University Linz**, Austria, where the second year of the ULD conference will take place as one of the thematic sessions.

In the present proceedings, full texts of the papers given in the individual tracks are published; further information and materials that were available to the conference par-

ticipants or which were part of the partial output of the conference up to now (abstracts, presentations and electronic versions of the full texts of the individual papers, video recordings and speech to text reports from the conference rooms, etc.) are available to registered participants online on the conference website www.uld-conference.org.

ULD conference organizers

Section 1

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

Modifications of the admission tests at the Faculty of Arts of Charles University in Prague – options and limits

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Keywords: Physically disabled individuals, special educational needs at university studies, modification of entrance examinations and study programmes, putting modifications into practice at the Faculty of Arts, CU in Prague.

Abstract

The article deals with some issues regarding equal approach of disabled individuals to university education in the context of terms and conditions of studying at Charles University, Faculty of Arts, Prague. It deals with the options and limits of modifications of entrance examinations and the study programmes themselves. The modification of study requirements forms an essential prerequisite for successful admission, process and completion of university studies for individuals that have special educational needs. The modifications are based on the student's needs and at the same time on the programme's characteristics, on the graduate's profile, type of study, possibly even the possibilities of further assertion on the job market. The broad range of programmes offered at the Faculty of Arts, CU in Prague presents a variety of experiences.

1 Introduction

The article deals with modifications of entrance examinations and study programmes for individuals with special educational needs in the context of university studies, and it focuses on the practice that has been applied within the past several years at the Faculty of Arts, Charles University (CU) in Prague. It respects that one of the assignments of the National Action Plan for Inclusive Education is also equalizing opportunities for disabled individuals at universities. At the level of the Charles University in Prague we also reflect the Rector's Provision 25/2008 *Minimal standards of support provided for students and prospective students with special needs at Charles University*. Among other things this document states that "*the goal of Charles University's activity given in the document is to allow all students and prospective students, without regard to the nature and level of their disability, equal access to education, to develop their character, talent, intellectual and physical abilities in the scale of their full potential.*" This document distinguishes the following groups of students or prospective students with special educational needs:

a. Persons with locomotive disabilities;
b. Sight impaired persons;
c. Hearing impaired persons;
d. Persons with specific learning disorders;
e. Persons with psychological and psychiatric disorders;
f. Persons with chronic somatic illnesses or weaknesses;
g. Persons with combined disabilities;

The article talks about the whole group of prospective students with special educational needs or we name a certain group specifically. Opposite to elementary and secondary schools, where persons with special educational needs are considered to be children, pupils and students with disabilities or students that are socially disadvantaged as well as exceptionally gifted students (e.g. Mertin, 1997), we will use the term special educational needs in the sense of the groups of students or applicants mentioned above (meaning that we exclude exceptionally gifted students and to a certain extent those that are socially disadvantaged).

2 Individualization as One of the Principals of University Studies

The Czech education system is on the whole still based on the principal of **masses**, according to which all pupils and students should master individual requirements in the same way and at best all in one period. Only postgraduate studies (doctoral) are based primarily on **individualization**. In general among the public as well as among pedagogical professionals, individualization of studies and of evaluation creates the impression of favouritism, privilege, inadequate alleviation and at the same time a certain amount of unfairness towards other students. Individualization as an education principal is valuable for all pupils and students, for disabled students it is more of a necessity. The right of an individual to be educated along with others (inclusion) is being applied laboriously. Nonetheless, it represents the dominating direction of the education system (Gillernová, Mertin, 2008). What remains an open question is the readiness of schools and teachers for the transformation of the way they look at **shared and modified education** of pupils and students with various special educational needs and the conditions for educating in such a way.

For a long time the individual's **singularity** (difference, disorder, illness) represented often a fatal obstacle on the way to successful education in mainstream education. Professional awareness was not feasibly inclined toward inclusion, although many inspiring examples of exceptional individuals with a disability, whose specific educational path led to receiving a very good education, already existed in the past. Let us mention one for all. It is the story of the deaf and blind Helen Keller from the turn of the 19th and 20th century, which is well known to the media:

The destiny of Helen Keller, who became deaf and blind when she was about two years old and still she managed to graduate from Harvard, may seem so unusual that her destiny may appear to come from another world. H. Keller was born in 1880, that is at a time when specialized fields or education itself were in no way inclined to educate disabled individuals, and not in the least within the main education path. Special education, special fields of study, special assertion in life represented the peak of progress. However, Helen's parents wanted her to live as much as possible as other healthy children. An incredible amount of effort on the side of Helen's parents, her assistant, Helen's own effort and hard work (certainly also her great capabilities), resulted in the fact that she learned several foreign languages and was able to study at Harvard. Perhaps she was exceptionally gifted, perhaps it was due to some lucky circumstances; nevertheless, the main thing is that hours and hours of tiring and sometimes useless hard work were behind her success. The message she left us is that you must keep hoping to achieve your goals. In her letters she describes how she managed to

pass examinations at secondary school. "It was decreed that I should take my exams in a different room, so the noise coming from the typewriter would not disturb the other girls. Mr. Gilman read to me all the questions with the help of manual alphabet. A man was guarding the door so there would be no interruptions. On the first day I had an examination from German. Mr. Gilman was sitting next to me, first he read the whole page and after that each question individually, which I repeated out loud so we would be sure that I understood them correctly..."(Jarošová, 2009, page 209).

Although the singularity of each child and individualization of education is generally and orally accepted in the Czech education system, its actual assertion is still hard to implement. We can find integrating tendencies in the world already since the 1940s. For example in Great Britain there is the Education Act of 1944, which sets for local education offices the duty to educate the disabled "*either by regular school attendance or in other ways*" (Armstrong, 2007). Basically two education systems were developed in the Czech Republic: unified education for healthy children and high quality special education for children and youth requiring special care. The tendency to integrate individuals with disabilities into the main education stream has gradually become predominant after 1989. Several years ago a legislator came with the idea of individualization for all pupils at elementary and secondary schools and this **obligation to respect singularity** is embedded in the Education Act that is valid as of 2005. The Act states that education is founded on the principles of "*taking into consideration the educational needs of an individual*" (Education Act, Section 2, Subsection 1b). It is thus essential that each individual has an equal opportunity to educate him/herself. Sex, race, religion and social-economic status cannot be an obstacle towards receiving an education. Being disabled must not be a discriminating factor either, unless it is directly related to the given field of study or to being able to carry out the future profession.

The acceptance of exceptions brought a certain move in the approach towards different individuals. This was more of a humanity gesture rather than a thought through pedagogical measure. For university studies the exceptions were connected with e.g. pardoning some obligations. A disabled individual received a mainstream education, however, he/she did not have to attain certain knowledge and abilities or the person attained them to a lesser degree and quality. At first glance the procedure when exceptions take place or even when some obligations are exempted appears to be pedagogically correct and at the same time very humane. However, if we take a closer look, and from the point of view of an individual's long-term educational perspective, this approach is not productive – it is erroneous. While within an education system it is possible to secure significant exceptions for elementary, secondary schooling and to some extent even for university studies, in real life this can be done only to a very small degree. Especially if the employer can choose when the work position requires specific abilities (*e.g. to read and understand quickly, to deal with correspondence without errors*).

There is one other relevant reason for looking for other ways than making exceptions to help educate disabled individuals. Let us presume that pupils learn in school relevant knowledge and attain abilities that are necessary for further education, or even for performing a profession or for regular everyday life. If we alleviate the study programme for an individual, he/she will not master the subject's content, will not acquire the skill, and

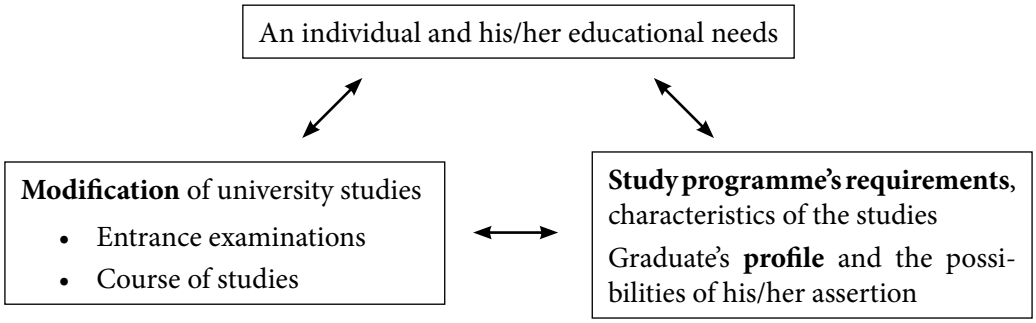
will not then be able to successfully continue in receiving further education. If we think through the procedure of using exceptions *ad absurdum*, then a graduate of a university will have the necessary qualification, but will not know much, or the person will not have mastered some of the relevant parts of the programme. At the same time in our country some professions require qualifications that are documented by a leaving certificate from a corresponding type of school. It is presumed that the student fulfilled the given standards of education with an adequate quality (at least sufficiently).

For at least these reasons we prefer a different attitude to adjusting the approach towards students with special educational needs. Today instead of the former exceptions we primarily use **adjustments or modifications of educational approaches and contents**. The word modification that we use is not all that important, but what is important is the changed approach towards education among these pupils and students. While in case of exceptions we resign on fulfilling the educational goals and we accommodate the disabled person by lowering our requirements, by not insisting that he/she does not need to learn the given material, does not need to do one thing or another; in case of modification we adjust the environment or procedures in such a way that allows the disabled person to achieve everything just like intact individuals, i.e. persons without disabilities. It is obvious that this change is supported by technical progress, which allows us to adjust several requirements quite easily. It is possible to copy and enlarge a text, give access to a learning text by recording it, it is possible to use voice output, and assistants are at the disposal of disabled students. Modifications are not exceptions, because they result from deeper understanding of real educational needs and they take into account even the learned content. For example, by giving more time to a bad reader when writing a written examination from mathematics will allow him/her to devote the same amount of time to solving the mathematical problems as his/her fellow students that are stronger readers. A written math exam does not test reading and a bad reader should not have to pay for his/her reading insufficiencies in mathematics. Therefore, this is not an exception, but it gives equal opportunity to a dyslectic (bad reader) to show his/her knowledge of mathematics and it modifies the way a common task is carried out (Krejčová, 2010). This is the basic principal of universities' approach towards modifications.

3 Modification of approaches at universities and their possibilities

In the Czech society, universities and colleges represent selective institutions, among which education represents a large bonus for graduates of this level of education. It is clear that still some university professors are convinced that the only criteria for accepting a student is that he/she masters all of the requirements allotted by them. However, education does not only have value for the individual, the achievement of which only comes from a personal decision and personal merit, but more and more social value is also ascribed to it. The society is interested in having its members educated at the highest level because it believes its competiveness increases, among other things. The society also recognizes more and more that it is not possible to only offer education to an individual, but that it is necessary to help him/her master each education level. At universities it is also recognized that some applicants (students) cannot fulfil the study requirements only because some partial personal characteristic distinctly complicates their access towards

education, even though it does not have anything to do with the field of study. The moment when the form and organization of the studies is adjusted to the student's needs, he/she receives the opportunity to fully assert his/her abilities. At the same time we hold the opinion that while at the elementary and secondary school level the educational system must help all individuals with learning problems, a grown-up individual (university student) must put in his/her own effort. **The optimum seems to be** a university that offers **individual support** in the form of modification while considering **not only the specific educational needs, but** at the same time also **the requirements of the given study field** (Figure 1). At universities modifications may relate to **entrance examinations, organization of lessons, adjustment of learning tools, and the form of fulfilling the requirements of attestations.**



[Fig. 1]

Admission represents a challenge for the applicant and even for the university itself. If the university decides that the requirements of individual programmes, their study plans do not represent a contraindication for the specific form of disability (e.g. the study of medicine requires the applicant's good health condition etc.) and that it will accept an individual with the specific disability, then traditionally the first approach used for the **entrance examination** is **exception** – the individual does not have to go through the whole or part of the admission procedure, for example persons with impaired sight do not have to take the written part of the entrance examination. Let us remind ourselves that partially this approach was given by insufficient technical means, we respect that the applicant with special educational needs should have equal chances to apply, to be accepted just as an individual without a disability. For him/her the obstacle represents his/her disability. Therefore, we try to **modify** the conditions of entrance examinations in such a way that would eliminate the effect of these obstacles as much as possible. We can even eliminate some completely (*wheelchair access to entrance examination rooms*), some we can eliminate only partially (*a dysgraphic person writes the test on his/her notebook, a person with impaired sight receives the assignment written with larger letters*), but it is also true that for the time being in some cases we do not know how to overcome the obstacles related to the given disability, or that overcoming them represents such a complication that it is easier to choose an alternative solution including exceptions, but only as the last resort. It is important to realize that each modification has its down sides, because some circumstances remain present, and we do not know how to grasp and evaluate their importance and impact. *For example we increase the size of letters to twenty-four for a person with impaired sight. That way we provide him/her with suitable access to the text,*

at the same time it is possible that his/her orientation on the surface may become worse in comparison to intact individuals. The time that he/she must devote to become acquainted with the assignment may prolong slightly. It is then logical to give the person more time to solve the assignments. But how much time? Should we add 50%, won't 10% be enough? Empirical verification would certainly help, but for that we do not have data from a large enough group of such applicants. The idea behind modification is such that they should help achieve a corresponding result only to for the individual with the specific disability, while persons with other disabilities or without disabilities should not be helped by them. This requirement was recorded in the so-called **interaction hypothesis**, according to which any kind of adjustment of an examination is valid if **individuals with a disability profit from it; others do not** (Mertin, 2006). This actually means that an intact individual should have the same results with or without the modification.

Modifications of studies are carried out with the help of individual study plans (ISP). Modification of the **course of study** is a more complex process, during which at first the student with special educational needs is confronted in detail with the demands and requirements of the specific programme. There is a wide range of requirements for fulfilling the study plans at the Faculty of Arts, which reflects the reality that there are many programmes that can be studied. Only then on the basis of an agreement between the student and the department is it possible to suggest a modification. It is necessary to state that mere lowering of the number of credits can be a manifestation of an exception, which does not get us anywhere; respectively it can start off extension of studies, postponing difficult examinations etc., and in the long run even not completing the studies. Sometimes all that is needed is to understand the student's needs (e.g. a talented blind student does not need to have a lowered number of credits needed for proceeding to the next year, but in order to adequately fulfil the requirements he/she needs specific learning tools; a student whose specific educational needs result from his/her current state of health, may just "need" to have an individual regime set for attending lectures and seminars; a dyslectic student may just "need" to have modified the form of examinations in foreign languages).

3.1 Modification of entrance examinations

We are able to partially evaluate modification due to the several years of **experience** we have with it at the Faculty of Arts, CU in Prague. At the Faculty of Arts, CU in Prague there is a great **variety of programmes** (there are studies focused on history, linguistics, philosophy, art and studies with a social science focus), while each programme or group of programmes have **specific demands and requirements on the applicant or student**. These specifics are reflected in entrance exams for the given programme, and their modification with regard to the special educational needs of prospective students is made possible each year due to the conditions for admission to the Faculty of Arts, CU in Prague.

When making a decision regarding future studies it is important to consider not only the **admission process, but also the requirements of the studies themselves and of the future profession**, since at the Faculty of Arts there are programmes for which it is likely that some disabilities may represent contraindications (e.g. film studies, archaeology), just as e.g. the study of medicine presumes that the student is healthy, or at the Faculty of Education it is presumed that the student will pronounce properly, since a major part of

the teaching profession is formed by verbal expression. Contraindication of studies needs to be evaluated with great care and with regard to the future profession. There are several study fields where there is such a wide range of related work positions to choose from that it is possible to imagine a disabled person finding some sort of manageable work in the profession.

Therefore, it is suitable for the applicant to become well acquainted with the admission requirements as well as with study demands and work options. The prospective student hands in along with the regular application form a request form for modification, which he/she supports with a report from the given specialist. The report should not be older than two years and it should be issued by a specialized institution that takes care of the prospective student on long-term basis in relation of his/her disability. Gradually we pay more attention to the fact that the report comes from a specialized institution, which is competent to attend to the disability (e.g. the diagnosis of dyslexia coming from a doctor working at the railway health centre is not acceptable anymore). With some forms of disabilities it may seem to be redundant for the prospective student to keep on documenting it over and over again on account of its unchanging character (e.g. severely damaged sight); however, the report from a specialist should more specifically comment on the modification of the entrance examination, possibly the study itself – changes may occur here. At the same time it may be adequate for the specialist to give his/her opinion on the suitability of the chosen programme. The Vice-Dean responsible for the admissions in collaboration with the faculty's specialized department and the relevant programme's department evaluates all of the applications, and he/she will decide and send the prospective student information regarding the form of the entrance examination's modification.

A certain **problem** connected with the request for modification emerges up when neither the prospective student nor the specialist becomes acquainted with the content and the form of the entrance examination, and the specialist's recommendation is not set on reality, and his/her report is not sufficient for the university's decision. If e.g. all the tasks in the test are *multiple-choice*, and the correct answer is marked by a cross or by a circle, then it is inadequate to ask that the conditions are modified by using e.g. a notebook or by giving more time to individuals that are dysgraphic or dysorthographic. Equally the diagnosis itself is not helpful, neither is a medical description of the applicant's state of health or results from laboratory tests etc. A medical diagnosis per se does not automatically tell us what necessary measures need to be done. General recommendations are also hard to use when choosing the form of possible modification (e.g. it is pointless if a specialist writes "*with regard to the disability it is necessary to approach the prospective student individually*".) The given facts of the state of health must thus be transformed into educational psychological measures.

It is definitely **not possible** to set modifications **mechanically** – as an example of a modification that cannot be completely justified we can give adding more time than necessary (e.g. twice as much time). This is especially true for assignments where the time limit is a relevant variable, which should help choose suitable candidates. In the future we can consider as relevant criteria for the amount and specific form of modification the effort the applicant made up to the given time – some disabilities may have a permanent character, but it is possible to improve the applicant's adaptation to the conditions, to new tools. With other disabilities (specific learning disabilities, ADHD, stuttering etc.) the

applicant should work permanently on improving his/her state with a professional institution. Our experience so far tells us that this is not often the case. We have come across cases when the applicant was diagnosed years ago, and since then he/she has not attended a specialized institution, only currently in order to receive the recommendation for modification of the admission procedure. With respect to the acceptable number of prospective students asking for modifications of entrance examinations, it is thus important and for the time being also practically possible to contact the specialized institution and even the applicant him/herself in indicated cases. Our experience with communicating with applicants regarding the modification of entrance examinations are overall positive, and among professionals we have the best experience with special education teachers, school psychologists and counsellors, to a lesser degree we are able to make use of information received from medical doctors and clinical psychologists. The Faculty of Arts, CU in Prague wants to provide relevant modifications of admissions, but it must also defend the interests of all applicants and cannot privilege some groups of prospective students.

Examples, experiences, reflexion

The following types of modifications belong among commonly used and effectively performed modifications of entrance examinations at the Faculty of Arts, CU in Prague:

- Extending the time limit for taking a test. If the applicant is e.g. dyslectic we add about 20% of the given time (the added time is for reading the assignment, not for its solution; that is why the added time may seem relatively short). If the applicant reads with rows of Braille or voice output, he/she has an assistant at his/her disposal. If the person is physically disabled, the time may be extended more distinctly – maximum by 75 %.
- Letter enlargement – the usual sans serif (e.g. Arial), if needed bold, word size 20-24 (in such cases we also increase the time limit by about 10%, because it is more difficult for the prospective student to get oriented and to work with the test.)
- Taking advantage of computer technology. The applicant can use his/her own (possibly the faculty's) computer with e.g. a voice output, Braille display. Similarly if the applicant is severely dysgraphic a notebook can be permitted.
- An assistant from the relevant programme's department reads questions and writes down the answers.
- The prospective student writes answers directly next to the questions, an assistant then rewrites the answers onto the answer sheet while the applicant supervises this.
- The applicant takes the written part of the examination in a different room, possibly with one or two more applicants that are taking a modified entrance examination.
- It is also possible to extend the time limit during oral examinations if the prospective student stutters. In this case it is possible to combine written form of expression with oral expression.

With some modifications it is not necessary to bring the office or specialized faculty apparatus into it. If an applicant has problems hearing and the only thing that he/she

requests is to sit in the front row, it is best to accommodate the person on site. This decision is then in the authority of the person responsible for the room, where the written examination is being held.

If we take into account the fact that the modification is always provided by the faculty for an individual's specifically stated problem and at the same time for a specific entrance examination, it is senseless to burden the applicant and the faculty's apparatus if he/she asks for modifications that are unnecessary with regard to the character of the examination. However, it is easier to deal with and reject an undue request for modification than to subsequently deal with a request for revision on account of insufficient modifications.

Examples of rejected requests:

- The applicant asks for the modification of the written part while the entrance examination only consists of an oral part.
- The applicant asks for modification of the written part of the examination on account of dysorthographia and dysgraphia, while the only graphic thing the person does during the test is to make a cross in the boxes on the answer sheet.

Disputable requests:

- The applicant asks for a modification due to several disabilities, but he/she does not provide an expert opinion or other documents for some of them.
- The applicant asks for modification on account of specific learning disabilities, while he/she has already graduated from another university and he/she does not document that he/she has asked the previous school for any modifications.

It is always necessary to keep in mind that all of these measures are to equalize the chances of a disabled applicant and not to give him/her advantage over intact applicants!

3.2 Modification of the course of the studies and inspection of study requirements

Modification of admissions is usually an easier task, because it is a one-time affair, all of the participants are usually highly motivated in order for the examination to go well. Nevertheless, the actual studies, which have a wider range of requirements and demands and even time schedules, may present a larger obstacle. It is not possible to start studying, ask for distinct modifications and then to excuse oneself from some of the key study activities on account of the disability. It is likely that for several of the study fields it is possible (desirable) to clearly define requirements for the applicant's abilities.

Charles University in Prague offers students with special educational needs variously aimed **support**, usually through the Information and Advisory Centre. The environment at **the Faculty of Arts, CU, is also as a rule obliging towards modifications of studies**, it has several experiences with students whose hearing is impaired or who are deaf, with students whose sight is impaired (we have many experiences – e.g. the Czech Language Department in communicating with the deaf, operating the Language Resource Centre at the Faculty of Arts etc.). Students with locative disabilities usually require more materially technical support (wheelchair access). On the other hand students with **specific learning disabilities, students with psychological and psychiatric disorders**, and students with chronic health problems or weaknesses also often require modifications, and for the mo-

ment in such cases we proceed rather confusedly. Currently the number of persons who were diagnosed (usually during school age) with specific developmental learning and or behavioural disorders (most often dyslexia, dysgraphia, dysorthographia, dyscalculia, ADD syndrome, ADHD syndrome) and thus the number of university students with such diagnosis is increasing and it is necessary to adjust the course of their studies and the form of evaluation. The disorders manifest themselves by a complex number of symptoms, which may have effect on the study's course as well as the student's everyday life. In no way do these specific learning disorders represent a handicap that should prevent the student from graduating from the chosen programme, they are not connected with the student's talent or his/her ability to carry out the specific profession. The students must manage to fulfil the study requirements, however, the form of their course is to a certain degree adjusted – modified. At the Faculty of Arts, CU we can offer these **students and their professors** the services of the Psychological Counselling Centre (e.g. individual counselling focused on managing the study demands, including providing information regarding various compensating tools, which may help students receive information at lectures and their further processing, consultations with the student's professors, creating standard procedures for testing students).

In a similar way it is possible to work with students that have **psychological or psychiatric disorders or chronic somatic illnesses or weaknesses**. Their support and study modifications are based on having sufficient information regarding individual types of weaknesses, on individual approach (not only towards studies but also towards counselling) and at the same time they are based on helping the teachers who come into contact with these students, and who have study related demands on the students. Usually these are also disorders and illnesses that do not represent a handicap that would prevent the student from graduating from the chosen programme, they are not connected with the student's talent. It is also possible to consider socially disadvantaged students (the Romani) in this manner.

The above mentioned study conditions at the Faculty of Arts, CU in Prague, the possibility of support based on individual approach towards students with specific educational needs indicate the procedure for creating an **individual study plan with the need for modification (ISP)**.

Student's request for ISP

- The request form contains a description of the most distinct student's problems, which he/she has encountered during his/her studies, the student's specific idea of the form of modification (lowering the number of credits, attendance corresponding to the current state of health, modification for mastering the courses and their form of evaluation etc.). This request form is supported by a report from an expert (doctor, psychologist, special education teacher). The request form can be handed in at the beginning of each semester, in case of unexpected health complications even during the semester, but in a way that would allow the modification to take place. (Sometimes it is better to think about interrupting the studies on account of health problems). It is preferable if the student first discusses his/her request with the coordinator of support for handicapped students.

Consulting professors regarding the form of the modification

- Any modification must be supported by the Department's or Institute's report, where the specific studies are taking place. Therefore, in order for the suggested adjustment to be as close to the regular procedures as possible, it was carried out by specific teachers with regard for the individual possibilities of the given student and in compliance with the requirements of the given study plan.

Creating an ISP with the modification's specific content for the given academic year

- On the basis of this information, the coordinator of support for students with special educational needs will create an ISP, which will be signed by the Dean of the Faculty of Arts, and this document regarding the modification for the given academic year will be received by the student and the Head of the relevant department or institute at the Faculty of Arts.

Specific modifications reflected in ISP obviously have different forms, which especially consider the student's possibilities and his/her successful mastering of the courses without difficulties and complications. Mechanical lowering of the number of credits does not prove to be useful, on the opposite side measures that prove to be useful are the ones that are the result of the student's communication with the department's or institute's professor and with the faculty's specialist, who is responsible for working with students with special educational needs.

4 In conclusion

The change in the approach to university studies for persons with disabilities is based on the acceptance of the theory that if you manage to eliminate the effect of the disability, the disabled person has approximately the same possibility to study as an intact student. Modifications of the entrance exams and of the form of evaluation corresponds to this. Communication with specialized institutions, with the applicant/student him/herself and certainly with the department or institute, which carry out the modifications, proved to be useful when choosing the form of modification. Currently modifications of entrance examinations are better worked out and reflected at the Faculty of Arts, CU in Prague.

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A model of Accessibility Service Provision for Students with Disabilities in Higher Education

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Abstract

The number of universities offering services for students with disabilities has grown considerably over the last decade worldwide. Nevertheless, not all students with a disability receive adequate level of support, even in the same country. Providing effective academic services for students with disabilities demands among others thorough planning, appropriate organizational scheme, human resources with specific expertise, advanced technological support, considerable implementation effort and functional evaluation. This paper presents a model of accessibility service provision for students with disabilities in higher education. The development of the model is based on the analysis of the requirements of students with disabilities. The methodological designing of the services critically takes into account both Design for All and Individual Accommodation approaches. We emphasise the important role of advanced ICT systems for the effective service organization, management and provision and we describe the necessary specific applications. The involvement of public (environmental modifications e.g. in the libraries, student laboratories, infokiosks, etc.) as well as personal Computer Assistive Technologies is also presented. The services for the students with disabilities discussed in the paper include: recording of the needs of the students, evaluation of students' abilities, provision of Personal Assistive Technologies, accessibility of structure environment, transportation, psychological cancelling, provision of accessible text books and other educational content, training of the staff and the volunteers, developing of guidelines (e.g. for tests and examinations, for producing accessible educational content), accessible workstations in libraries and labs, evaluation of websites' accessibly, structural arrange of volunteer work for helping the disabled students, Video Relay Service and Sign Language Interpretation for deaf students, organizing seminars and meetings, dissemination of accessibility know-how (website, leaflets, posters, booklets). The organizational structure (at university, faculty and department levels for both the academic staff and the other employees), the involvement of disable students in the decisions along with legislative, financial and standardisation issues are also discussed. The application of the above model over the past few years in the University of Athens, the largest higher education institution in Greece, will be also presented.

1 Introduction

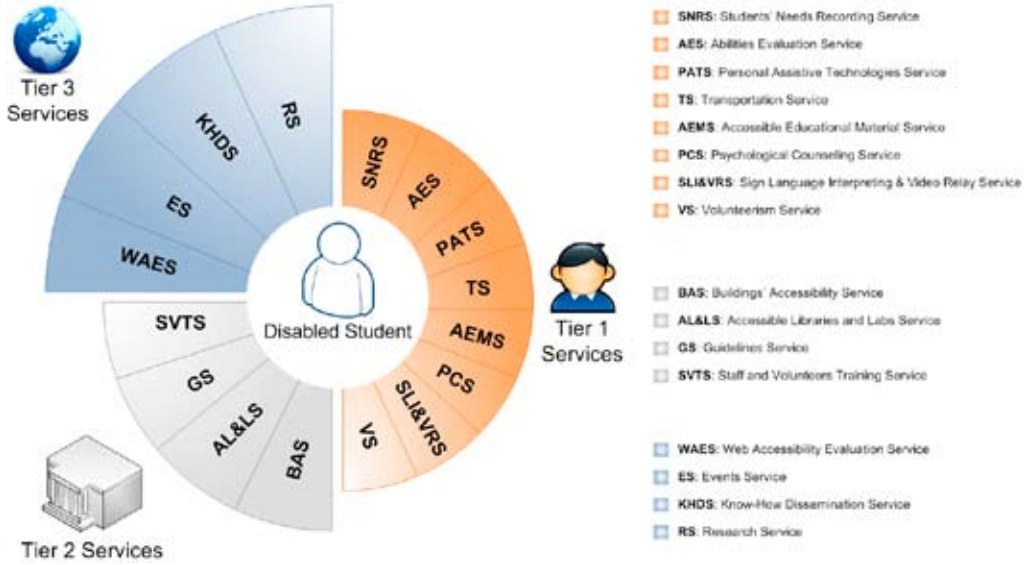
The number of universities offering services for students with disabilities has grown considerably over the last decade worldwide. Nevertheless, not all students with a disability receive adequate and equal level of support across countries or even nationwide. Providing effective academic services for students with disabilities demands among others thorough planning, appropriate organizational scheme, human resources with specific expertise, advanced technological support, considerable implementation effort and functional evaluation. In this domain there are only some very basic original metaphors, theories and models that have been developed to describe, explain, and develop good practices [Killean & Hubka, 1999], [Banes & Seale, 2002], [Embry et al, 2005], [Seale, 2006], [Boguz & Buxzynski, 2009], [Kiss-Glavas & Zubak 2009]. This paper presents a model of accessibility services provision for students with disabilities in higher education. The methodological designing of the services takes into account both the "Design for All" and the "Individual Accommodation" approaches. We emphasize the important role of advanced Information and Communication Technologies (ICT) for the effective service organization, management, and provision and we describe the necessary specific applications. The involvement of public environmental modifications (e.g., in the libraries, student laboratories, etc.) as well as personal Computer Assistive Technologies is also discussed. The proposed model has been successfully applied over the past years for the design and implementation of the Accessibility Unit for Students with Disabilities in the University of Athens, the largest higher education institution in Hellas.

2 Accessibility Services' Model

The basic requirements of the students with disabilities include:

- access to interpersonal communication with the members of the academic community,
- access to the structured environment of the university,
- access to the printed or electronic educational material,
- access to the board and the presentations in the classrooms,
- access to the exams/tests, and
- access to the information and the WWW content.

The proposed accessibility services provision model follows a student-oriented approach. It is based on the requirements' analysis of the students with disabilities during their studies. Moreover, this model influences their academic environment and the accessibility policy inside and outside the educational institution. The main pillar of this model is the "Accessibility Unit" which provides a number of supportive services, arranged in a three-tier architecture according to their "proximity" to the student: (i) accessibility services addressed directly to the student, (ii) accessibility services applied to the student's environment, and (iii) accessibility promoting services. Figure 1 presents a general overview of these logical layers (tiers) of the model, along with their services that are described in the next sections.



[Fig. 1] Accessibility services provision model architecture for students with disabilities

2.1 Accessibility Services Addressed Directly to the Student (Tier 1)

Services included in the first tier are directly dealing with specific requirements of disabled students. They have an immediate impact in a number of their activities, namely:

- participation in the educational process,
- interpersonal communication with the fellow students, the professors, and the university staff,
- transportation and housing accommodation, and
- interaction with their academic environment (e.g. libraries, labs).

2.1.1 Students' Needs Recording Service (SNRS)

The first contact of the disabled student with the Accessibility Unit is made through the Students' Needs Recording Service (SNRS). The service aims at a systematic and detailed registration of the disabled students' needs, and the main obstacles that might arise during their studies. Students are informed about the Accessibility Unit before entering the University through its website or during their registration. They are encouraged to fill out a Students' Needs Recording Form. This form is provided in alternative formats (paper, Braille, auditory, electronic) and can be submitted in various ways (online, email, telephone, fax). The SNRS is available during all the years of studies and can be revisited when students' needs change.

2.1.2 Abilities Evaluation Service (AES)

Trained staff of the Accessibility Unit meets with disabled students, after studying the output of the SNRS, and discuss the possible accommodations that are applicable to each one of them. Together, they conduct individual diagnostic assessments in order to determine main obstacles through the educational process, such as reading printed books, ac-

cessing libraries, navigating to university campus, test taking, etc., and figure out ways to accommodate them. The ultimate goal of the AES is to assign the services each individual student with disabilities needs. This goal is accomplish using the mapping of the student's accessibility needs with the services described in the model (Fig. 1).

2.1.3 Personal Assistive Technologies Service (PATS)

The PATS offers the infrastructure and the appropriate tools needed for testing and assessing a wide variety of Assistive Technologies (AT). Nowadays, computer based AT aim to augment and enhance the capabilities of students with disabilities towards independent and equal academic participation [Parette & Peterson-Karlan, 2010], [Voytecki et al, 2009]. Open Source and freely available AT software partially solve their cost problem and online inventories [Pino et al, 2010] facilitate the search for the appropriate product. The student's needs for AT and the potential efficiency of using a specific AT are evaluated based on the AES output. Personal AT is suggested or offered / donated to the student. Then, one-to-one training, technical support and consulting on AT is provided by the PATS.

2.1.4 Transportation Service (TS)

The Transportation Service provides accommodations on how motor-impaired students come to university from their home and go back. The students have to apply for transportation in the beginning of each semester and each examination period. This service comprises the use of special vehicles (usually vans in an urban environment) that can transport wheelchair users. The personnel of the TS include drivers and dedicated secretary.

2.1.5 Accessible Educational Material Service (AEMS)

The AEMS has the task of converting academic educational material into accessible format, in order to facilitate equity of access to information and knowledge especially for print-disabled students. The production procedure include number of steps: (i) receiving applications for a specific item (e.g., textbook), (ii) contacting publisher or author in order to acquire it (possibly in electronic form), (iii) scanning printed material; (iv) optical character recognition (OCR), (v) correction of the OCR output, (vi) transcribing text in order to conform with accessibility guidelines (e.g., description of figures, scientific formulas in MathML1[1], etc.), (vii) securing and distributing accessible material (in various formats such as e-book, Braille ready, and large print). For some disciplines, like Physics, Mathematics, Chemistry, etc., the production of accessible books requires dedicated methodologies [Klaus, 2009], [Federsel & Miesenberger, 2009], [Kouroupetroglou & Kacorri, 2010]. Students can submit their application for accessible transcripts at the beginning of each semester.

2.1.6 Psychological Counseling Service (PCS)

The PCS provides individual and group psychological counseling to students with disabilities. Disabled students may request advice on any of the following difficulties: (i) interpersonal and social relationships (difficulties in relationships with family, the other

1 http://www.w3.org/Math/

sex, and friends), (ii) academic difficulties and stress through study and test-taking period, (iii) low self-esteem, (iv) anxiety and phobias, (v) mood and eating disorders, and (vi) whatever makes it harder for them to function in everyday academic life.

2.1.7 Sign Language Interpreting and Video Relay Service (SLI & VRS)

The Accessibility Unit provides both SLI and VRS. Deaf students can ask for a sign language interpreter for a course. SL interpreters can be permanent personnel or outsourced. The VRS service addresses students with total or partial loss of hearing, dysarthria and severe speech disorders and generally those who cannot use the phone for interpersonal communication. This service intends to provide immediate remote interpersonal communication with fellow students, professors and administrative staff of the university.

2.1.8 Volunteerism Service (VS)

A disabled student, who needs assistance on a day-to-day basis, can apply for a volunteer help through the VS. Volunteers, who may be students or persons from the local community, are coordinated by the VS to aid and facilitate disabled students in various activities, such as transportation, mobility, communication, accessible educational material, notetaking, tutoring in courses, tutoring in computer use, and other academic activities.

2.2 Accessibility Services Applied to the Student's Environment (Tier 2)

Services included in the second tier are related to adjustments made on the academic environment that are required to improve accessibility. These services, although not applied directly on the student, have a direct impact on student's participation in the educational process since they deal with physical access on university's facilities, training of volunteers and university staff, developing guidelines, and providing accessible libraries and labs. The student-oriented approach is still applicable in this layer in the sense that a lot of emphasis and priority on the students needs is placed on the implemented services.

2.2.1 Buildings' Accessibility Service (BAS)

The staff of the BAS (such as civil engineer and mechanical engineer) evaluates the physical accessibility of structured environment in the university campus. It inspects buildings and the external structured environment in perspective of accessibility legislation compliance, and monitors construction of new buildings in order to ensure a high level of physical accessibility to students, employees, and visitors. BAS also provides assistance on facility managers with accessibility concerns in their buildings such as placing ramps, elevators, handrails, and accessible toilets, putting specific markers for people with vision loss, low wall payphones and water coolers, and car parking spaces for the disabled.

2.2.2 Accessible Libraries and Labs Service (AL & LS)

The AL & LS provides the specifications, installation and technical support of public workstations in university libraries and labs with AT hardware and software for students with various disabilities. Alternative computer access systems include voice recognition, speech synthesizers, screen readers, screen magnifiers, large displays, Braille translation and embossing, Braille displays, scanning and reading machines, closed circuit television magnification systems, a variety of switches and mounts, screen keyboards, alter-

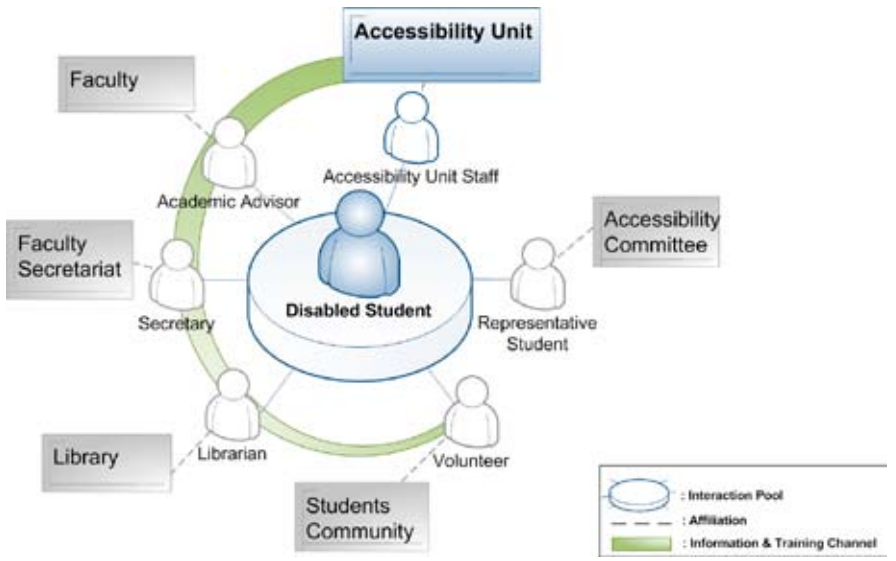
nate pointing devices, wands and sticks, trackball and joysticks, and a variety of devices to accommodate special seating and positioning needs. Moreover, AL & LS maintains a website that includes all information on the available assistive technologies, user manuals, and tutorials as well as physical access information for libraries and labs.

2.2.3 Guidelines Service (GS)

One of most important services in the second service tier is the GS. It provides guidelines and standardization on procedures and services applied on students with disabilities during their studies, so that all students are treated and assessed fairly through different courses and departments. The activities of the GS include the development of: (i) guidelines for the accommodations in exams or test-taking, including media and proctoring adaptations such as computers with AT, reading and writing assistants, extended time, and alternative testing locations, (ii) guidelines for the production of accessible educational content (e.g. accessible DOCs, slides or presentations, web pages), and (iii) standards for the services and procedures of the Accessibility Unit.

2.2.4 Staff and Volunteers Training Service (SVTS)

Via the abovementioned services of layers 1 and 2, a student will interact with the Accessibility Unit staff, his/her academic advisor, volunteers, secretaries, and librarians. The accessibility stakeholders' interactions are shown in Figure 2 (The representative Student and Accessibility Committee shown are further explained in section 3.2). It is the Accessibility Unit's responsibility to inform these people about the newly introduced role they have. As part of that responsibility, the SVTS raises general staff's and professors' awareness on disability issues. For example, faculty secretaries who deal with disable students are trained on: how to communicate with them using alternative means, how to provide support to them, the Accessibility Unit's services in order to notify the student in turn, and they are familiarized with the Students' Needs Recording Form. Librarians, on the



[Fig. 2] Accessibility stakeholders' interactions

other hand, are attending special seminars on using and demonstrating the available assistive technologies installed in the libraries. The advisor professor for students with disabilities in each faculty is informed by the SVTS about the course attendance, examination arrangements, and of all the alternative options for the disabled students. Finally, all volunteers involved with the VS, are trained on how to aid the disabled students.

2.3 Accessibility Promoting Services

The third layer of the proposed model includes services that attempt to disseminate good practices and reach more people in the community. An effort is made to promote accessibility issues within the university community, the educational system, and even to other social groups outside the academic institution. This influence is achieved through a number of activities like web accessibility evaluations, meetings and events, know-how dissemination, and research projects.

2.3.1 Web Accessibility Evaluation Service (WAES)

The WAES provides accessible web page and document templates to the university's web developers and educational content providers. It also helps web developers to analyze and take the most of accessibility reports and to create accessibility documentation, facilitates AT enhancements and accessibility modifications to university websites, and when requested, conducts web evaluation reports for W3C accessibility compliance on a national level such as e-government services, e-newspapers, libraries websites, etc.

2.3.2 Events Service (SES)

Social and informal events like meetings, galas, press conferences, training camps, etc., are very important for promoting the Accessibility Services Provision Model, the Accessibility Unit and the University itself. Such events help all stakeholders to come together, know each other, interact, and interchange knowledge and views. Moreover, such events disseminate the services and activities to the community, nationwide and internationally.

2.3.3 Know-How Dissemination Service (KHDS)

The KHDS is responsible for organizing or participating in workshops, seminars, and scientific conferences in the domain of accessibility, Information and Computer Technologies, Assistive Technologies and inclusive education. Through this service the Accessibility Unit cooperates with other institutions on training and specialization programs for education. This service also issues leaflets, posters, and other dissemination material, useful to other institutions and organizations or similar Accessibility Units. It also develops and maintains the Accessibility Unit's website presenting its services, the provision model, and the information on the available AT.

2.3.4 Research Service (RS)

The Accessibility Unit and its scientific personnel is leading or participating in research projects related to facilitating equity of access to learning and teaching for students with disabilities. Such projects can extend to various scientific domains such as Web Accessibility, Design for All, Universal Learning, Assistive Technologies, etc.

3 Implementation

The proposed model was applied on the Accessibility Unit of the University of Athens in Hellas. The University of Athens has 98.675 undergraduate students, 2.128 professors, 2.536 employees, and 34 faculties. The Accessibility Unit was officially founded in 2006.

The Unit's mission officially is "*to actively realize coequal access to academic studies for students with different abilities and needs, through environmental modifications, assistive technologies and access services*". The Unit mainly deals with students with deafness, blindness or visual impairment, learning disabilities, such as dyslexia and dyscalculia, students with chronic diseases, those with complex or multiple physical, mental, and emotional disorders, and the motion impaired. As shown in Table 1, over the past four years 288 students have been recorded by the SNRS and 427 by the faculties' secretariats. The merging of these figures, after removing duplicates, is 497 disabled students. Some of them have multiple disabilities, and that is why the sum of the separate disabilities numbers shown in Table 1 is larger than the total numbers of the recorded disabled students. Not all students are recorded, mainly because they don't want to be classified as disabled. The total number of the disabled students is estimated to more than 1.000.

[Table 1] Students with disabilities in the University of Athens

Recorded by the Accessibility Unit (2007-2010)	288
Recorded by Faculty Secretariats (2006-2010)	427
Merged	497
Estimated (not all are registered)	>1.000
Blind or low vision	69
Deaf	56
Speech impaired (except from the deaf)	40
Motion impaired	174
Other (+ chronic diseases)	307

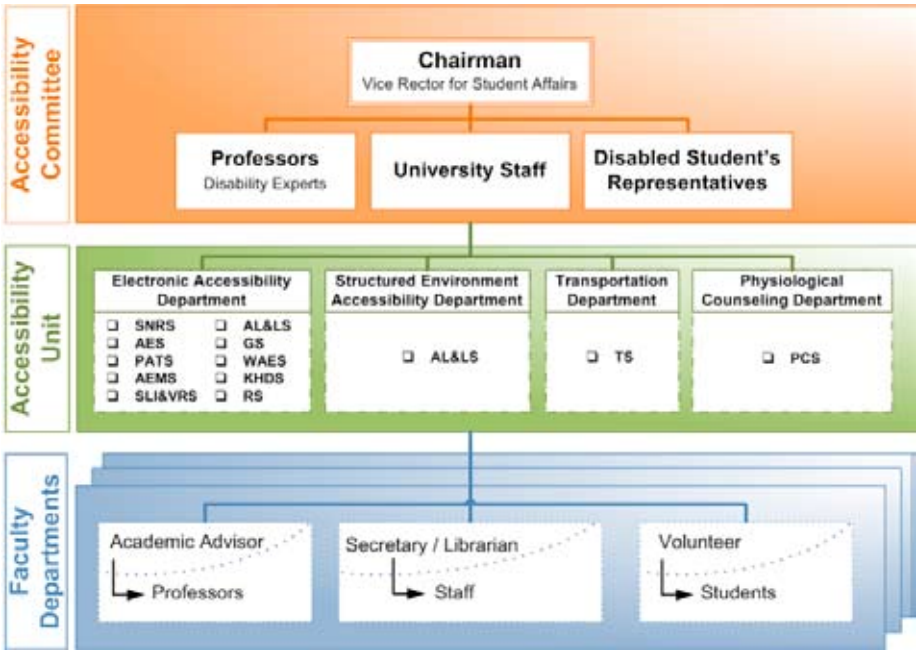
The proposed model of Accessibility Services Provision can be extended with Organization and Management schemes, which are presented in the next two sections. The reason that these extensions are included in the implementation section is that an Accessibility Unit organization and management is very tightly dependent on the institution's size and organogram, as well as on governmental policy and legislation environment, which are different between countries. So we present here the organization and management schemes that are suited for the Hellenic context as a good practice, and suggest to accommodate them according to each institution's or country's individual requirements.

3.1 Organization

The University of Athens Accessibility Unit includes four departments, namely, a) Electronic Accessibility (e-access), b) Structured Environment Accessibility, c) Transportation, and d) Psychological Counseling.

We mostly focus on the e-access department for three reasons: firstly, we believe that access to computers and electronic information sources like the World Wide Web and digital books is the most important tool for successfully and efficiently study in a higher education institution nowadays, secondly because ICT and AT are the strongest means of overcoming one's disability especially in the educational environment, and thirdly because we head towards computerizing most of the services the Accessibility Unit provides. By "computerizing" we mean the use of innovative service-supportive information systems and computer applications, which we develop in order to facilitate, monitor, speed up, and optimize each service.

Figure 3 presents the "Accessibility Unit" section, the organization described above, and the services as they are distributed to its departments. The permanent personnel that is currently employed in our Accessibility Unit (totally 12 persons) includes: in the e-access department one Electrical Engineer with an MSc in IT and one Computer scientist, both specialized in accessibility, one Digital Document Technician, one Sign Language Interpreter, and one Sociologist for supporting the VS; in the Structured Environment Accessibility department one Civil Engineer and one Mechanical Engineer, both boarded in the University's Technical Services offices for practical reasons; in Transportation department we have 3 drivers (and 2 specially modified Vans) and one secretary; finally, one Clinical Psychologist works in the Psychological Counseling department of the Unit.



[Fig. 3] Organization and Management of the University of Athens' Accessibility Unit

3.2 Management

The Accessibility Unit was founded after a formal decision of the Academic Senate and was introduced in the University's organization chart as an autonomous entity which

comes directly under the Vice Rector for Student Affairs. There is also a supervisory Committee for Students with Disabilities, with 10 members, which comprises besides the Vice-Rector, three professors with expertise on Accessible Computing, Special Education, and Psychology respectively, the head of the Students' Club, a representative of the Technical Services of the University and three delegate students appointed by their National Associations of the Disabled, namely one visually impaired, one motion impaired and one hearing impaired student.

4 Future Work

Future plans of the Accessibility Unit of the University of Athens and potential extensions of our model include:

- The creation of a digital library with accessible transcripts, and its integration with other digital libraries of the same content.
- Development of a larger accessible educational material production unit, in order to quickly produce all necessary formats (like Braille, DAISY, large prints) and in larger quantities.
- Funding Assistive Technologies for all the disabled students who need them.
- Electronic archives for disabled students merged with the general student records of the University.
- The creation of an Open Source AT community.
- Participation in new research and development projects.
- Focusing on Global Academic Networking for knowledge dissemination and exchange.

Acknowledgments

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Meaningful means of making universities accessible and their meaning(fulness) in practice

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Keywords: Universal Learning Design, design for all, accessibility, inclusion, education of person with special needs

Abstract

Universal Learning Design has been a key political issue for several decades and during that time, its terminology and concept have changed several times. Although it remains a key issue, efforts in the area have resulted in mutually incompatible concepts while education of persons with special needs has often remained unchanged. The paper mentions controversial issues of inclusive measures in the Euro-American area and it suggests some standards in legislation, methodology, and technology as a condition for a necessary economic solution.

1 First look back into history – disabled persons' services for aristocrats

Most of us probably realize that interest in disabled persons has been a part of aristocratic policy from time immemorial. It became a matter of style to have a mentally or physically disabled courtier in Europe in the high Middle Ages:

[Fig. 1] Diego Velázquez: El bufón Calabacillas (1637–1639)

[Fig. 2] Diego Velázquez: El enano Sebastián de Morra (1645)

These persons were granted exclusive rights (including rights to be integrated into an aristocrat's private life) as a way of compensation for providing aristocrats with entertainment and novel world views on the one hand, and on the other as a result from the feeling that they are not fully responsible for their actions and utterances due to their disability:

[Fig. 3] Diego Velázquez: Las Meninas (1656-1657)

Pliny the Elder[1] gives evidence about such policy in the Antiquity when he mentions a mean-spirited jester (*planus regius*) at the court of King Ptolemy I, and the New Testament[2] does the same by implication at the very same time when it mentions contempt for Christians as fools for Christ. In my opinion, it is here in the ancient history where it is possible to look for the roots of the rather awkward relationship which the contemporary society of the 21st century still holds: charity events for the sake of disabled persons have

1 **Nat. Hist. 35, 89:** non fuerat ei gratia in comitatu Alexandri cum Ptolemaeo, quo regnante Alexandriam vi tempestatis expulsus, subornato fraude aemulorum **plano regio** invitatus, ad cenam venit indignantique Ptolemaeo et vocatores suos ostendenti, ut diceret, a quo eorum invitatus esset, arrepto carbone extincto e foculo imaginem in pariete delineavit, adgnoscente voltum plani rege inchoatum protinus. (http://penelope.uchicago.edu/Thayer/L/Roman/Texts/Pliny_the_Elder/35*.html)
Apelles had been on bad terms with Ptolemy in Alexander's retinue. When this Ptolemy was King of Egypt, Apelles on a voyage had been driven by a violent storm into Alexandria. His rivals maliciously suborned the King's jester to convey to him an invitation to dinner, to which he came. Ptolemy was very indignant, and paraded his hospitality-stewards for Apelles to say which of them had given him the invitation. Apelles picked up a piece of extinguished charcoal from the hearth and drew a likeness on the wall, the King recognizing the features of the jester as soon as he began the sketch. (http://1stmuse.com/alex3/apelles.html)

2 **1 Cor 4, 10** ἡμεῖς μωροὶ διὰ Χριστόν, ὑμεῖς δὲ φρόνιμοι ἐν Χριστῷ· ἡμεῖς ἀσθενεῖς, ὑμεῖς δὲ ἰσχυροί· ὑμεῖς ἔνδοξοι, ἡμεῖς δὲ ἄτιμοι.
'We are fools for Christ's sake, but ye are wise in Christ; we are weak, but ye are strong; ye are honourable, but we are despised.'

remained a popular aristocratic activity, despite the lack of substantial practical influence on these persons' lives.

The Spanish dramatist Vallejo[3] popularized an event which stood at the birth of modern education of the blind: a grand concert performed by the blind of the Quinze-Vingts hospice in Paris (*Grand concert extraordinaire exécuté par un détachement des Quinze-Vingt au caffé des Aveugles*) to entertain the public in the Saint-Ovide market in 1771:

[Fig. 4]

The king's linguist Valentin Haüy, disgusted by the scene, decided to engage for the sake of economic independence of the blind and created a system of tactile writing later developed by Louis Braille.

2 Second look back into history – aristocrats' services for the impaired

At this point, it is worth to consider the age of Valentin Haüy, Louis Bralle and, in case of the deaf, of abbé de l'Épée, Ferdinand Berthier and abbé de Deschamps, or the golden age of the European Enlightenment: special education experts who were often individualities with the best education and philosophical outlook became themselves curiosities similar to disabled persons and they would tour courts around Europe with their lectures. Let us not cherish an illusion that we have much moved away from those times. Enlightened monarchs have stood models for contemporary European commissioners and funding

3 VALLEJO, Antonio Buero. El concierto de San Ovidio (1962).

committee presidents and results of their often rather generous decisions and even more generous investments stand before our eyes as a matter of fact.

[Fig. 5] Quinze-Vingts, Paris

[Fig. 6] Institut royal des jeunes aveugles, Paris

[Fig. 7] Institut national des jeunes aveugles, Paris

[Fig. 8] Municipal Institute for Education of Deafmute Childred, Valašské Meziříčí [Zemský ústav pro výchovu dětí hluchoněmých]

[Fig. 9] Municipal Institute for the Blind, Brno [Zemský ústav pro slepé]

Just as there are similarities among these monumental buildings that were built for education of the disabled in and outside industrial Europe in the 19th century as a result of the enlightened monarchs' interests and the gradual building of which elsewhere maps a network of diplomatic and political relationships in Europe, systems of tactile writing and sign language were spreading at the same time. If we take a close look at the Russian Braille alphabet table, we can will immediately identify German (or, more precisely, Prussian) influence on the transcription table. And if we compare sign systems in Europe you will easily notice mutual similarities of the sign languages in the countries of the former Austrian-Hungarian empire and their dependence on the French sign language and, in contrast, their difference from the enemy German system and from the Polish one.

3 Third look back into history – disability, war and politics

When observing the ties between high European politics and the system of care for persons with disabilities, we cannot ignore another sadly pragmatic aspect of it: the influence of wars. The mentioned Quinze-Vingts hospice in Paris, one of the oldest institutions of its kind in Europe, was founded by Louis IX around 1260 when the king's soldiers were struck by a loss of sight at the Seventh Crusade. The Hôtel des Invalides in Paris (1671–1674) is the most monumental case of this great game with disability as a result of war, a tool of public charity politics of Louis XIV and later Napoleon Bonaparte:

[Fig. 10] – Hôtel des Invalides

It would be a simple task to give other examples of this political game: influence of the use of chemical weapons in WWI on the development of national libraries for the blind and assistance dogs' breeding, emergence of charity projects of large industrial corporations that participated on the armament during WWII, and Russian and American governments' policies towards war veterans. It would be certainly pointless to remind these issues did they not provide context for viewing European and world policies towards disabled persons in the 20th and 21st centuries.

Just as we know what stood behind the creation of the great educational and assistance institutions in European history and how their establishment contributed to Europe

eventually, it is no secret what the dark side of this progress was: the everyday reality of what was happening in these institutions was tragic. Not a long time after the Quinze-Vingts hospice was founded, a well known satire was written by Rutebeuf[4] commenting on a sad state of affairs in the prestigious institution, which is to my knowledge the first criticism of special education:

An official parliament report from the 18th century is comparably catastrophic and lead to release of investments for the establishment of what is INJA today.

4 Alternating political concepts

When we look at the intense efforts with which Europe invested into the use of information technology for the blind in the late 1980s and early 1990s, we will certainly not succumb to the idea that this initiative was propelled by uniting Europe's enlightened altruism. Instead, we will look for its roots in the computer boom investment policies. Given that we know that laws recognizing rights of the deaf to their own sign language were popping up all over Europe of the 1990s like mushrooms after a rain shower, we shall not see in this a sudden awakening of politicians responsible for education. Again, we must place these legislative activities into a wider context and notice the approximately hundred year periodicity of the emergence of such initiatives:

- 1776 *C'est une langue naturelle* (Charles-Michel de l'Épée: Institution des sourds et muets par la voie des signes méthodiques, Paris : Nyon l'Aîné, 1776, p. 135)
- 1880 *Il metodo orale deve essere preferito a quello della mimica per l'educazione e l'istruzione de' sordomuti.* (Congresso di Milano, risoluzione I)
- 1988 *Proposal to the European Council concerning official recognition of the sign language used by deaf people in each Member State* (European Parliament Resolution on Sign Languages, 17 June 1988)

It holds for all these political decisions that the decision makers acted in accord with ideological postulates of their times without being aware of educational, psychological and economical impacts of their decisions would have, should they take effect.

4

Les ordres de Paris.
Li rois a mis en un repaire.
(Mais ne sai pas bien pour quoi faire)
Trois cens aveugles route a route.
Parmi Paris en va troi paire,
Toute jour ne finent de braire:
«Au trois cens qui ne voient goute!»
Li uns sache, li autres boute,
Si se donent mainte sacoute,
Qu'il n'i at nul qui lor esclaire.
Se fex i prent, se n'est pas doute,
L'Ordre sera brullee toute:
S'aura li rois plus a refaire.

The King has put into one shed
(but I don't know why he's done that)
three hundred blinds, all as a bat.
Whole Paris is now full of rogues
who shout out loud and thus it goes:
"To the three hundreds, who can see naught!"
One falls down long, the other short,
Their bodies full of hurts and bruises,
No one to lead the poor old loosers.
If a fire bursts, there is no doubt,
The Order will burn in and out:
Build us a new one, King, be stout!

Similarly, official figures of registered persons with disabilities and persons with specific learning disorders are worth taking a look at:

	% of disabled students among all students	% of specific learning disorders among disabled students[5]
Canada (Ontario) 2003	5 %	85 %
Great Britain 2003	3 %	15 %
France 2003	0.2 %	0 %
Germany 2003	5.3 %	6.3 %
Czech Republic 2010	*0.35 %*	*25 %*

It is possible, for example, to see how dramatically different policies of various countries are and that the Czech Republic has applied the British-American attitude towards specific learning disorders while remaining conservative towards disabilities in general in the European fashion (the French model).

We may observe similar dependencies concerning penetration of some other ideological concepts such as *integration* and *inclusion*. The term *inclusive education* has become an ideological demand of our times and it is not doubted even by those who could by no means say how it differs from integrative education. And so it is often not clear to those who do not doubt advantages of the inclusive concept whether it is not the case that the compared concepts differ in terms just as the Czech words *neslyšící* v. *hluchý* or the German *gehörlos* v. *taub*, and differences between these two expressions are not at all expressible in English and only rarely expressed in French and Italian.

5 Universal Design for Learning

This is even more striking when we consider the concept of *universal design for learning*. It is very obvious that its roots are outside Europe, has concerned it only marginally so far. The current state of various national versions of the Wikipedia page may serve as an indicator of the public discourses; these terms are developed in **English** Wikipedia:

- universal design[6] / design for all / design for all (in ICT) / barrier-free concept
- universal design for learning[7]

5 Source: *Disability in Higher Education*, OECD, c2003. For Czech Rep.: *Analýza současné situace studentů se specifickými nároky na VŠ [Analysis of the Contemporary Situation of University Students with Specific Learning Disorders]*. A study for University department, Ministry of Education, Prague: Alevia 2010.

6 Ronald L. Mace, North Carolina State University.

7 *Learning to Read in the Digital Age* (1998) by Anne Meyer and David H. Rose. Cambridge, MA: Brookline Books.
Teaching Every Student in the Digital Age: Universal Design for Learning (2002) by D. H. Rose & A. Meyer, with N. Strangman and G. Rappolt. Alexandria, VA: Assoc. of Supervision & Curriculum Development;
The Universally Designed Classroom: Accessible Curriculum and Digital Technologies (2005), edited by David H. Rose, Anne Meyer, and Chuck Hitchcock. Cambridge, MA: Harvard Education Press.
A Practical Reader in Universal Design for Learning (2006), edited by David H. Rose and Anne Meyer. Cambridge, MA: Harvard Education Press.

- universal design for instruction *(universal instructional design)*[8]
- instructional design

German version:

- universelles Design / Design für Alle
- Barrierefreiheit
- barrierefreies Bauen
- barrierefreies Internet
- Instruktionsdesign

French version:

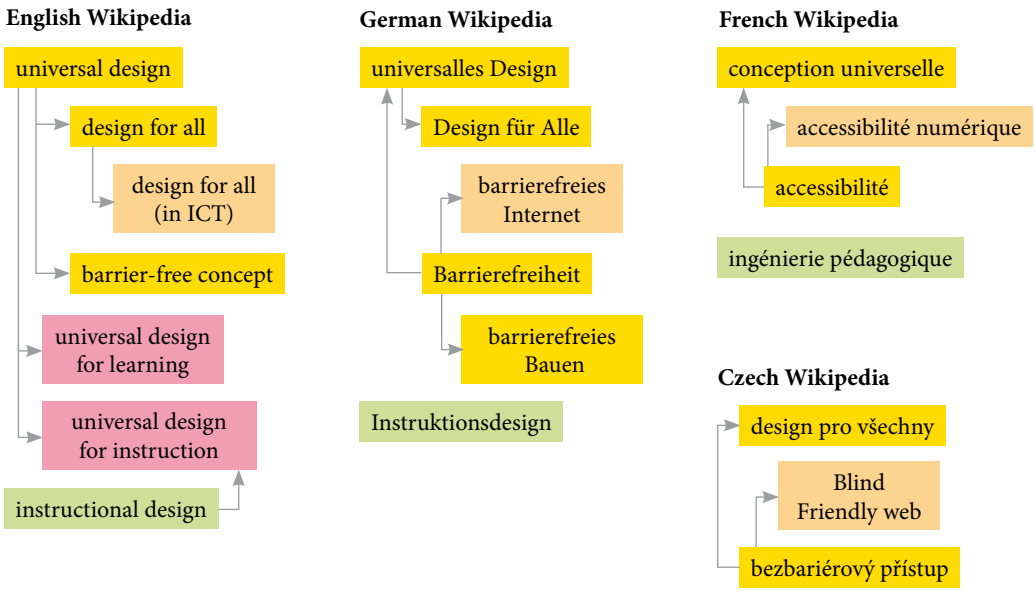
- conception universelle
- accessibilité
- accessibilité numérique
- ingénierie pédagogique

Czech version:

- design pro všechny
- bezbariérový přístup *(přístupnost)*
- Blind Friendly Web

It follows from this comparison that there are two original ideological sources coming from the USA:

- industrial psychological – *instructional design* (1930s and 1940s)
- interior design (originally architectural) – *universal design* (1960s and 1970s)



[Fig. 11]

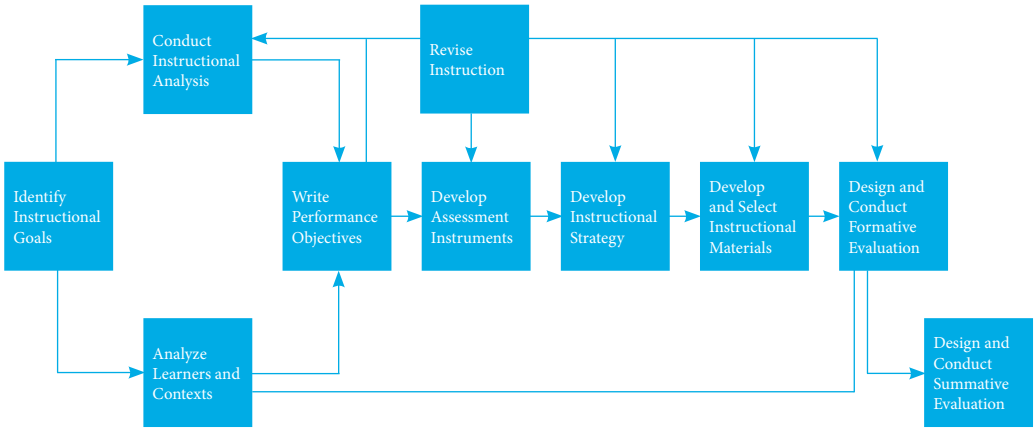
8 Chickering, Gamson. Center on Postsecondary Education and Disability at the University of Connecticut.

In their place, there is the term accessibility/barrier-free in Europe, joined by the specific term of *Web accessibility* (in the Czech environment it becomes limited to the *Blind Friendly Web Initiative*). The general term *design for all* has been spreading under the influence of the European Commission since 2002, mainly through partnership networks (EDeAN, EIDD). In some countries, *design for all* thus appears to be a term widening the older terms *accessibility/barrier-free*; in others it even has no predecessors and it represents the first initiative of its kind. The European public remains completely unconcerned with American discussions about educational derivatives of the *universal design* concept and different conceptual and methodological frames of these derivatives preventing identification of *universal design for learning* and *universal design for instruction.*

6 Today's reality

What practical impact do the described differences among the various cultural areas have on accessibility of European university education?

A number of European countries skipped the pragmatic technological phase of *instructional design* with its sophisticated theoretical procedures applied in commercial or military practices as well as the phase of *universal design*.



[Fig. 12] DICK, Walter; CAREY, Lou. *The Systematic Design of Instruction.* 1978.

So it happens that the all-embracing *design for all* accepted by Europe and which is habitually not to be questioned now has no factual foundation in many places. It is therefore filled in with a completely arbitrary content, especially in pedagogical contexts. Agreement on the abstract level is typical for this situation (as it is often at meetings of special teachers or politicians) as well as helplessness in technological, administrative and teaching practice. This deep discrepancy forces us to admit that much has not changed since the mid-13th century when Saint Louis founded Quinze-Vingts and thus gained recognition of the Pope Clement IV, while Rutebeuf labelled this initiative as foolish for equally convincing reasons.

Managements of European universities accepted with a fatal resignation the task to integrate as large part of the population as possible and they began to fulfil it in a way that resembles the desegregation policy in the United States in the second half of the 20th

century with all its paradoxes and excesses. As it was the case during the U.S. campaign for human rights, the unrestrained haphazard nature of this process drives to despair many a European teacher, except, perhaps, for special teachers, who are usually, although there are some exceptions, not able to give professional, to-the-point answers to their colleagues' questions. The most frequent special-education answer is based on an all-embracing principle of an individual positive attitude: insufficient study results are the responsibility of a teacher who did not find the proper teaching method, did not make the subject matter attractive enough and did not give enough motivation for study to the student; hardly ever is such answer accompanied by a practical illustration of what makes the given subject matter more attractive for the given group of students and how the teacher must proceed to fulfil his or her task.

7 Problematic stereotypes

Let me comment on some of the frequently recurring misunderstandings which, in my opinion, typically arise when providing support for people's specific needs.

7.1 Mistake number 1: We know what special education needs are and how to meet them

In reality, we unfortunately don't know. This issue is so much ideology-laden that it is difficult to grasp rationally at the moment. The ideological development in this area is well-reflected in the language used to grasp the issue:
On the Enlightenment level which transformed the Christian charity institutions into rational research and service departments and which was affective in practical education throughout the 19th century, there are the key terms such as *cripple* (*mutilatus;* mutilé), *blind* (*coecus;* aveugle) and *deaf*, *deaf-and-dumb* (*surdus, surdomutus;* sourd, sourd-muet). In the 19th century, the generic French term invalidité was an innovation historically associated with war veterans. It remains a neutral term in Russian, for example.

The Anglo-Saxon term handicap represented a parallel line of development (I will not remind its comical etymology at this point) which entered the use in the sense of *invalidité* in 1915 and has kept its neutral tone for example in spoken Czech. In the United States it was replaced to the term disability in the 1980s, which is difficult to translate into Czech. Etymologically, it corresponds with the traditional Czech word *invalidita*, but this term was seen as politically compromised and the term *postižení* was chosen as an equivalent, which has a lot of politically incorrect associations in Czech in contrast to *disability* in English. The second half of the 20th century was marked by a struggle for political correctness known as *People First Language* in the United States. This movement introduced into the English language constructions using generic denotations for individuals in the first position (*person*) and a functional specification in the second (with a disability, *using a wheelchair*). It is also a well known fact that this language is often rejected in Great Britain because it contradicts the social model (it is not a disability *owned by* a person).

At the same time, the term **special (educational) need** appears in the context of Education for All. The Czech translation of this term, "speciální (vzdělávací) potřeba" ("mít speciální potřeby") results again in unwanted associations so it is replaced at Masaryk University by the term "specifický nárok", which is close to the English *right* or *claim*. This last generic English term – special need – has included into the focus traditionally

neglected disabilities (specific learning disorders, mental disorders, chronic illnesses, and so on) as well as disabilities independent of the physical condition (social, ethnic, and so on). The policy of correctness and generalization in the beginning of the 21st century thus leads to the realization that special needs apply to all as there is no such person that would not have any special individual needs. Within these masses, for persons with disabilities that were in the focus of European Enlightenment scholars with their fascinating erudition in the 18th and 19th centuries, i.e. severe sensory and motor disabilities, it is as difficult to assert themselves as in the past – again, they have become *rarae aves*, or, in our American colleagues' terms, *low incidence need*.

The term **universal learning design** fits well into this context: it takes for granted a joint effort of all teachers (thus not specialists in special needs) to change the whole educational environment. These steps are to be taken **a priori**, without regard to particular persons who can take advantage of the educational environment, so that a large number of persons with relatively small special needs (by estimation 10–20 %) is satisfied from the beginning. There are also **specific individual adjustments**, termed *reasonable adjustments*, which differ from the general steps as they are taken by professionals and cannot be implemented into the educational environment *a priori* because in these adjustments, one person's needs contradict other person's needs. A typical example: a verbal expression of relations among terms instead of a graphic one will provide access to the information for visually impaired persons but it will reduce access for hearing impaired persons and vice versa. Such steps thus must be provided a posteriori, that is to say above the level marked as *universal learning design* and with regard to a particular person given the fact, however, that administrative and technical conditions for this work have been prepared in advance.

Unfortunately, in practice there is no agreement in what the former term includes nor what the latter means. The term **minimal standards** is jointly used for results of both processes. The British *Code of practice for the assurance of academic quality and standards in higher education*, developed in collaboration with Alan Hurst, is probably the most detailed in this respect but even this extensive material does not include technical standards such as those providing access to buildings. It is a common practice that a team responsible for meeting this standards consists of 1–5 persons, exceptionally it is more; teams of 20–30 persons are rare in the European context. It is clear that in comparison to hundreds or even thousands of students with special needs and hundreds and thousands of teachers who are supposed to provide for the needs, such negligible teams can hardly have a role different than that of an advisor and supervisor. A huge amount of work (structure of study materials including graphics and video, structure of text documents, structure of digital work environments of applications and libraries, speech-to-text reporting and interpreting services, diagnostics, testing and much, much more) is done without any chance for the responsible team to supervise and guarantee its correctness.

Recommendation:

Let us distinguish the term *universal design for learning*, that is to say a general accessibility of an environment and flexibility of academics towards everyone, and *individual special needs* which are often in conflict with needs of others who are themselves specific individuals in different ways. Both terms must have clear limits and the area of special

needs must be defined with better precision than it is today and not merely by the means of a general political declaration. Generic principles of individual approach towards everyone else either do not work, or they are unrealistic – in the end, they usually turn against everyone's interests.

7.2 Mistake number 2: Segregated education is a sin of our fathers and inclusion is the only solution

Inclusion has become a key term and it probably also differentiates our contemporary efforts from the ones in history. Until the 20th century, the effort had been directed to find and address persons in need of a service and to gather them at places where they could get the service. The 20th century, however, came with the opposite idea. Inclusion is often presented as a logical outcome of democratic comforts in a society that is not ashamed for its persons with specific needs and wants them to feel as an integrate part of the society everywhere and at all time. This point of view is very true, but it is not the whole truth.

I believe I do not have to remind psychological and sociological theorems about dangers of collectivism which prevents those who feel special in some ways from getting together based on these specifics and meeting their specific needs separately from others or purely individually. Examples of fighting against the "evil of individualism" or "sectarianism" can be drawn from the post-WWII reality of Eastern Europe as well as various religious communities that see permanent universal coexistence as a tool to guarantee a community's integrity. It would not be a realistic task to try to analyse the roots of such policies, as they are too numerous to mention here. Let me just point out that one such root lies in the traditional, originally religiously motivated collectivism of the U.S. society and another in economic interests – this aspect of the issue is not traditionally discussed. To provide service for a diaspora of specific persons who may claim their needs anywhere and any time is much more demanding from the managerial point of view and thus it requires more staff. The result is of course a convenient tool for raising the level of employment. If the law states that a linguistic minority has a right to use the minority language not only at places with a certain frequency of the minority members and perhaps also in the written communication with governmental authorities but anywhere and any time, it will support the development of language schools and demand for interpreters. The inclusive theory thus calls for complex economic and administrative base and it often turns against itself where this base is missing – it is less effective than separated education.

Let me present an example of the system of education and health care as a whole: in general, there is no doubt that the key role must be performed by family and that it is best to provide service for the schooled as well as the sick in the circle of persons with whom he or she has natural personal ties, and not in specialized institutions that remove him or her from the family circle. At the same time, however, there is no doubt that even if we delegate the largest possible part of the necessary work to the family, family practitioners and family teachers, a still larger part will remain that cannot be taken over by them should the professional level of education and health care not be lowered. Let us understand inclusion this way, too. In many countries with a different traditional culture, such as in Germany or, outside Europe, in Japan, the emphasis on special schools has not decreased under the influence of the Anglo-American inclusive policy: special schools

are seen as prestigious institutions (similarly to private schools) with wide networks. This policy does not result in worse conditions for students, just as education at separated schools for boys and girls did not decrease girls' and boys' abilities to make social contacts in Europe. Whether education is organized collectively or separately (if there is a choice) is not the decisive factor, what matters is how it is focused and what it leads to. When a blind person should compete with a sighted one, and a deaf person with a hearing one, information generally provided to the sighted and hearing will be insufficient as such information does not take into account the specifics of work with and access to information – what these persons need is a specific technological and linguistic know-how and a specific training exactly for the sake of their own competitiveness.

Recommendation:

Let us not criminalize separated education on condition that it is not the only choice for persons with special needs and that it offers, on the contrary, a higher standard of satisfying their needs. Gallaudet University – a separated education institution – may serve as an example – just ask the Deaf if they see as discrimination a scholarship at this university.

7.3 Mistake number 3: An impaired person is the only arbiter of accessibility

A democratic participation of students on their own education is a psychologically very sensitive topic. The sensitivity and complexity of this topic can be illustrated by the following example. Some of my European colleagues have the tendency to expect that the years the Czech university education spent in the shadow of Moscow (and national socialist Berlin before that) were also reflected in the attitudes toward the issues of academic freedoms and democracy. They are often surprised by the fact that it was precisely this historical experience that has made Czech very sensitive to the issue of academic freedoms and that Masaryk University never abandoned the model of fifty percent of student representatives in all its senates. They themselves could not imagine such a model of management and they are often used to the fact that since the end of the last century schools have abandoned even an external democracy of management and tended to be run by appointed and not elected managers. I personally have respect for the current democratic nature of Czech university education but I do not consider it possible to substitute it with a populist concept of school as a free market of ideas where a student deals with what he or she is interested in and what he or she confirms to the teacher as an appropriate teaching method. It is absurd to ask a blind student how to solve matrices, to study heraldry or graph theory. The absurdity of this question is not in the fact that he or she is blind but in that he or she must be first educated about these issues before he or she can deal with them in a professional way and propose a teaching method. A school cannot leave it up to a student to decide what and how to study just as a director does not leave it up to the audience to decide about mise-en-scenes to be performed. It is a task for a school (and often a serious research task) to know general possible solutions to situations with very specific needs of a students just as it is a task for a scientist to know his predecessors' and competitors' views and bear the responsibility for decisions in areas with no previously suggested solutions. A democratic school has a developed feedback system so that a student can express an opinion any time and the school can observe

effectiveness and usefulness of chosen methods. The final decision however cannot be made by the student disregarding whether a disability is at play or nor.

Recommendation:

Let us not delegate to students such decisions which must remain professional, not democratic. A teacher or a school invites its students to premeditated programmes of studies and these programmes must be premeditated even from the point of view of specific needs; only exceptionally is it justified that a student should search for a teacher and assign how to teach.

7.4 Mistake number 4: The only guarantor of accessibility is an educational or psychological counsellor

I have commented on this issue on a number of occasions and I will only mention it briefly. Counselling is an indispensable part of the service that a school is obliged to offer. No administrative or technological processes can be functional if they are not connected with advice about their use. And it also holds true that any advice can only be functional where there is a solution ready at hand and only information about it is missing. No educational counselling will ever create a digital library, which will be created by IT specialists and librarians and no counselling will provide for interpreting, which will be done by an interpreter; no psychological advice will ever determine an alternative method in medicine, linguistics, mathematics, or physics.

Let us learn from history. The era which began with Enlightenment projects in the 18th century ended in the mid-19th century with a result that cannot be overlooked and that still visibly influence what we do today: networks of state funded schools existed across Europe even then and these schools used adapted systems of tactile writing derived from Braille alphabet as well as the national sign languages which, in the case of Central Europe, were again derived from the French sign language via the Austrian sign language. The end of the 20th century brought a renaissance of these efforts of the Enlightenment but despite available technologies that were undreamed of in the 19th century, there is a danger that they will be less material if they will only be expressed by teachers and psychologists: there still remains a desideratum:

- a generally accepted, psychometric procedure for tests learning potential and knowledge that would enable a truly objective testing of technically differently communicating persons,
- an internationally accepted code for tactile record of scientific and multilingual texts (or operative conversion tools),
- a fixed document format that would present a secure basis for end users' text, tactile, graphical and audio formats (in contrast to the current fluctuation among OpenOffice, Microsoft Office, PDF, various digital book formats, video books, and so on),
- a generally fixed form of user interfaces that are voice-controlled or operated via keyboard, mouse, or any other device,
- generally accessible catalogues of shared libraries with documents that are accessible, access ready and impossible to access,

- incorporation of sign languages into common web applications of lexicographic or translation nature.

None of the above can be regarded as counselling.

Recommendation:

Let us not identify professional services with counselling or pedagogy. Personal communication counsellors will not provide availability of communication technologies – a computer or a mobile phone will. Neither is it logical or professional for English department staff to write project reports for a school in English and interpret at meetings with an Indian supplier of flooring. The contemporary network of higher education counsellors is a model that may be inspiring and whose services may serve as a basis. However, it is not a network of offices providing service which needs to be created step by step. It is clear beforehand that this network can only exceptionally cover all types of services on the same level (just as medical facilities cannot) at any school, and that professional centres with a variety of specializations must be created that will share their professionals and their services (which will be subject to public control).

7.5 Mistake number 5: An assistant must be provided when counselling is not enough

Assistive services have become a still more common solution. They are employed by elementary and high schools, used by public figures with disabilities. A feeling emerges at some schools (and among some students) that employment of an assistant is almost a symbol of the professional level of educational service. A wide range of assistance begins quite innocently with *peer counselling* which cannot be objected to. In practice, however, it is difficult to guarantee counsellors' professional level and thus the limits of the provided services as it generally holds true that it is difficult to refuse services offered in all honesty and free of charge. An active counsellor thus easily becomes a teaching and personal assistant.

A difficult psychological situation developed in a number of cases that we could observe and analyse in the past:

1. A disabled adolescent ceases to realise that the assistant, who is a person without a disability, gradually becomes the performer of expert tasks as he or she has gained expert competences on the same level as the disabled person during the course of assistance. A habitual use of such services becomes an ethical problem when the disabled person enters maturity, that is to say university.
2. An assistant forces himself of herself artificially to remain passive, although he or she would be able to perform a requested task independently and not only as an assistant to a disabled person. This result of assistive services is typical of the tertiary education and research levels when a correct assistance can only be provided by a person with an education in the field, acquainted with necessary technologies and methods, knowledgeable of valid procedural and safety regulations (for example, in laboratories and archives), etc.,
3. Some schools, due to a lack of other possibilities, in fact abuse assistive services. They solve a lack of professional staff by incorporating classmates and peers into

the process who then necessarily break into an open door: along with their own studies, they gradually learn about professional standards of services that have been fixed and form independent occupations (accessible format of a written text, accessibility of graphics, speech-to-text reporting, note-taking, interpreting, spatial training for the blind, and personal assistance to the mobility disabled). Thus, the same problem as in the case of schools applying inclusive education appears: unlike a teacher at a special school, a teacher who encounters certain types of disability very sporadically, sometimes only once in a lifetime, cannot master complex teaching strategies for students working in a specific way and he or she does not tend to save the gradually developed strategies for use in the future because a repeated instance of the same type of disability is not much probable. As a result, the student paradoxically does not receive standard quality but encounters provisional solutions instead of professional ones in the whole life. Similarly, peer assistive services do not build up experiences that can be further used by a university and shared with other schools – service providers leave with their partial experiences and a disabled person ends with a tiresome stereotype: he or she explains yet to another and another assistant elementary facts about providing the necessary service.

Recommendation:

Let us make sure that common schools do not provide personal assistance unless it is unavoidable for evident reasons. Dispatch centres of spatial orientation for the visually impaired or interpretation and speech-to-text reporting are school's central services and not services for an individual, just as transportation of a severely mobility impaired person and his/her movement indoors, occasional assistance at manually demanding activities, sports, and field work. While assistance to the mobility impaired and spatial orientation for the visually impaired is a one-side service that a school provides to impaired persons as a part of their activities, interpreting and speech-to-text reporting dispatch services are services providing communication between persons without impairment and the impaired, and these services are used to an equal degree by both parties, that is the academic public, impaired or not.

8 Conclusion

Meaningful investments into accessible tertiary education are conditioned by professional services and the professionalism is based on the following:

- setting up the boundaries between *universal learning design* and *reasonable adjustment*,
- clear, technically defined standards for *universal learning design* and *reasonable adjustment*, especially standards for measurement of admission and output competences,

- courage to admit what lies beyond both and what
  - is not a task for a school but for a student,
  - is a task for neither of the parties and what cannot be accessible,
- sharing of services among schools and creation of servicing networks,
- courage to insist on a professional output level that education must never fall short of should a student earn a degree.

(Ex)Change for Success – The Higher Education Accessibility Guide (HEAG)

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Keywords: Higher Education, university, inclusion, disability, disability support centers, students mobility

Abstract

This paper presents the work carried out within the HEAG framework amongst a joint European group of service providers for people with disabilities in Higher Education – and what is missing or better what could foster equal access to higher education of people with disabilities and mobility.

Higher Education institutions from all over Europe were screened following a standardized questionnaire on their activities for students with disabilities in terms of Universal Design as well as support given and accessibility services provided. The gained data was published online and enables up to date information on studying in a specific country at a specific institution and has the potential to foster European exchange and students mobility even amongst students with disabilities, a group underrepresented in Higher Education mobility programs so far as well as on the degree of inclusion of domestic students with disabilities on site that has to be discussed based on the observation that in most cases students with disabilities can cope with traditional (often technological) barriers but run the risk of failure and drop out because of lacking social links and skills – a topic also to be discussed concerning eLearning activities.

1 Idea

All over Europe, policy initiatives underline the importance of increasing the numbers of students entering and completing higher education. This gets obvious at European level within the Council of Education Ministers' statements regarding participation in Higher Education as part of the 2010 Objectives for Education in Europe, also postulating targets and strategies to reach the "Lisbon objectives" that – following EU publications 2010 – will only be reached in some side parts on time (http://ec.europa.eu/education/lifelong-learning-policy/doc1951_en.htm). At National level core areas for their initiatives to increase participation rates, one common area however being the increased participation of students from 'non-traditional' backgrounds, including students with disabilities and chronic illness.

Studies and research projects (e.g. the EU funded project HERN – Higher Education Reform Network (www.hereform.net, 2004) identified "accessibility" as general key to successful participation in Higher Education, especially for this target group.

From getting information on and applying to a specific study program, the general accessibility of a specific campus over the accessibility of study-related information / literature and eLearning platforms to support schemes, counselling, housing, transportation and funding possibilities – without proper information, first and foremost students with disabilities will be left outside.

Therefore initiatives like Eurydice (http://eacea.ec.europa.eu/education/eurydice), HEAG – Higher Education Accessibility Guide (http://www.european-agency.org/agency-projects/heag) or "Study Abroad without Limits" (http://www.studyabroadwithoutlimits.eu/) work on providing as much and as specific accessible information as possible in order to enable students from all over Europe to equally take part in Higher Education and get the chance to spend some time abroad, start a successful career and finally reach integration in society corresponding to their personal skills, competences and preferences and independent from a possible disability or country of origin.

2 State of the Art

Following studies and research co-operations (HERN – Higher Education Reform Network; HEAG – Higher Education Accessibility Guide; "Study Abroad Without Limits") dealing with the support of students with disabilities in Higher Education, one core issue that serves as an example in this paper is the raising necessity (if not "condition sine qua non") of going abroad, building up self esteem and self dependence and learn within different cultural, social and educational frameworks – that asks, especially for students with a disability or a chronic illness for intense preparation and organization measures and accurately fitting information before even thinking about "going abroad".

Websites, set up to collect and store this information are already in use (e.g. Eurydice or HEAG website), providing at least *some comparable* core information (educational systems, funding, institutional contacts and general study framework), in case of HEAG for 29 European countries in 21 languages. The project "Study abroad without limits" used a totally different approach, enabling interaction and the informal information gathering by connecting trained peers from 5 different countries (Austria, Belgium / Flanders, Ireland, Sweden and The Netherlands) acting as experts "on site" with students interested in going abroad, asking for specific information best answered by students dealing with similar concerns and constraints every day, what would complement the more formal HEAG / Eurydice database to cover the full scope of issues to be sorted out before going abroad and getting the most out of it.

3 Methodology Used

The work presented in this paper was carried out within the European initiative HEAG, co-ordinated by the "European Agency for Development in Special Needs Education" (http://www.european-agency.org/), an independent and self-governing organization established by European member countries to act as a platform for collaboration regarding the development of provision for learners with special educational needs.

The European Agency for Development in Special Needs Education is maintained by the Ministries of Education in the participating countries (member states of the European Union as well as Iceland, Norway and Switzerland) as well as supported by the European Union Institutions via the "Jean Monnet programme" under the "EU Lifelong Learning Programme".

Represented by National Agencies (located within the responsible ministries and national institutions / structures), the Agency facilitates the collection, processing and

transfer of information at European level and reliable country specific information and offers the opportunity to learn from each other through different types of knowledge and experience exchange.

Those National Agencies appointed national experts working in the field of supporting students with disabilities or chronic illness in Higher Education.

In a starting meeting, those expert institutions were asked to identify the core topics and issues concerning studying (abroad) and the European Agency for Development in Special Needs Education presented the general framework for getting and providing relevant data that in the end should act as comprehensive Europe-wide repository for all interested countries, institutions and individuals – in English and the national language(s).

4 R & D Work and Results

A questionnaire was designed – following the identified core topics – in order to be sent out to national Higher Education institutions (universities, universities of applied sciences and similar). Designed in English, the involved experts translated the questionnaire into 21 national languages in order to adapt the questionnaire to national realities and concepts.

The questionnaire covered the following core topics and categories:

- Key Data
  - Contact information of the department / person filling in the questionnaire / supporting students with disabilities
- Available institutional support services (including those for students with special needs)
  - From an office / person supporting incoming / outgoing students to support schemes for different possible disabilities
- Accessibility of the built environment
  - From Campus over student halls to the provision of personal support
- Support for teaching and learning
  - Asking for all possible support activities (Accessible study literature, sign interpretation, note taking till flexible timetables and study / exam schemes)
- Other information
  - Asking for information on and availability of social network possibilities like students clubs, sport facilities, or community/NGO groups for people with disabilities on site

The adapted different versions of this questionnaire were implemented accessible and put online to the HEAG website.

The national experts were asked to contact the national Higher Education institutions, send out the link to the questionnaire and validate the data filled in by the institutions in terms of completeness and appropriateness of information given.

As described above, 29 European countries (distinguishing between Flanders and

Kingdom Belgium, including EU countries and Switzerland, Norway and Iceland) took part, providing 543 submissions from 490 different institutions.

[Table 1] Countries, submissions and institutions taking part in the HEAG survey 2009, sorted by name

Country	Submissions	Different institutions
Austria	17	17
Belgium (Vlandern)	13	13
Belgium (Royaume)	11	11
Croatia	62	30
Cyprus	1	1
Czech Republic	18	18
Denmark	41	41
Estland	6	6
Finland	38	36
France	48	48
Germany	30	30
Greece	3	3
Hungary	0	0
Iceland	4	4
Ireland	18	18
Latvia	8	7
Lithuania	30	30
Luxemburg	0	0
Malta	2	2
Netherlands	22	22
Norway	7	7
Poland	0	0
Portugal	42	41
Slovakia	0	0
Slovenia	21	4
Spain	19	19
Sweden	28	28
Switzerland	16	16
United Kingdom	38	38
Total	**543**	**490**

The submissions handed in ranged from information on faculty level up to information given for whole university campuses. Therefore the number of submissions might be different from the number of participating institutions.

The power of this collection becomes obvious when one looks at the amount of data and information provided. In the moment it is possible to look up the support schemes of 490 different institutions in the most possible variety of categories.

5 Impact on or Contributions to the Field

This huge collection of data – once consolidated – enables researchers and policy makers to compare support structures and funding schemes, benchmark the own institution and/or country and plan following reliable actual data.

As the survey ended in November 2009 and the website was put online (relaunched) in January 2010, the data are only available for nations / institutions – what means that interested individuals might look up specific institutions and their support structures but it is not possible to get an overall database to evaluate / benchmark support structures throughout Europe in the moment.

Also some countries are underrepresented / don't have any submissions, a fact that asks for a further investigation to get submissions in order to complete this first comprehensive and comparable educational and support map for students in Europe independent of a possible disability and/or wish to go abroad and some supplementary sources.

6 Conclusion and Planned Activities

Seen from researchers' view and as described above it finally depends on the contributions from nations underrepresented or missing and on the availability of compiled, consolidated stable and reliable data what is possible with this huge data repository.

Research potential also depends on funding possibilities and the impetus brought in by European / National agencies and the national experts (in terms of involving missing institutions / countries, keeping the data actual and the network of experts alive).

Seen from the view of structures / institutions supporting students with disabilities, this collection of data represents also a collection of showcases and best practise examples in supporting students with special educational needs.

Seen from the perspective of students with disabilities, these individuals get the chance for a one-stop-information repository at their fingertips, 24 hours a day, 7 days a week.

It would be most beneficial for students with disabilities when – as mentioned above – this "formal" data collection could and would be linked with the more informal and interactive peer support offer the website / project "Study Abroad without Limits" is able to provide, in order to complement this huge data collection with personal knowledge, experience and expertise giving a real incentive / kick to everyone thinking of studying abroad by connecting trained peers (that already were abroad and therefore know exactly what information / organisation and co-ordination actions might be necessary and beneficial) to interested young people with disabilities.

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Section 2

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

Students with severe hearing impairment as competent learners of English as a foreign language

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Abstract

Contemporary deafness is understood not as a condition of total lack of cognitive abilities but as a situation when properly recognized competencies and talents of the hearing impaired students can be magnified and can lead to successful cognitive development. The task of the professionals working with the hearing impaired students is to carefully diagnose the individual student's conditions and potentialities in order to find ways to support his/her education. In such a perspective students with severe hearing impairments can be also perceived as persons who present specific predispositions to learn foreign languages which might be connected with their experiences as users of more than one language (national and sign) before starting to learn a foreign language, their ability, gained through extensive lip-reading, to decipher meaning out of the context that is not fully understood, and their consciousness of speech production process that they received during their speech therapy classes. These predispositions are magnified by the contemporary technological development that offers new generation of hearing aids, cochlear implants and other equipment.

The aim of this paper is to present the language competence of Polish students with severe hearing impairment which they present during the English as a foreign language classes learning to speak foreign languages. The paper is based on the authors' 10-year experience as a teacher of English for the deaf and on scientific research conducted in this field during last two years.

1 Introduction

Hearing impairment creates a serious obstruction in the process of acquiring a new language. It is especially difficult in the situation when the level of mutual understanding of the signals transmitted via visual or aural way between a student and a teacher is not sufficient. It commonly happens so when a teacher does not know sign language well enough or speaks in such a way as to make it impossible for the deaf child to lip-read the words. Such episodes give rise to situations when the teachers doubt whether the deaf and hard of hearing students are skilful enough to learn a foreign language at all, presuming that the students' failure stems from his or her intellectual, cognitive disabilities rather than from difficulties in the language reception.

2 English for the deaf and hard of hearing at John Paul II Catholic University of Lublin

In the academic year 2010/2011 nine deaf and hard of hearing students have been participating in English for the deaf and hard of hearing classes and the number of students in need of such a class, comparing with the beginning of 1998, is still growing. They are students of Pedagogy, Computer Sciences, Economy, Philosophy, Culture Studies, Land-

scape Architecture, Law and English Philology. The degree of hearing impairment in the group varies between 70 dB and 110 dB, all of the students are pre-lingualy deaf persons. The students communicate in many ways in everyday situations, the main means of communication is lip-reading, Polish Sign Language and Cued Speech. All of them highly rely on writing.

Students attend English classes once a week and the class lasts 90 minutes. All the language skills are practised during the classes: reading, writing, speaking and listening (cassettes and CDs are not used, though). As the students are supposed to pass a university foreign language exam together with hearing students, the books used and the syllabuses cannot be much different. However, the class techniques implemented by the teacher must differ, so as to match the special educational needs of the students. Computer and Information Technology is widely used during the course: the laboratory is equipped with *Smart Board* and Internet access. Practical teaching is accompanied by extensive in-depth research on the deaf students' reading abilities (Domagała-Zyśk 2010), motivation in foreign language learning, (Domagała-Zyśk 2010), learning style (Domagała-Zyśk 2010), foreign speech pronunciation (Domagała-Zyśk & Podlewska 2010), grammar teaching (Domagała-Zyśk in print) and others.

3 Deaf students' abilities to learn a foreign language

Taking into account both the contemporary psycholinguistic knowledge and the accounts about successful attempts of teaching foreign language to the deaf, it must be stressed that there are no psychological or methodological obstructions to teaching a foreign language to the deaf. To prove that many psychological research may be cited, e.g. Krakowiak (1995), MacSweeney (1998), Parasnis (1998), Marschark, Lang, Albertini (2002), in which deaf students present intellectual abilities similar to these of hearing students, in some areas reaching even better results (Bavelier 2006, Parasnis et al. 1996, Rettenbach R., Diller G., Sireteanu R. 1999), although the danger of over-generalisation of these results should be avoided. In pedagogical literature there are also described some successful experiments of teaching a foreign language to the deaf (Domagała-Zyśk 2001, 2003, 2005, 2006, Harań, Gulati 2006, Janakova 2005, Allen 2005, Valgerdur 1999, Zabajewska 2004, Kennedy, Cohn 1992, Batyra 2004). It is worth noticing that the students presented different degrees of hearing loss and different methods of teaching were used. Taking this into consideration it may be pointed out that surdoglottodidactics1 in general does not differ from a classical foreign language learning methodology, neither as far as the approach nor as far as the method of teaching is concerned. Moreover, the author's view is that creating a special methodology would mean creating a special "language ghetto", that is why it is advisable to try to do the opposite: foreign language learning should be treated is a tool to open the deaf peoples' minds, to give them a tool to communicate with others, to provide access to different sources of information (e.g. Internet) in order to help them feel integrated not among the Deaf community, but within the general society.

While teaching the deaf a teacher can use the approach which he or she thinks most suitable: be it communicative approach, humanistic approach, self-directed learning ap-

1 Surdoglottodidactics – the science of teaching a foreign language to the deaf (*surdus* (lat.) – deaf, *glottis* – language. *Surdoglottodydaktyka* was a term first used in Poland in 2001.

proach or Total Physical Response, just to name a few most common ones (Harmer 1991). The methods of teaching (understood as a way of selection and portioning the material to be taught into didactics units and individual lessons), are also not different from these used in a regular classroom. They depend on a teacher' intuition or style of work, and are usually based on the approach chosen by a teacher. The only things which are different are the techniques of teaching, understood as the teacher's and the student's activities during a lesson. During a lesson we use textbooks and class equipment similar to these used in the classes for the hearing students. Generally the techniques used in a classroom should be modified according to the abilities and disabilities of a particular deaf child, that is why the ideal solution seem be to work with the students individually or in small groups of 3–4 people. Teaching the deaf, a teacher must know a special way of communicating with his or her deaf students, bring special prompts to make the clues for learning visible, much more often use writing as a way of communication, be careful about his or her position in a classroom, speak more clearly than usual, etc. (Domagała-Zyśk 2003a, b, c, 2005a, b, 2006a, b).

4 Principles of teaching English as a foreign language to the deaf

Teaching the deaf for ten years now I feel like being able to make some general statements about teaching a foreign language to the deaf. The principles of this work can be divided into general and detailed ones. The general principles are all these which should be obeyed while working with deaf students in general classes, while the particular principles say about how to teach a foreign language to the deaf. A lot of general principles of good communication with the deaf are mentioned in literature (comp. e.g. Krakowiak 1995). The most important ones are listed below.

Attention should be mentioned as the first principle. Looking at the student carefully and listening to everything he or she communicates (both verbally and non-verbally, by gestures, mimics, signs) enables the teacher to monitor the students' way of perceiving and understanding the material. At the same time it is a way of registering immediately the moment the student loses their way through the English grammar path and give them a helpful hand. Paying attention to all the students' attempts to communicate enables the teacher to notice a moment when a student is able to take his or her turn, show his or her understanding of the problem. It creates a situation when the students' activity may be immediately fully appreciated by the teacher which in turn motivates the student to be even more active in future. Teachers of the deaf sometimes complain that the pupils are rather passive, however, for me it seems to be a stereotype: among the deaf, like in a general population of students, there are both active and passive students. Majority of the deaf students are eager to take part in a lesson, they want to play roles, give their own example sentences, read and translate. They know the importance of language well: their disability is a language disability. They know that the aim of language learning is to be able to communicate one's needs, emotions, experiences. It should be noted here that almost all deaf students have learnt a second language so far: being born in a deaf family they have learnt their national language as their second one, being a child of hearing parents they usually must have learnt sign language at school.

It is important for the teacher to be aware of the influence on the student both of his or her verbal and non-verbal reactions. The way of speaking should be rather calm, but at the same time not missing the emotionality and engagement of the speaker. The teacher should speak not to quickly, but without making the speech flow too slow and unnatural. All the vowels and consonants should be pronounced naturally, without exaggeration, as it disturbs perception rather than facilitates it. The teacher must take into account that the students are absolutely aware of all the signs and gestures the teacher performs. As they communicate in sign language, each gesture, even the smallest one, may transmit a message for them, so a teacher should avoid exaggerated gesticulation, making too many gestures, even the unconscious ones like touching glasses, "brushing" hair, etc.

External conditions of teaching also influence the process of learning. A teacher should stay or sit in a place easily visible by a pupil, his or her face and hands must be well lit, the teacher should address the students only if the student is in front of the teacher. Our experience (comp. Domagała-Zyśk 2001b, 2001c, 2003a, 2003b, 2003c, 2005, 2006, Batyra 2004, Zabajewska 2004) is that the groups should not be bigger than three: only then the teacher is able to monitor the students' work precisely. This postulate creates of course a financial question, and our answer is as following: in order to learn a foreign language deaf student do not need any expensive equipment, like automatic or electrical wheel-chairs, Braile's software, etc. They need more time and more individual treatment, that is why they should learn in small groups and during individual classes.

The next detailed principle would be to let the student be active, expecting the student's engagement and encouraging him or her to it. It is very important for the student to be aware that English can be *useful*, even for the deaf. During the classes it is advisable to propose such kind of activities which would engage student personally: describing their own hobbies or interests, playing the roles of a shop assistant or a customer they feel they can use language. It is especially important for Polish deaf students: almost every teenager in Poland learns English; speaking it is a synonym of being well-prepared for taking an interesting job position, being prepared to travel and work abroad etc. Just to give one example: one deaf student of mine went abroad and got lost somewhere in Spain. She asked for the nearest bus stop and received help. After coming back she was really motivated to learn English, as she felt its usefulness. I presume she must have used not more then several English words to be understood, let's say: *excuse me, bus stop?* Saying the same in Polish *(Przepraszam, przystanek autobusowy?*) she would not have a chance to be understood. Students are also really engaged writing letters to their nearest persons, or describing these things which really engage them emotionally (e.g. their young brother's school problems, last good or bad mark at school, holiday plans or memories). Psychologists say that we better remember and quicker learn things we experience emotionally, not cognitively only, that is why such topics help the students to learn English more effectively. On the other hand it gives the teacher the opportunity to get to know the students better and prepare for them exciting additional tasks, it also deepens the interpersonal relationship between the student and the teacher.

I would also like to stress that it is very important to teach the students all the aspects of a new language: during the classes it is advisable to exercise both reading and listening (as far as it is possible), writing and speaking. It is essential to teach not only the written form of the language, but also the spoken language to some extent. None of my students

would ever speak the RP form of English, I am aware of it. On the other hand I am convinced we do not have any right to stop anybody speaking any language, even if he or she stammers or has some other speech problems. That is why I encourage my deaf and hard of hearing students to speak English, hoping one day they may speak similarly to their deaf English peers.

5 Extra values of teaching English to the deaf

Thinking about the aim of teaching a foreign language to the deaf the teacher should have a much wider perspective than only achieving a certain level of language skills. Learning foreign language for a deaf person is sometimes a means of creating one's own attitude to learning in general. On the other hand during the lessons we do not only obtain some information but also develop our personality. It is very important to be aware of the fact that foreign language learning has also a therapeutic value, as it compensates the state of deprivation experienced by our pupils. Hearing impairment is first of all a language impairment that is why each English language lesson is first of all a language lesson, it creates an occasion to learn something about a nature of language in general. Deaf students, even after several years of learning, usually have some problems with using their national language perfectly, even being almost adults they make mistakes. While learning a new language they revise grammar (e.g. the names and functions of the different parts of the speech), become more aware of creating some basic structures, have the chance to compare their language and the newly learnt language. At the first stages of English as a foreign language program Polish deaf students often conclude: *English is easier than Polish.* There seem to be a grain of truth in it: Polish inflection, all the exceptions from the rules make it for the deaf almost impossible to use Polish language correctly. English is more predictable for them, so at the beginning they feel better at it. I try to communicate with my students in English and I must admit that their sms'es or e-mails in English are sometimes more correct that their Polish ones. I also remember one lesson, when we did the second conditional. Just after giving the rules of creating the sentences I asked a student of mine to give me his own example of the second conditional and I received a sentence: *If I were a monk I would live on an uninhabited island, I would swim in a sea and I would play with exotic animals.* I am almost sure that even now he would add some improper suffixes to the Polish version of it. It is worthy to add that during foreign language classes the students enlarge their general knowledge and also get some new vocabulary, learn synonyms and antonyms of the words. It sometimes happens that I give them the Polish translation of a word and I am asked to explain what the Polish word mean, the examples I remember may be as following: *chauffeur, manor, spa, bossy*, and a lot of others.

6 Conclusion

In conclusion it should be stressed that English teachers of the deaf all the time face the question of *how to do it* , and this is especially true for the situation in Poland where we work hard to create the methodology of teaching English to the deaf (*surdoglottodidactics*) that will be based on trustful scientific research and practical experience.. New tasks on this way include to diagnose the personality and social characteristics of the deaf student population in Poland so as to be able to tailor the English as a foreign language courses to the deaf participants in an even more suitable way.

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A Methodology for Automatic Sign Language Dictionary Creation

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Keywords: sign language, interactive 3D avatar, on-line dictionary, automatized dictionary creation, accessibility

Abstract

In this article we present the sign language dictionary being developed by a research team of the University of West Bohemia, Masaryk University and Palacky University. The aim is to create both an explanatory and a translation dictionary, which respects linguistic requirements. The dictionary is designed as an on-line application with access for all registered users, who are structured hierarchically to ensure lexicographic consistency of the dictionary's content. The basic structure of the dictionary is proposed so that it meets the linguistic criteria of both spoken and sign languages. We use written text to represent spoken languages and several types of representations for sign languages: videos, images, HamNoSys, SignWriting and an interactive 3D avatar. To decrease the time required for data collection and their publishing in the dictionary we use computer vision methods. We detect the boundaries of the dictionary entry. If the entry is a single sign , we analyze the manual component of the performed sign for the purpose of automatic categorization. The content is being created by linguists using both new and pre-existing data. Later on the dictionary will be opened to all users with the possibility to add, modify and comment on the data. We expect that this possibility of on-line elicitation will increase the number of informants, cover more regions, and make the elicitation cheaper and the evaluation easier.

1 Introduction

A dictionary is an important source of information about a given language. It is true especially of sign languages, in which no official written form exists, and dictionaries or lexicons are one of the main sources for teaching and linguistic research of sign languages.

There are many existing on-line sign language dictionaries, but not all of them offer the expected features, quality and content:

- easy and intuitive usage
- searching – not only by text, but by other, sign language specific criteria
- completeness of lexicographical data, covering most of the language, not only limited topics
- being up-to-date
- usage of the sign language written forms (HamNoSys, SignWriting, etc.)
- a version for mobile devices
- an off-line version for download

Usually the existing dictionaries of sign languages specialize in selected topics (vocabulary of a particular semantic field) or support only some of the above-mentioned features. Our goal is to create a state-of-the-art sign language dictionary which supports all the mentioned features, is both a translation and explanatory dictionary, and supports an unlimited number of languages so that a dictionary entry (word or collocation) can be translated e.g. from Czech sign language into Czech, English and American Sign language.

Adding a new lemma to the dictionary is usually a time consuming and difficult task, that is why this article introduces a methodology for automatized dictionary creation which can speed up the process.

2 Dictionary Structure and Content

The dictionary combines three main principles:

1. Full autonomy of the data for each language (the signs are not considered equivalents to some words and primarily, a sign should be explained by means of a sign language)
2. Philological exactness and completeness (using the same lexicographic procedure for signs as normally used in thesauri online, such as Merriam-Webster, Duden, Garzanti, Trésor de la langue française etc.)
3. Semantic synsets (groups of synonyms) as conceived by George Miller and Christiane Fellbaum et al. for the well-known WordNet structure (http://wordnet.princeton.edu/wordnet/).

In such a way, each language represents an independent lexical network connected by synsets and collocations, and these independent networks (lexica) are freely connected to each other just by means of identical semantic features of their lexical items. Each lexical item (entry, lemma) is described by means of two groups of fields:

2.1 Formal description

Presentation of the lemma form:

- alphabetic text (standard spelling as the primary word presentation in spoken languages, alphabetic transcription of a sign if such a system exists)

- audio/video presentation (one or more audio or video formats to present pronunciation and/or mouthing in a spoken language and signing in a sign language)
- analytic description of the acoustic or visual reality (IPA transcription in spoken languages, SW or HamNoSys in a sign language etc.)
- verbal description of the acoustic or visual reality (textual comments to pronunciation or mouthing, verbal description of signs)

Classification of the lemma form:

- part of speech
- grammatical categories
- stylistic categories

2.2 Semantic description

Presentation of the meaning:

- verbal description of the meaning (semantic features) with examples for each semantic unit
- synsets: hypernyms/hyponyms, antonyms/synonyms, coordinate terms
- collocation, phrases with examples for each syntactic unit

Classification of the meaning:

- semantic categories

2.3 Organisational and legal description:

- performer: who filled in the data
- authorisation: who is the author of or responsible for the data
- history: when particular data were entered or deleted

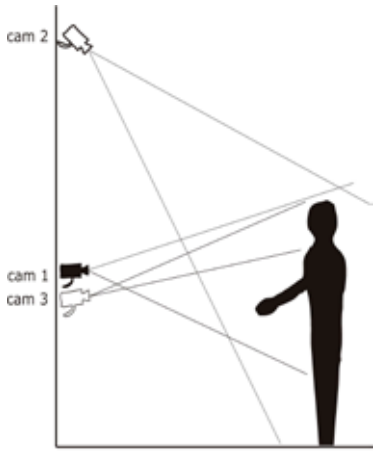
The content of the dictionary will be continuously extended and modified. For this purpose a special administration section is available where the users can (depending on their permissions) create, update or delete dictionary entries. Special work-flow management is prepared for administration users with limited permissions; here all modifications must be confirmed by administrators with full permissions. Thus the quality of the content is preserved with the possibility for many users to edit the content. The decision as to wheter a new or updated dictionary entry is valid will be supported by a discussion under each dictionary entry, where the community can decide, whether the provided information is correct.

3 Methodology for Automatized Dictionary Creation

3.1 Scene Description

We use computer vision techniques to automatically detect boundaries of signs in a recorded session. There are certain conditions that need to be met in order to successfully recognize the boundaries. There should be a neutral pose of the signing person. This pose

defines the beginning and the end of the sign. Also, the stage where the person is signing should have laboratory-like conditions so that the hands of the person are clearly visible and easily distinguishable from the background. Since the intended purpose of the recordings is to use them in a SL dictionary, these conditions are reasonable.



[Fig. 1a] An example of a configuration of cameras

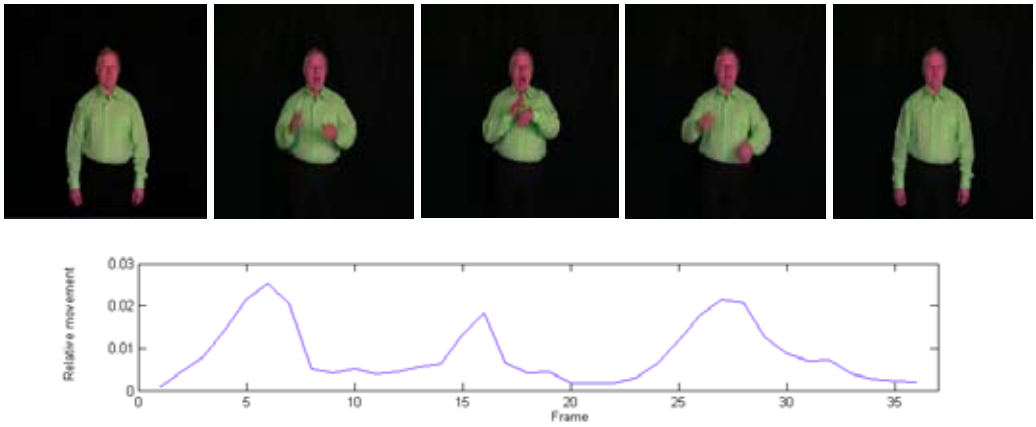
[Fig. 1b] Example of the laboratory-like conditions and an initial pose. Different color of the background, the shirt and the skin is important to successfully segment the image.

3.2 Sign Boundary Detection

We detect two features: motion and position. First, the image is preprocessed and segmented so that we obtain parts of human body. In some cases a simple thresholding can be used (if the signer wears dark clothes). In more complex situations, when the brightness level of pixels is not sufficient to distinguish between parts of human body and the rest of the scene, we use skin color segmentation. Next, we use object detection in the segmented image. We compare the position of objects (hands and head) with the practised initial position. If the distance is below the given threshold, we assume the signer is in the initial pose (Figure 1b). In some cases we do not need to compute the distances but rather examine the position of the object and check whether it is in a predefined region. This is an alternative approach with the same mathematical foundation. In the next step we describe the movement as the sum of pixels in the difference image. This does not give us a detailed description of the individual movements but rather an estimate of all the movements in the image. This value is normalized by the resolution of the image. A threshold is set and when the relative motion in the image is above this threshold we assume there is a significant movement of hands (Figure 2). The features of the movement and the initial pose are measured throughout the whole recording. The first frame in which the neutral pose is not detected and movement is detected is considered as the beginning of the sign. Similarly, the first frame in which the neutral pose is detected and no movement is detected is considered to be the end of a sign. We have to shift the boundaries of the detected sign a bit so that the resulting clips begin and end in a stationary pose. Usually we use the shift of ± 50 ms.

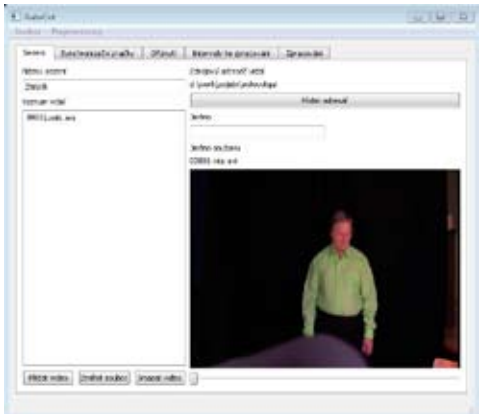
3.3 AutoCut

To speed up the processing of video recordings we made a specialized program. The program was developed with the aim to take the user through the whole treatment of videos from preprocessing to publishing the recorded signs. The first step of video processing is conversion of the recorded videos to the video format appropriate for the next processing.



[Fig. 2]
Top row: selected frames from a sign video recording
Bottom row: relative movements in the sign video recording

This can be done in a simple dialogue for file managing and running of the preprocessing. The main window (see Figure 3) of the program has five cards in the order of usual processing of chosen videos. On the first card the user can add, change or delete source video files (made in the preprocessing step). On the second card a synchronization mark, which is important for processing video records from different point of views, can be set. The next card is for the crop settings and the third one for choosing the intervals to process. The last card is for the automatic detection of the sing boundary, setting of the model of the skin color and final generation of the individual signs for publication.



[Fig. 3] AutoCut main window

4 Sign language dictionary online

The dictionary is a joint venture of Masaryk University, University of West Bohemia and Palacký University, accessible at the following URL's: http://slovnik.zj.teiresias.muni.cz and www.znaky.zcu.cz. The primary platform for the dictionary usage is a PC connected to the Internet, using any modern internet browser (Internet Explorer version 6 and above, Firefox, Opera, Chrome, etc.) with Adobe Flash plugin installed. To enable hardware accelerated high quality 3D avatar animation, a special plugin (Google O3D) is required. Without this a lower quality 3D avatar is used.

The secondary platform is a mobile device (PDA, smartphone, etc.) with an internet browser. For this platform the dictionary will be formatted according to the possibilities of the device and the video clips will be resized and compressed for the needs of those devices.

Another platform is a PC in the same configuration as above but without internet connection. The dictionary will be able to create an off-line version automatically, which will be updated every day and available for download. This off-line version will be limited in functionality in comparison to the on-line version, mainly in the possibilities of searching.

4.1 Sign Language Representations

Video

The dictionary entry can be represented by one or several video clips (Figure 4). They can be recorded separately (different speaker, place) or can be recoded simultaneously from multiple perspectives (e.g. front, side and face view). The video data can be stored on the dictionary server or can be stored on an external server anywhere on the Internet, including video sharing websites (Youtube, Vimeo, Dailymotion etc.). The video data will be available in more compression qualities and sizes, mainly for the usage on mobile devices.

[Fig. 4] Video player showing a sign

[Fig. 5] 3D avatar displayed on a web page

3D avatar

The synthesis of the sign language creates a computer animation of the signing avatar, [2] (Figure 5). A 3D animation model of a human figure was designed especially for this purpose.

Image

Multiple illustrations, photos or any other images with a representation of a sign can be used.

HamNoSys

The dictionary includes a special editor for HamNoSys (Hamburg Sign Language Notation System, [3]) strings which allows the users to create new or modify existing HamNoSys strings (Figure 6). Nowadays the Hamnosys notation of each sign is crucial for the automatic synthesis of sign language.

SignWriting

Similarly to HamNoSys, a special editor for SignWriting is included, [4] (Figure 7).

[Fig. 6] HamNoSys editor

[Fig. 7] SignWriting editor

4.2 Searching

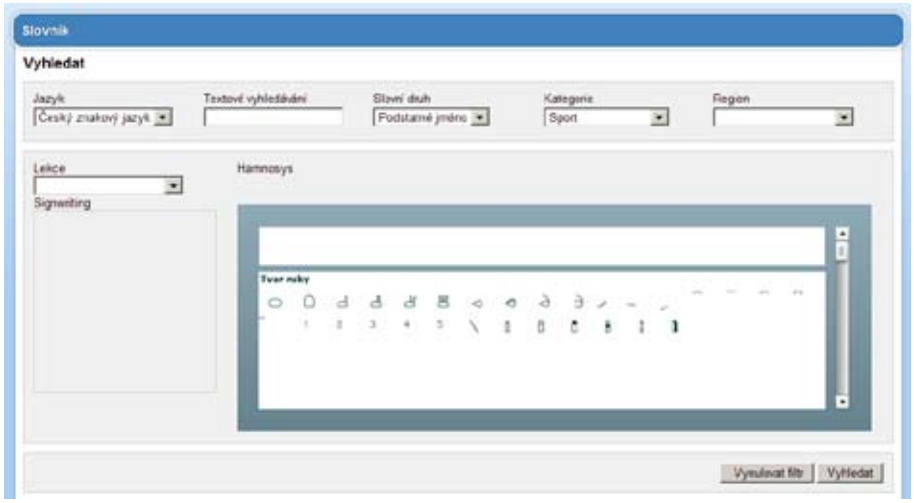
A key feature of the dictionary is searching. The goal is to create a searching function which will provide relevant results for user query. For spoken languages there are basically two ways to enter data for searching: text data via standard spelling (possibly in combination with grammatical and stylistic or semantic information), or acoustic data via voice. A specific combination of both ways is represented by searching based on phonetic transcription (usually an intuitive one, rather than an exact system). The result is a list of dictionary entries which satisfy the given search criteria. For the Czech language a lemmatization engine is used to enable searching among different inflected forms of the same words. Furthermore, the searching is not necessarily limited to dictionary lemma

forms but may provide, if needed, full-text search in all text items (meanings, explanations, examples etc.).

In the case of sign languages both the above-mentioned ways are complicated by the lack of standards: there is usually no system of text transcription, there is no standard sign notation, and not enough visual data to use a camera and motion capture as a standard searching technology. Our goal is to examine the possibility of using HamNoSys and SignWriting as search criteria and to find a way of providing related dictionary entries for the given criteria. As we expect that the results list when using this way of searching will contain many items, other criteria can be used to limit the search as for text search (semantic and grammatical information) (Figure 8).

4.3 Automatic Processing of Signs

As described in [1] we are able to track hands and the head in recordings designed for the sign language dictionary. By now we are able to obtain the trajectories of both hands and the head (Figure 9). On a relatively small dataset we achieved good recognition results with features describing the manual component of SL. The features can be used for the annotation of a portion of the manual component in the desired form. From the signal of trajectories of both hands we are able to determine whether the sign was symmetric or



[Fig. 8] Searching form

not. We compute Pearson correlation coefficients between the x and y signals of the trajectories. The absolute value of the coefficients determines the probability of the sign being symmetric. The trajectory can be also utilized to determine the location of the sign, the type of movement and the contact between body parts. This is work in progress. The trajectory also gives us information about the position of hands in every frame. Thus, we are able to obtain an image of the hand in every frame. This image can then be used for determining the hand shape. This task is very difficult and has not been completed yet. Our approach will take into account only 27 hand shapes, which makes the problem a little less complicated. Based on this information we can automatically group similar signs and make use of this information for searching purposes.

5 Conclusion

The sign language dictionary which offers so many options and meets all the abovementioned criteria is a complex and ambitious goal that will need the co-operation of several teams on an international level. We hope that it can be achieved in spite of the fact that, apparently, the number of native signers is decreasing (due to several reasons) and it is not easy to build up a professional team dedicated to sign linguistics.

6 Acknowledgment

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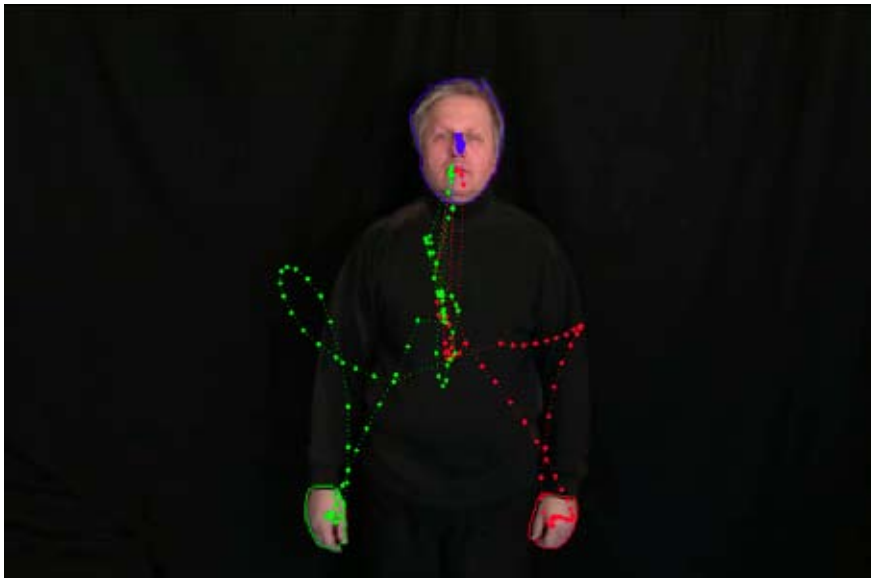

[Fig. 9] Example of tracking result

Programme Education for Competitiveness of the European Social Fund and Ministry of Education, Youth and Sports of the Czech Republic, project No. CZ.1.07/2.2.00/07.0133; by the Operational Programme Education for Competitiveness of the European Social Fund and Ministry of Education, Youth and Sports of the Czech Republic, project No. ME08106; and by the Grant Agency of the Czech Republic, project No. GAČR 102/09/P609.

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Multimedia Dictionary of Terms for Drama Education, Czech – Czech Sign Language

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Keywords: drama education, sign language, Czech sign language, Drama Education for the Deaf, innovation of degree course, dictionary, Subject Heading System, context sentence

Abstract

Subject Drama Education for Deaf was founded in 1992 and was the first subject for deaf students in the Czech Republic. In June 2009 began realization of the project Study Programme Innovation of the Drama in Education for the Deaf Department in the Faculty of Theatre JAMU. Thanks to this project are innovated some subjects and was also created brand new subject – Sport-Movement Games. Sign language course is being lectured by deaf teachers from partner organization Trojrozměr and provide students with theoretical knowledge of sign language and Deaf culture as well as practical sign language lesson. Furthermore, innovations and work experience placements are being made thanks to the project. Project partners are also involved in these activities, where students can gain valuable practical experience.

Partial aim is also Systematization terminology of drama education in the Czech sign language. In this activity are taking part sign language tutors and foremost partner of the project – the Czech Chamber of Sign Language Interpreters. The aim of systematization of terminology is to enrich the character-stock and clearly define the technical terms of drama education. The dictionary contains about 400 terms from the drama education that are presented in Czech language and Czech sign language. The dictionary contains also commentaries written in Czech, which explains each term. For each term is there also a contextual sentence in Czech sign language. Thanks to this students will understand the importance of the term and at the same time they can see an example of an adequate use of the term.

This multimedia dictionary will be used mainly by students of the subject Drama Education for Deaf during their studies and later they will use the correct terminology in schools during their practice.

This project is cofinanced by the European Social Fund and the Czech Republic state budget.

1 Drama Education for the Deaf

The degree course Drama Education for the Deaf was founded at the Faculty of Theatre at the Janacek Academy of Music and Performing Arts in Brno (JAMU) in 1992. Professor Mgr. Zoja Mikotová became the head of the Drama Education for the Deaf and she is on this position until now. This is the first university degree course designed for deaf students. The teaching was customized for deaf students and the sign language has become an integral part of their education. Deaf students were given the opportunity to obtain a university degree. The conditions for the creation of these studies at the faculty have been

favorable. The faculty management approached to the potential deaf graduates of JAMU without prejudice and it also has taken into account their individual physical talents. The need for sign language interpreter presence is respected. The classes are interpreted into sign language. The sign language interpreter is available to students even for the necessary matters of study and at events organized by the faculty.

Today, the offer of university studies for the Deaf students is much broader and they can choose among many possibilities. Study Programme Drama Education for the Deaf is done in at art school, that's why the subjects like Acrobatics or Physical Theatre are mandatory. There is also a range of subjects like Juggling, Classical Dance, Course of Theatre Make-up, etc. Students get training in courses of Psychology, Pedagogy and History of Care of the Deaf. The study also includes the preparation and realization of theatre performances presented then by students on various occasions in the Czech Republic and abroad. Deaf students can use the offer of subjects from throughout the Faculty of Theatre and are also involved in projects of other fields of study at the faculty.

Structure of subjects is changing and adapting to the demands on today's university students. Subjects using media such as editing, photography, etc. are gradually added to the study programme.

2 Involvement in the Study Programme Innovation of the Drama in Education for the Deaf Department

Realization of the project Study Programme Innovation of the Drama in Education for the Deaf Department (as part of the study programme Dramatic Arts in Faculty of Theatre at JAMU) is one of the proofs of enriching the study possibilities. This project is cofinanced by the European Social Fund and from the Czech Republic state budget.

2.1 The project partner

The project partners are these organization. *Trojrozměr* – Brno Centre for Sign Language, *Neslysim* Theatre Company, Kindergarten and Elementary School for the Hearing Impaired in Brno, Kindergarten, Elementary and Secondary School for the Hearing Impaired in Prague-Radlice, the Czech Chamber of Sign Language Interpreters.

2.2 Aims of the project

The project aims to upgrade the study programme of Drama Education for the Deaf, to improve education of students in this department and develop the field in accordance with the new trends and thereby increase the chances of this programme's graduates in the labor market. Next aim is also to begin a systematic cooperation with employers, which in this case are the schools for hearing-impaired and organizations related to Deaf issues.

Part of the aim is to expand the knowledge in the area of new trends and methods of teaching sign language and to increase knowledge and skills in the area of sport and physical activities, to familiarize students with the future working environment, present knowledge and skills in the practice of the Drama Education for the Deaf with potential employers and create a dictionary for the field of drama education in sign language.

2.3 Specification of the project

This project is innovative for some subjects – for example Sign language and there is a brand new subject – Sport-movement Games. It enriches students with other techniques and methods of physical activities and with broad scale of games they can use in their future teaching career in both drama education and leisure activities. Thanks to the project, students can take part in practical training and internships in partner organizations. All partner organizations are devoted to the issue of hearing impairment, work with the Deaf and are employers of hearing impaired individuals. Thus the students may enter an environment where the sign language is used as a common means for communication. Most of the lessons are taught in sign language, so communication is not mediated by an interpreter, but is direct.

In the practical training at schools in Brno and Prague, students take part in lessons, where they can learn about their methods used for teaching. In addition, students have their own in workshops, where they lead the lesson themselves and work with pupils. Also Deaf educators teach at these schools, so students can see their work, the teaching of sign language.

The Czech Chamber of Sign Language Interpreters is a professional organization for Czech Sign Language interpreters, the goal is to protect the interests of interpreters, to increase the level of professional interpreting, educational activities in the field of interpreting, interpreting for Deaf clients and it also aims to spread the awareness of Deaf issues. Students are introduced to the activities of this organization and are also involved in the preparation of certain projects, as actors and collaborators.

The *Neslysim* Theatre Company is a civic association, founded by the graduates of Drama Education of the Deaf study programme. In this association, the students get familiar with the entire creative process – from preparing the initial phase of introduction to the realization of the first night. Students acquire theoretical information on the history of the *Neslysim* Theatre Company and its management from the perspective of Deaf individuals. This transfer of personal experience is of a great benefit for further professional advancement of Deaf students.

Partner organization *Trojrozměr* guarantees the teaching of sign language by Deaf tutors provided by this organization.

3 Education of Sign language

Education of the Czech sign language is important for Deaf sign language users, because they need theoretical knowledge about their own language.

The teaching of the Czech Sign Language for students of Drama Education for the Deaf has two parts. The first part, the theory of the sign language, includes information about the results of the available researches in the Czech sign language and contrastive approach to teaching of the Czech sign language and Czech language. The second part contains practising of production and perception of the Czech sign language and processing an essay on a linguistic topic.

Only a small percentage of Deaf is aware of linguistics, the structure and functioning of the Czech sign language, of the fact that the grammar is different from other sign languages grammars. Most Deaf people use the Czech sign language actively, but only on

the basis of their language feeling. It is a significant difference from the other Czech users, who study the grammar and literature of their language throughout the whole school time and a large portion of this time is dedicated to this matter in the subject of Czech language and literature *Why is this so?* In all elementary and secondary schools for the hearing impaired is the subject of Czech sign language not an integral part of curricula, so Deaf students do not acquire information about their first language. These students learn only their second language, Czech, in elementary and secondary schools, but this a foreign language for them. However, only the importance of the competence in their second language is instilled to them, often without basic knowledge of their first language. It is a sad experience that the Deaf students don't pass further the „special" education awareness of the value and beauty of their own language – Czech sign language.

I am convinced that the subject of the Czech sign language should be a natural part of education at elementary and secondary schools for the hearing impaired. Good practical and theoretical knowledge of the Czech sign language is essential for the deaf. Having this knowledge they are much better prepared for the learning of a second language of the majority. They will be better equipped and prepared for life, like their hearing peers, who have several years of studies in the Czech language and literature.
If Deaf students will be able to get in the schools also general information about their first language – the Czech sign language, they will be better educated and better prepared for an independent, full life.

Education of the Czech sign language has benefits for hearing sign language users too. Hearing gain information about the language of the Deaf. Thanks to the lectures in the subject of the Czech Sign Language, hearing students will be able to affirm that the Czech Sign Language, as a first language of the Czech Deaf community members, is a full language, which meets all the features of natural language.

4 Multimedia Czech – Czech sign language dictionary for drama education

An integral part of the project Study Programme Innovation of the Drama in Education for the Deaf Department is systematizing of the terminology of drama in sign language. Multimedia Czech – Czech sign language dictionary for drama education has been created. Project Partner – The Czech Chamber of Sign Language Interpreters was involved in this part.

The main purpose of the dictionary was to collect the constant terms in the field, to create new terms and record them on DVD in order to best serve to teachers and students of the field as a tool for education and study. Deaf students will have easier further education and a better understanding of the study texts in Czech.

4.1 The terminology of drama in sign language

Czech technical terms occurring in the courses of the study programme Drama Education for the Deaf are many and ever-emerging new terms. Lack of knowledge of technical terms and characters brings problems to the first-year students. Deaf that use Czech as a foreign language have difficulties get to understanding of many of the terms or they are uncertain about the meanings. This is one of the reasons, why the specialized Czech-Czech Sign language dictionary for drama education has been created. To collect or cre-

ate the equivalent for the terms in Czech and the Czech sign language, supplement them with commentaries explaining the Czech – study language of Deaf students and examples of use in the Czech sign language – preferred communication system of Deaf students. Some terms and corresponding characters the students already know, in some cases those terms has different meaning in different fields. E.g.:

Association:

1. Associations or organizations with the word association in the name, such as sports, professional and other associations
   – This meaning is used in everyday life, in sociology and law
2. Association – a form of economic cooperation between different enterprises and companies
   – This meaning is used in Economics and Management
3. Association – the connection between mental perceptions, thoughts, feelings, moods, etc., which hypothesis explained the association thought at all
   – then the associative memory in which the contents of equipping the basis of similarity, in computer memory, addressed to the content

4.2 Creating a dictionary

Creating a dictionary is very responsible and difficult issue and it has been done in the following steps.

The first step to the creation of the dictionary was a Subject Heading System, which contains the basic terms used in drama education courses. A list of technical terms became the basis of the Subject Heading System, which has been created during the lessons, where students noted the terms they did not understand or were not sure of their meaning. The task of hearing students has been the cooperation of the final version of the Subject Heading System, therefore revise and organize technical terms, which will be processed in the dictionary. From original five hundred entries, after consulting both the Chamber and the JAMU, collected nearly four hundred basic terms. These terms can be found in the dictionary, as in the Czech sign language and in written Czech.
After that, another important lexicographical step followed, which was a professional interpretation of all terms in Czech. Understanding of the proposed terms were consulted with hearing and primarily with Deaf students. To each term was then made comment that explains the term in written Czech, so that there is a clear interpretation to the student whose first language is not Czech.

Then, equivalents in Czech sign language were assigned to the terms, which were settled and regularly used in lectures in the field. For those which did not have equivalent to assign, was created a working group of students who were asked on a thorough understanding of the term and to create a new equivalent according to linguistic principles. The members of the Deaf community will decide about the use of these new terms. To better grasp the meaning not only the commentaries have been used, but also the examples of usage in Czech sign language. These context sentences are in the dictionary as a specific example spontaneously used in Czech sign language. These sentences are designed to clarify in what context or in which connections we can find or use them in Czech sign language.

On the creation of this dictionary worked students of Bachelor and Master's degree, hearing and Deaf. The advantage was, that students of a Master's degree have more experience in similar work. Filming equivalents in the Czech sign language and examples in the Czech sign language conducted with the professional support, took place in the Czech Chamber of Czech sign language interpreters.

5 Summary

A huge benefit of this project is the involvement of Deaf tutors in the teaching of Deaf students and that the students get familiar with the institutions, which communicate with sign language and that are dedicated to education, artistic activities and provide interpretation to/from Czech sign language.

We hope that this Multimedia Czech – Czech sign language dictionary for drama education will used not only students of the study proramme Drama Education for the Deaf, but also to the students of other programmes. And also that the glossary will enlight other groups of people who are interested in this problem.

http://esf.jamu.cz/projekty-jamu/0367.html

OCELLES Project – Concepts and Lexicons in Written and Signed Languages Observatory

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Abstract

The Académie Française institution is assigned and devoted to defending the French language and to making it a common heritage for all French speakers. The French Sign Language (LSF) has never had such a support.
To face this situation, a reference tool has been created, supported by the French Ministries of Education and Culture. This tool is a collaborative website entirely bilingual French and LSF, which proposes for each concept at least one definition and its associated descriptors in various knowledge fields. Before being spread on-line, the information given by users is examined by experts on form and content, and is validated or rejected by these experts.
Several signs may be proposed and validated for one concept. Our project does not wish to choose the "ideal sign", but wants to submit to our identified users all the proposals and to list their comments. A set of information is thus collected for each sign and can be related to users profiles. The website is therefore an exchange platform, but can also be used as a linguistics observatory.
One of our main issues concerning the data organization was to manage to adjust users different viewpoints and different uses of the website. Indeed, our platforms goal is not to make a simple dictionary but to create a network of ontologies. We cannot use a rigid organization model, because our website must constantly evolve and include new concepts and new descriptions or functionalities.
We will first describe our platforms goals, then present our specific data organization which allows for example several classifications to be used simultaneously. We will finally present our current work on integrating direct resources in LSF through linguistic's descriptors defining a sign. We will also show that this data organization allows an easy conversion to other countries sign languages.

1 Preamble

According to Gillots official report[1], 80 % of the French deaf people are illiterate. Dalle has also declared in (Dalle, 2003) that "illiteracy, short knowledge of written French, lack of diploma and of qualifications as well as communicating problems have great consequences on deaf adults' social and professional integration". Furthermore, a study realized

1 http://cis.gouv.fr/spip.php?article1516

by ORS of Pays de la Loire in 2007[2] estimates at 9.6 % the part of deaf from 25 to 39 years old with a qualification superior to "baccalauréat" (french high-school diploma), against 25 % for the whole population.

Since the French 11th February 2005 act, public schools cannot refuse for any reason to take in a child living in its defined area. Besides, all public websites must be entirely accessible. In 2010, a state diploma will be created for LSF teachers. In this context, new needs have appeared, and appropriate bilingual teaching tools are increasingly demanded.

Just as the French language, LSF has many regional vocabulary differences, and it constantly enriches itself with new words, thanks to its speakers who create signs to name new concepts and/or concepts that are specific to a knowledge field. As the deaf people increasingly access university and professional environments, this phenomenon is enhanced. (Duquesne-Belfais, 2007) stresses out that each concept – once its has been attributed a name or a sign – can be used to define a more abstract concepts characteristics and can take part in building a knowledge network. Nominalizing the concepts characteristics allows it to change its status, switching from implicit to explicit, and to take part in constructing a rigorous language.

2 "OCELLES" PROJECT

The main support of the "OCELLES" project (Moreau, 2008) is a collaborative website, entirely bilingual French/LSF, and which proposes for each concept at least one definition and its associated descriptors – in both languages – in all possible knowledge fields. Before being spread on-line, the information given by users (text, picture, video, presentation) is examined by experts on form and content, and is validated or rejected by these experts with an explanation.
The project is currently under testing and will be published at http://www.ocelles.fr.

2.1 Managing users and rights

Running with a GPL licence[3], the website is free to all. Users may access different statuses:

- visitors browse on the websites public content,
- they become users when registering and filling a form establishing their profile. The collected information – on their scholarship, track record, languages used within family and social lives – will balance their answers and advice concerning proposed signs,
- writers are users who have accepted the publication terms. They may propose new contents and concepts to experts – possibly supported by a classification. They may also add videos to illustrate other authors text sequences,
- experts are writers who validate the contents deposited by writers. They must also provide an explanation to the writer in the event of non validation,

2 http://www.sante.gouv.fr/handicap-auditif-en-france-apports-de-l-enquete-hid-1998-1999.html

3 http://www.gnu.org/licenses/licenses.html

- the administrator is expert in all fields. However his main role is managing the portal without taking part in expertises and publications.

We must specify that writer and expert statuses are only attributed to a users knowledge field: a user may be expert in mathematics, writer in philosophy and plain user in all other fields.

Managing users rights so precisely should lead to a democratic and community use of our website, because the hierarchy only depends on the chosen theme.

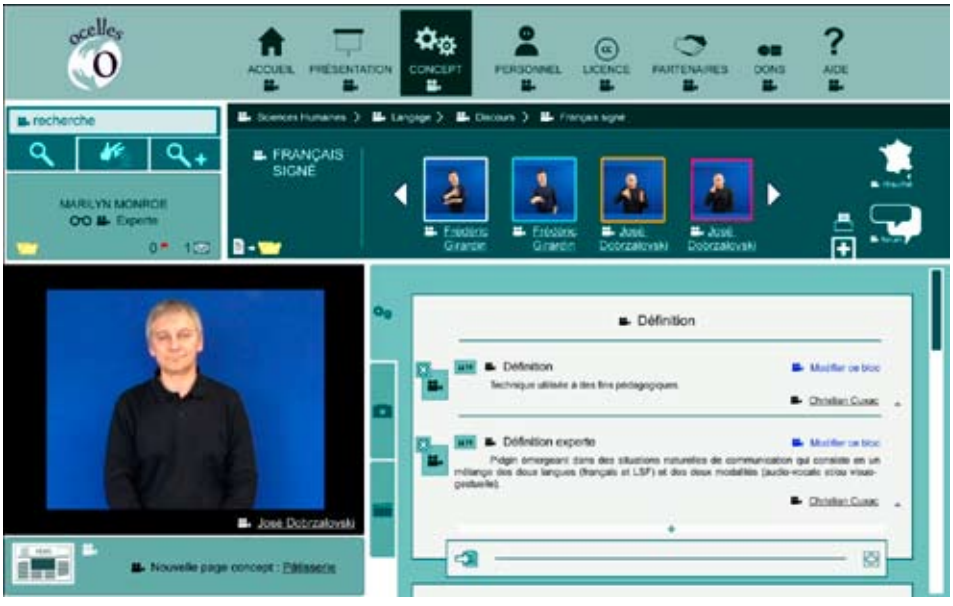
2.2 Concepts

For each concept, a specific and dynamic webpage proposes a definition, a translation into written language and one or several signs in Sign Language. Considering regional and sociological differences, several signs may be proposed for each concept. Our project does not wish to choose the "ideal sign", but wants to submit all proposals to users. The definitions respect the following rules.

Written definitions must:

- give the concepts meaning and its main characteristics,
- be precise,
- begin with a general explanation,
- be a suitable substitute to the unknown word in a text,
- not integrate other definitions,
- not contains other words having the same root,
- not be circular.

Illustrations, examples, comments (educational or linguistic etc.), slight differences, regional uses, connotations and other are in addition to the definition, not a part of it.



[Fig. 1] Screenshot of a "concept page"

A Sign Language definition:

- must not contain any regional code or name (however local signs may be used to refer to a concept),
- must avoid neologisms,
- should be punctuated in order to enable its sequencing.

The signing flow is adjusted for deaf or hearing learners.

The platforms goal is not to provide a plain dictionary, but a real network of ontologies. Links enable associations between concepts – ex. "thesis" refers to "arguing" – thanks to the "see also", "close concepts", and "opposite concepts" descriptors. The links between concepts are flexible, and more type of links can easily be integrated to "OCELLES".

2.3 Signs

Each sign proposal opens a new web page. Examples, context and other descriptors as well as linguistic and epistemological comments can be added. Users are encouraged to answer questions about:

- the context(s) in which they have encountered each sign (class, job etc.),
- the sign characteristics – i.e. formed with one or two hands, coming from a transfer (Cuxac, 2000) in form, situation, person, configuration, position, moves, facial expression etc.

2.4 Proposals summary

For each concept, the answers given by other users are gathered and summed up on one page. They can be linked to their profiles, thus enabling for example a collection of information about geographical localization of each sign. More than an exchange platform, the website is also a synchronic linguistics observatory.

[Fig. 2] Screenshot of a "summary page"

3 Data organization model

3.1 A rigid classification and its limitations

At first we have used Deweys decimal classification (DDC), usually used in libraries. We have chosen this system, developed by Melvil Dewey in 1876[4], because it exists and classifies the whole set of human knowledge.

However, user tests, made on both deaf and hearing persons, rapidly pointed up the difficulties we had sensed. The DDC consists in classifying works and knowledge into 10 general categories, each one of them being divided and subdivided each time into 10 subcategories and so on as many times as needed. Looking for a specific concept through this tree diagram makes it imperative to:

- know into which categories and subcategories the concept will classified,
- make no mistake through the tree diagram in choosing the subdivisions.

This approach, not intuitive, will locate a low-level concept very far from the head of the diagram, thus the lowlevel concepts will be found only if the high-level ones are known and understood.

As for the linguistic system LSF, it combines a categorical aspect with its vocabulary structure. According to (Courtin, 1998), the use of LSF by deaf children whose parents are deaf and already signers increases categorizing abilities compared to hearing or oralizing children. Courtin has observed this phenomenon especially when the categorization respects our worlds complexity by using prototypes or diagrams (Bideaud et al., 1993). Indeed, signers often refer to a concept through a series of prototypical examples of it, thus defining the concept by extension. A rigid and arbitrary classification could then disturb deaf users.

Besides, where and how should new concepts directly stemming from Sign Language be classified, in a rigid classification set upon written language? (ex. "LS Video", video recordings of formalized LSF used as a differed communication, or "signary", set of all signs in Sign Language).

3.2 Dynamic classification

One of our main issues concerning the data organization is to manage to adjust users different viewpoints and different uses of the website. Our portal must be able to easily evolve and include new concepts as well as new descriptions or functionalities, such as illustrations, homonyms, antonyms, etc. Keeping using a rigid data organization is impossible. That is why we have chosen a data organization which considers a priori each one of the web site's elements as a content. In parallel, an associative and dynamic structure has been set up, enabling to link contents together according to their roles and to the descriptors associated to these roles (Moreau and Mascret, 2008).

This way, one content may be used several times because in different contexts, depending on the associations it belongs to roles and descriptors (Bénel, 2003).

Let us give an example: in our website, a classification node has a role of theme. A theme is also a concept for example "language". This theme lists other themes and con-

4 http://www.oclc.org/dewey/

cepts. "Language", as a theme, contains the themes "lexicon", "semantics"… Moreover, "language", as a content, also has a role of illustrator to the concept "semantics". This way, one content – here "language" – has different roles (theme, concept). Each one of these roles has its own descriptors (concept's illustration, other related concept…).

Finally, the diagram tree must allow a concept to be classified in several themes without duplicating it. Libraries often face this problem when classifying works containing several themes – a book about science in the 19th century should be classified into history as well as science.

3.3 Discussion: a dynamic classification built on LSF linguistic parameters?

According to (Cuxac, 2000), two discursive enunciation strategies coexist in LSF. Through the visual-gestual channel, the signer chooses to say without showing, or to say and show. This way, he can visually re-present the experience thanks to the greatest resemblance between a sequence of signs and the experience itself. Or else he can use the standard sign that does not resemble the referent. Based on this theory of iconicity, our research draws the assumption of a hierarchy between the linguistic parameters used in signs as meaningful elements.

If those greatly iconic structures involve infra-lexical linguistic elements that do not belong to the lexicon, they appear most often in narrating sequences and remain nonetheless unmentioned in Sign Language dictionaries. However, if we consider that these structures are an integral part of Sign Language, how should we integrate them into our web site?

Two perspectives are suggested to answer this question.

The first one consists in considering the minimal structures of realization in Sign Language. The linguistic parameters of configuration, movement, location (Stokoe et al., 1965) and orientation (Friedman, 1977), (Liddell, 1980), (Moody, 1983), (Yau, 1992) cannot be considered as such. Indeed, even if a human mind can make a relevant distinction between them as isolated elements conveying meaning, they must be used simultaneously in order to be activated while communicating. Contrary to vocal languages, realizing a signifying form in a Sign Language cannot be made through a succession of distinct realizations of isolated and non-signifying elements. Minimal realization structures in Sign Language may be ranged on a growing complexity scale, starting from the formal transfer (infra-conceptual level) and going up to the double transfer (level where several actors, location parameters and utterances can be combined). These various structures use the same linguistic parameters during the same realization laps of time.

The second perspective is based on the dialectics between syntagm and paradigm. When narratives contain highly iconic structures, the value of an element at a given time undergoes a type of syntagmatic pressure – which does not necessarily come from preceding or following units, but from other units occurring at the same time and taking part in the minimal form of realization as well. Yet, the simultaneity is not a sufficient clue to conclude that it is a paradigm, since this pressure can be seen. In a Sign Language, the pressure stemming from the context does not only influence the temporal dimension. The spatial dimension exerts constraints as well, but this time simultaneous instead of successive.

Regarding these two perspectives, our users are questioned about their perceptions and representations of the meaningful infra-conceptual units – while first visiting each "sign page".

We do not want to collect "correct" answers, but to gather the most identical ones. This way, our classification leans on a consensus amongst users. However, our experts can impose a classification and may concentrate the researches for a sign through these answers, without necessarily using the material as a final classification.

Based on our users' answers, descriptors and/or classifiers are assigned to each sign, according to the summary of a dynamic amount of identical and meaningful answers. The data base model we propose is based on the idea of modeling the interactions giving sense to the content – and not the content itself. The polymorphic use of contents implies a data organization based on the role we wish a content to play, as explained above. In this way, an "answer" – as a content – has both roles of answer to a question and of classifying and research element. One or several specific descriptors correspond to each role.

This approach of a dynamic classification of concepts, built upon LSF linguistic parameters specific to each sign, enables us to propose our users to look up concepts through the site directly in LSF, without having to know the concepts' written signifiers. Later on, a dynamic classification could also be based upon sign writing[5].

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5 http://www.signwriting.org/

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Experience of Providing Simultaneous Transcript to Universities and Sample of Some Other Options, Including On-line Transfers

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Abstract

The report focuses on the experience with providing transcription services in tertiary education. The first university to provide transcription services for students with hearing disabilities in the Czech Republic was Masaryk University. The Czech Union of the Deaf has been supplying the service of simultaneous transcription for people with hearing disabilities since 2008. It offers these services for some universities via its pilot research project. Therefore, this service provided by Masaryk University is not a common one. The presentation looks at different types of simultaneous transcription (simultaneous transcription with the transcriber present on the spot, on-line simultaneous transcription with the transcriber and on-line simultaneous transcription with a trained speaker) which can be further used by individual universities having their own help centres for students with special needs.

1 Introduction

The transcription of spoken word in real time (here "simultaneous transcription") has abroad been a well established service for many years, known under the abbreviation CART. It is defined as a word-for-word transcription of what the transcriber hears in real time and it is meant to be used by individuals with hearing disabilities. It can be used at conferences, seminars and many other events. The transcriber transcribes the spoken speech on an electronic keyboard connected to a PC or to a laptop. If the text of the simultaneous transcription is designed for one person, it can be displayed on a monitor, if it is designed for a small group of people it can be displayed on a bigger screen or if it is designed for many people, for example at conferences, it can be projected on a big screen.

2 History

The impulse for a quicker introduction of transcription was given at the conference in the Czech Union of the Deaf where the hearing impaired participants did not know exactly what the lecturer was talking about in spite of the good pronunciation of the speaker. Substantially, several experimental transcriptions were done. In May 2006, we talked about this issue with Věra Strnadova who, in September 2006, proposed to introduce the simultaneous transcription into the Law on Communication Systems for the Deaf and Deafblind which was being amended at that time. The simultaneous transcription was called "recording a spoken speech in real time." During the next session of the negotiations, government officials of the Ministry of Education did not agree with the words "in real time". This communication system proposal did not even get into the first reading. However, thanks to the great effort of activists led by Vera Strnadova, the simultaneous

transcription as well as the provision of the right to a free choice of communication systems was successfully introduced into the legislation through the deputies' activity. The simultaneous transcription is thus implemented in the legislation and it is possible to make reference to this law. Thanks to the support of the Vodafone Foundation, the Czech Union of the Deaf has been, since September 2008, providing a special service within its pilot project. This service was registered as a common social service called Simultaneous Transcription Mediation Centre (further referred to as STMC) on 13 September 2010.

3 Why simultaneous transcription?

Even though the students have the possibility to hire an interpreter into the Czech sign language, for those students whose mother tongue is Czech it is much easier to receive the information in the language they think in. The student thus does not have to "translate" in his mind from one language to another. According to the above mentioned Law on Communication Systems, individuals with hearing disabilities have the right to a free choice of the communication system which meets their needs. Their needs must be respected in such a way so that they could lead a life equal to other people's lives. And this implies also to the field of education.

4 Simultaneous transcription provided to students at universities within the pilot project

Universities usually hold their own help centres for students with specific needs. The majority of these centres are independent and that is why the provided services differ both in scale and activities. Currently, the most developed centre for students with hearing disabilities is the Teiresias Centre of Masaryk University. Among other services, it ensures sign language interpreters and also transcribers for those students who prefer Czech. That is why many students with hearing disabilities choose this school.

When doing a research at other universities, we have found out that there is no such a student studying there and that is why the university does not provide appropriate services. Most students with hearing disabilities say that except for Masaryk University there is no other university which would provide the appropriate communication system for hearing impaired people. Moreover, many universities start to deal with the situation only after the student stars to study there and this situation is very stressful for such a student.

The Czech Union of the Deaf receives most of the demands concerning the simultaneous transcription from those students who have not even known about the possibility of consulting such a university centre. That is why we started to discuss and negotiate with individual help centres at universities and we agreed on "experimental transcriptions". The objective was that this service would be provided by the centres themselves in the future.

In Prague, the Czech Union of the Deaf supplied the service of simultaneous transcription eleven times at Charles University (Pedagogical Faculty, Faculty of Sciences, Faculty of Arts) and nine times at Czech Technical University (Faculty of Mechanical Engineering).

5 Some of the findings

The advantage of transcribing on a laptop is that the text remains on the screen for some time and the student can thus focus on other activity. For example, he can follow the PowerPoint presentation of the lecturer or he can make his own notes. The objective is that the student gets the most information possible and that he or she is in equal position to other students as far as the information accessibility is concerned. The question is whether the transcript should be given to the student or not. We once experienced that a speed writer (nine-fold world champion in speed writing) was transcribing a very difficult lecture and the student whom the transcription was being made for was sitting next to the transcriber, surfing on the Internet and did not pay any attention at all to the lecture. She thought that it is just a common transcription being made for her. In these cases, the transcription does not motivate the students enough and they think they do not have to make any effort. However, the students themselves should make notes from the transcription like other students. From now on, we are considering not passing the transcription to the students. They should study from their own notes and other materials as other students without hearing disabilities do.

Masaryk University helps the students to find the transcribers. The rules of transcription for students with hearing disabilities are different at this university. It is very positive that Masaryk University supplies this service not as a service to students with hearing disabilities but as a public service to students and scholars (available for both hearing and hearing impaired students and teachers) and it does not apply only to education. We think it is a very progressive and exemplary model for other universities.

6 The transcriber must be a professional

Some students with hearing disabilities who do not study at Masaryk University think that another student with no hearing disabilities should transcribe seminars, conferences, questions or exam terms for them during all the studies. Even though the help of hearing students is very important for students with hearing disabilities, it is not acceptable that their schoolmates should fulfil the function of a transcriber. Not only that these students do no write quickly enough, but they also have to concentrate on the lecture. The transcription should thus be exclusively a task for a trained transcriber.

It should be a professional who knows well the field concerned or he or she should at least have the opportunity to prepare for the lesson before, using the studying material he or she gets before the lesson. It should mention the dates, names and terms concerning the given subject.

7 Types of simultaneous transcription at universities

It may be possible to use several types of simultaneous transcription. So far, the only type that has been provided is simultaneous transcription with the transcriber on the spot.

7.1 Simultaneous transcription with the transcriber on the spot.

The student usually contacted the coordinator of the project and gave him all the necessary information about the subject in question and the time the transcription would be

needed. The coordinator informed the transcriber about the time of the lecture and he also contacted the students' help centre on this matter. When the transcription took place for the first time, there was also a coordinator who showed the technical equipment to the student and the lecturer and explained how to work with it. From then on, the students themselves participated in the preparation – either they had their own notebook or the Centre of simultaneous transcription mediation lent it to them.

The transcriber and the student always sat next to each other so that the transcriber had enough space for the speed writing while sitting comfortably and so that the student could see well the final transcribed text on the screen. The transcribers always brought their own keyboard they are used to speed writing on.

[Fig. 1] An illustration of simultaneous transcription at universities

7.2 Simultaneous transcription with a remote transcriber

In 2009, after consulting the Research Development Centre (further on referred to as RDC) of the Czech Technical University we started a new project providing a remote simultaneous transcription. In fact, most universities are equipped with a very good Internet connection and this project has thus many advantages: saving transport costs of the transcriber, saving the time he or she would spend on their way and, above all, more comfortable working environment for the transcriber, because sometimes there is not an appropriate chair and table in the conference hall. Therefore, the project eScribe was designed. Its objective is to find a solution which would be available to every user for free. It helps to transfer the lecturer's voice and the final text via the Internet in real time. Two ways of doing that were developed: project eScribe I and project eScribe II.

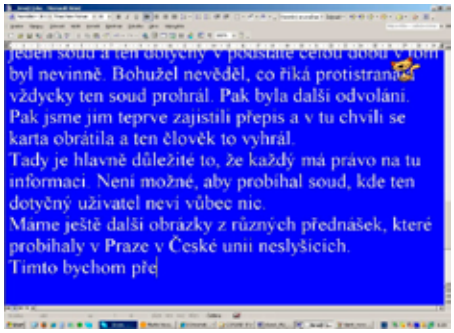
7.2.1 eSribe I (version 1.0)

eScribe I is based on the voice transfer using the Internet protocol VOIP and a software that can be downloaded for free at http://xlite.counterpath.com. The STMC has its own telephone exchange for this application that mediates the voice transfer. Both the user and the transcriber can get the necessary information for setting this application at the STMC. It is also possible to transfer voice from mobile phones directly to the telephone exchange through GSM gate. The student can use his own mobile phone. He connects it to a hands free set with a microphone, gives it to the teacher and asks him to put the mobile phone in his pocket and to clip the microphone near his or her lips. The transcriber then calls through the telephone exchange on the student's mobile phone and receives

the call which is paid off by the STMC. To transfer the real text a functioning application of the Microsoft Office Suite and a connection to the Internet is needed. The transcriber also needs to have a suitable web browser. Student then goes to the following address http://147.32.200.82/prepisy/ and there he or she opens the document created by the transcriber. In this document, the student just clicks on "Start Loading" and he or she can immediately see the transcribed text.

We have tested this type of simultaneous transcription several times at Czech Technical University and we found out that the installation of many programmes, setting the web, etc. increase the risk of technical difficulties. Another problem was that several transfers from particular port numbers of university webs were blocked. That is why the RDC decided that all the settings will be done in ready-made applications which would make the whole communication easier. This solution is called eScribe II.

[Fig. 2] User interface for simultaneous transcription

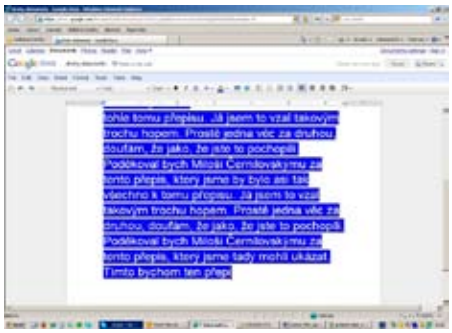


[Fig. 3] Transcriber-interface for transcribing into Word

7.2.2 eSribe II (version 2.0)

eScribe II follows up onto the previous projects of Czech Technical University. Its objective is to transfer some installations into ready-made applications. The difference from eScribe I is in transferring the voice through ready-made applications made by the Google corporation. The only condition to do this is to create a Google account. Moreover,

[Fig. 4] User interface for simultaneous transcription



[Fig. 5] Transcriber-interface for transcribing into Google document

instead of using Microsoft Office Suite, eScribe II uses the Google version of Word. The risk of not connecting the user and the client through the Internet is thus reduced. This

application is free for all users. However, now it is not a final version yet and t is available only for testing purposes. The final version is planned to be launched by the end of March 2011.

7.3 Simultaneous transcription with a trained speaker and with automatic remote transcription

In February 2010, we started to develop a specialised centre. Its objective is to test out the possibilities of using the automatic speech recognition for people with hearing disabilities. This project was based on the cooperation of the Czech Union of the Deaf with the Research and Development Centre of the Czech Technical University and with Newton Technology.

In the first phase, we tried to develop a corrector centre based on the voice transfer over long distances via Internet to a high-performance server using a comprehensive dictionary. Then, a person called "corrector" would manually correct the text and control the quality of the transferred spoken speech into the written form. The first tests started in July-October 2010 and they showed that this project is not feasible from the technical point of view. Moreover, the system reacted differently to individual voices and that is why we started to develop a centre with a trained speaker.

Currently, we have prepared a connection of the server and the automatic recogniser. The voice is transferred to the recogniser thanks to Google Chat application and the result is projected in the Google Document application. The recogniser will get used to the individuals we are training right now and then it will be able to recognise the spoken speech well and to transcribe it automatically. The technological problems of the first tests should be solved by the end of July 2011. It is a very complicated issue and to be able to understand it, we need to look at the possibilities of the automatic recognition and transcription of spoken speech.

7.4 Automatic transcription of spoken speech

Czech language is an inflecting language. Nouns, adjectives, pronouns and numerals are declined, verbs are conjugated. Declination and conjugation create new word forms and their existence has to be taken into account when the language is being recognised automatically. If the dictionary comprises these word forms, there is a chance of recognition. If it be the contrary, the speech cannot be recognised correctly and the programme makes mistakes in the transcription.

The difference between the English and Czech vocabulary can be demonstrated in the following example:

English	**Czech**
interpreter, interpreters, interpreter's	tlumočník, tlumočníka, tlumočníkem, tlumočníku, tlumočnících…
	tlumočnice, tlumočnicemi, tlumočnicí, tlumočnicích…
	tlumočnický, tlumočnická, tlumočnického, tlumočnickému…
	tlumočníkův, tlumočníkova, tlumočníkovu, …

In this example you can see how many forms exist for the English word interpreter and for the Czech word *tlumočník*. Czech morphology is so rich that it has several millions of word forms whereas English has only a few thousands.

This is why the system recognising the Czech spoken speech works with much more comprehensive dictionaries than the system recognising English spoken speech.

As far as syntax is concerned, English word order is fixed, usually Subject-Verb-Object-Adverbial. In Czech, we can change the word order and the meaning is the same (*Martin tlumočil Báře, Tlumočil Báře Martin, Báře tlumočil Martin*). This is another reason why recognising English spoken speech is easier than recognising Czech spoken speech.

Recognising spoken speech brings another important feature. In spoken form, there are no borders between individual words. In fluent speech, one word comes after another and pauses appear only when the speaker breaths in or thinks about the answer.

8 Conclusion

Help centres for students with specific needs are very soon going to include services of simultaneous transcription into their offer to help students with hearing disabilities who prefer Czech. The number of students with hearing disabilities will thus rise at many universities. The proof of this tendency is the high number of students with hearing disabilities at Masaryk University. Thanks to the Teireisias Centre, Masaryk University provides the simultaneous transcription service as well as other services for students with special needs.

All the applications developed in cooperation with the partners of the Czech Union of the Deaf will be, if possible, available for free. Simultaneous transcription of spoken speech considerably contributes to remove the information barrier for those students with hearing disabilities who prefer Czech.

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Educational Technology and other Learning Resources in English Language Instruction for Students with Hearing Impairment

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Abstract

Learning foreign languages is becoming more and more appealing these days due to a highly diversified base of educational aids available on the market: textbooks accompanied by various components that work together for more effective learning, teaching videos, CD-ROMs, audio CDs, graded readers, websites and other multimedia resources which are developed in a very interesting way in terms of factual information and design. However, better situation in the area of language education does not involve everyone. As most educational materials are inaccessible to them, students with disabilities, including those with hearing impairment, encounter numerous obstacles to acquiring foreign languages. Adaptation of teaching materials for use in foreign language instruction for deaf and hard of hearing students has rarely been the subject of any broad research. The lack of generally applicable guidelines on preparation of language materials for students with hearing impairment has made their teachers design and prepare teaching aids on their own.

The aim of the paper is to present basic adaptation tips for developing educational materials appropriate for teaching English to students with hearing impairment. The author suggests several ways to adapt language materials available in the form of audio and audiovisual recordings to special needs of deaf students. The solutions presented in the paper can become inspiration for a creative search for one's own adaptive methods.

1 Introduction

Education of people with hearing disability has undergone a lot of changes in Poland since 2001, when the Ministry of Education issued a decree stating that all deaf and hard of hearing pupils should be taught foreign languages. Previous to 2001 students with hearing impairment were exempted from foreign language classes and taught, if at all, on voluntary basis. Although, undoubtedly, a notable improvement has been made in foreign language instruction for students with hearing disability, there still exists the need to create equal educational opportunities.

Learning foreign languages is becoming more and more appealing these days due to a highly diversified base of educational aids available on the market: textbooks accompanied by various components that work together for more effective learning, teaching videos, CD-ROMs, audio CDs, graded readers, websites[1] and other multimedia resources which are developed in a very interesting way in terms of factual information and design. However, a better situation in the area of language education does not apply to everyone.

1 Deaf students who use Polish sign language as their first or preferred language cannot benefit from web-based English teaching programmes such as "SignOn!" or "SignOnOne" as the "Main texts" incorporated in the courses are not translated into Polish sign language (cf. www.signon.eu).

As most educational materials are inaccessible to them, students with disabilities, including those with hearing impairment, encounter numerous obstacles to acquiring foreign languages.

Adaptation of teaching materials for use in foreign language instruction for deaf and hard of hearing students has rarely been the subject of any broad research. The lack of generally applicable guidelines on preparation of language materials for students with hearing impairment has made their teachers design and prepare teaching aids on their own. The aim of the paper is to present basic adaptation tips for developing educational materials appropriate for teaching English to students with hearing impairment. The author suggests several ways of using the potential hidden in technological developments to adapt language materials available in the form of audio and audiovisual recordings to special needs of deaf students. The solutions presented in the paper can become inspiration for a creative search for one's own adaptive methods.

2 Teaching English to the deaf at John Paul II Catholic University of Lublin

English for the deaf and hard of hearing classes have been conducted at John Paul II Catholic University of Lublin since 1998. They were set up on the initiative of Ewa Domagała-Zyśk, Ph.D (cf. Domagała-Zyśk 2006, 2009a, 2009b, 2010). In 2009/2010 eleven hard of hearing students took the class.

The classes are taught in small groups or on one-to-one basis by a teacher/translator whose primary tasks include making the content of each lesson more accessible. Thus various methods of communication are used during classes, from speaking clearly and lip-reading, gesticulating wildly and giving students step-by-step instructions in Polish sign language, to using Cued Speech. The regular feedback provided by our students towards the end of each semester shows that they find these methods of communication both helpful and satisfactory.

In order to receive a credit for a course in English deaf and hard of hearing students need to pass tests in reading (types of tasks include: true/false, multiple choice, matching paragraphs to headings), writing (e-mail of introduction, holiday postcard, letter of application, letter of apology, letter of complaint, advertisement), lexis and grammar. They are not obliged to take tests in listening and speaking. These skills are nevertheless taught and assessed in class on a regular basis.

Teaching English to the deaf and hard of hearing at John Paul II Catholic University of Lublin is accompanied by in-depth research on methodology of foreign language instruction for students with hearing impairment. The research is carried out in co-operation with various institutions concerned with deaf education.

3 Adaptation of audio class listening material

CDs containing listening practice, pronunciation work and recordings of some of the reading texts have now become a basic component of every English course available on the market and an indispensable educational aid. They help foreign language learners with improving their listening skills and are the source of valuable language input. Sadly they are not useful to students with hearing impairment. Teachers who instruct students

with this type of disability and want to help them improve all language skills, including listening and speaking, face the necessity of adapting class listening material to the format suitable for their needs. Skipping an exercise based on a recording as a form of "adaptation" will inevitably lead to serious alterations in the methodological conception of a coursebook. It would also considerably reduce the number of tasks to be completed by the students. Reading tapescripts instead of listening to the recordings does not offer a real solution either as it shifts the focus of language skill development from one skill to another.

One way to prepare a useful adaptation of class audio listening material is by recording videos for each tapescript featuring cueing native speakers of English. Cued Speech, developed by R. Orin Cornett, Ph.D. in 1966, and adapted to more than 63 languages and major dialects (LaSasso 2010), is a mode of communication for visually conveying traditionally spoken languages at the phonemic level i.e., the same fundamental level that traditionally spoken languages convey via speech to hearing individuals. In Cued Speech, the speaker complements lip movements of speech with manual cues. A cue consists of two parameters: handshape and hand location around the lips. The British English form of Cued Speech uses eight handshapes corresponding to groups of consonants and four hand locations to convey vowels and diphthongs. Phonemes that are not distinguishable by lipreading are coded with different handshapes (e.g. /t/, /d/, and /n/) and hand location (e.g. /ʌ/ and /ə/. Conversely, phonemes that do not look alike on the lips (e.g. /b/ and /n/) are coded with the same handshape or at the same location (/iː/, /ɔː/, and /ʌ/) (cf. Krakowiak 1995, p. 68).

Conveying languages, alphabetic or tonal, at their most fundamental level enables cuers to present each phoneme of each cued word with the same specificity and distinction that speakers present each phoneme of each spoken word. In other words, Cued Speech makes it possible to visualize various dialects of English, different accents, whisper, excitement, scream or resignation. Cuers can also convey prosody to reflect stress, intonation and rhythm of the given language.

A video recording of audio class listening material can be prepared with the help of just one teacher or native speaker of English who is a fluent Cued Speech user willing to become an actor/ interpreter. A video recording participant can either read or recite from memory the lines of two interlocutors using left and right hand alternately.

Adapting audio material to the needs of deaf and hard of hearing students does not pose a serious technical problem. The basic equipment needed is: a digital video camcorder, a DV cable, a Mini DV cassette and computer equipped with IEEE1394 (DV) terminal or IEEE 1394 capture board. The editing software supplied with the computer/ capture board can be used to transfer video recording from tape to computer. A driver is preinstalled on Windows operating system later than Windows 98 Second Edition and Mac operating systems later than Mac OS 9, and will be installed automatically.

Adaptations of audio material take time to prepare, but they do have the advantage of being reusable. They can be transferred to students' computers by means of a USB flash drive. In this way, it is possible for deaf learners to watch the recordings repeatedly at home for specific information they missed during classes. Students should also be provided with video clip worksheets to be done as homework.

The benefits that accrue from a good adaptation can be maximized if cuers taking part in the recording control their gesticulation and facial expression. Under no circumstances should they make extra gestures that are not cues (particular handshapes at specific positions). Any visual component that does not belong to the Cued Speech system distracts deaf viewers and makes speech reception more difficult. Cuer's inappropriate dress may become another reason for poor comprehension of the conveyed linguistic content. Recording participants should avoid wearing too much jewellery and patterned fabrics. Hair ought to be tied up or done in such a way that it does not cover the cuer's face. It is noteworthy that speechreading becomes virtually impossible if a speaker has long facial hair. A wall or board contrasting with the colour of the cuer's dress make a perfect background to the recording (cf. http://www.learntocue.co.uk/player_content.html).

4 Adaptation of audiovisual material

So far the paper has focused on recorded material as audio material only. However, a lot of contemporary English courses include DVDs which provide additional listening practice linked to the topic areas in Students' Books. Film clips attract students' attention through the power they have to tell a story. They contextualize language through the flow of images, making it more accessible. This allows students to see a wide range of paralinguistic behaviour. For example, they can observe what gestures accompany certain phrases or pick up various cross-cultural clues.

Similarly to audio material, filmed extracts in a non-adapted form are of no use to deaf and hard of hearing students as they are not subtitled. To provide a really useful service, subtitles for the hearing impaired need to include descriptions of sound effects as well as the words that are spoken. Only very few courses available on the market (e.g. *New English File*) use subtitles produced to the benefit of hearing students. These do not include a description in text of sound effects and sounds off screen.

Teachers who want to use the DVD material linked to a particular lesson can prepare its adaptation on their own. Subtitles can be created by individuals using freely-available subtitle-creation software such as SubEdit Player developed by a Polish programmer Artur Sikora. The programme is a movie player and a subtitle editor. In addition, it is equipped with subtitle creation tools. In order to use SubEdit Player one must install standard Windows Media Player 6.4 or its more recent version. It is worth remembering that the programme will not co-operate with Windows Vista without a VistaWMPPatch. exe. patch available from the SubEdit Player home page.

In order to begin work with the subtitle creator, one needs to open a video file with SubEdit Player by clicking File, and then Open video file on the File menu. To pause the clip, you click the Pause button in the Monitor Buttons area. The next step is to run the subtitle editor by clicking Subtitle editor on the View menu and to turn the subtitles on by clicking View, and then Subtitles. Once the clip has been restarted, information about a current state of the window is displayed on the Status bar. The Status bar is divided into sections which show: the current frame, the total number of frames in the film clip, the current running time and the total running time respectively. To start creating subtitles, you press the Insert button on the keyboard of your computer. This command inserts the current frame into the editor window. The numbers in braces indicate the initial and final

frame of the video to show the subtitle. The dialogues and descriptions of sound effects and sounds off screen need to be keyed in (cf. Fig. 1).

To function in the intended way, subtitles created in SubEdit Player need to be displayed long enough for viewers to read. A single line should not consist of more than 45-50 characters. Longer texts can be divided into two or three lines at the maximum with the use of Shift and Backslash buttons pressed simultaneously. However, displaying more than two lines of text should be avoided. Descriptions of sound effects and sounds off screen ought to be placed in square brackets e.g.: [knocking on door], [groaning], [car engine starts].

Before one uses adapted audiovisual material in class, they should make sure students understand the often recurring descriptions of sounds. It is of vital importance to convey the most subtle shades of meaning so that the lack of conceptual knowledge does not prevent hard of hearing learners from interpreting non-verbal content of the film. Giving deaf students Polish equivalents of such onomatopoeic words as the aforementioned 'groaning' is not sufficient explanation. It is necessary for hard of hearing students to know the concept corresponding to the word and to be able to use it in their national language.

5 Sound grids

The ultimate aim of most students, and hard of hearing students are no exception, is to be able to communicate in the language they spend so much time trying to acquire. Correct pronunciation is one of the conditions of effective communication. Deaf learners of English from Poland are often frustrated by English pronunciation, particularly the sound-spelling relationships. They try to speak English using Polish sounds. They often do so not because they are incapable of articulating English sounds, but because they are unaware that the two languages differ in this respect.

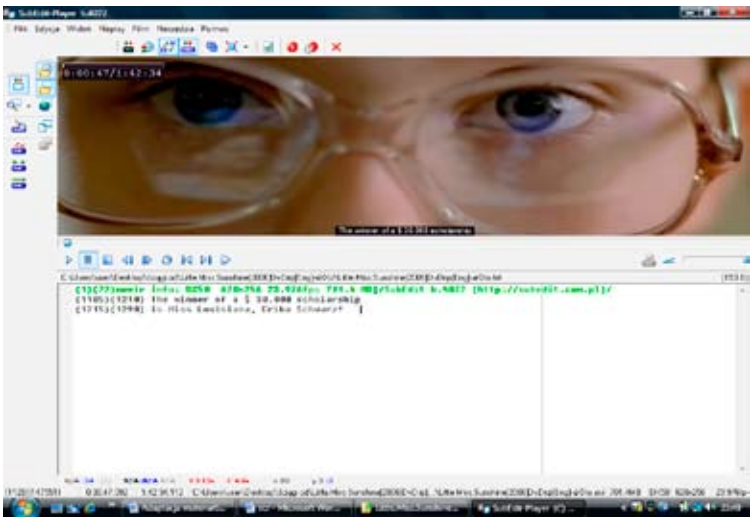
At John Paul II Catholic University of Lublin the 44 vowel and consonant sounds of English are introduced to deaf students systematically through sound grids (cf. Fig. 2), which give clear example words to help students to identify and pronounce the sounds. Each grid consists of a labeled picture which shows the most common spelling of a particular sound as well as information about the number of letters, sounds and syllables in a word. The grid with bike (cf. Fig. 2) is showing the /aɪ/ sound. The letters are fingerspelled whereas the sounds are first put down in phonetic transcription, and then in cue script. Finally students are asked to cue the word.

Sound grids make students comprehend the concept of there being one phoneme, e.g. /ɜː/ but often more than one letter to represent it, e.g. the digraph 'er' in 'verb' or the trigraph 'ear' in 'learn'. Breaking words down into consonant and vowel blocks and putting them back together helps deaf learners realise that a single graph can make different sounds in different words, e.g. 's' in 'smoke' is making a /s/ sound but in 'music' it is making a /z/ sound.

6 Conclusions

Since adaptation of teaching/ learning material in English language instruction for the deaf and hard of hearing is one of those spheres of special education where practice is

well ahead of the theory, it should draw on both the experience of practicing teachers and their students' opinions. The practical usefulness of the adaptive methods presented in the paper has been checked by its author directly in the classroom and it deserves further research. Foreign language teachers working with the hearing impaired can exert significant influence over publishers in getting them to make use of their practical experience and adapt coursebooks and other teaching aids to the needs of students with hearing disability. One of the principal tasks of educators working with the deaf is also to create a theoretical bank of generally applicable guidelines on preparation of language materials for their students. Such guidelines could be successfully used in other areas of teaching the hearing impaired, e.g. in teaching natural sciences.



[Fig. 1] A frame of a video file opened with SubEdit Player

		Word:  BIKE
How many letters?	4	Fingerspelling 
How many sounds?	3	IPA /baɪk/
		Cue script s_t s
How many syllables?	1	
How many vowels?	1	
How many consonants?	2	

[Fig. 2] A sound grid

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The Role of E-Learning in the Education of the Deaf

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Keywords: e-learning, deaf students, language learning, education of the Deaf

Abstract

The paper deals with the role of e-learning in education of deaf students and the relationship between ICT and deaf students. It is a well-known fact that the term "e-learning" has been widely used in all its aspects for the last five years. It is an educational process which consists in the use of multimedia and information technologies to facilitate access to study materials and support the learning process (in more general terms). The level of computer usage depends on current technological possibilities as well as access to the technology for intended users.

The introduction of the paper describes the relationship between ICT and deaf students in general as well as in the educational process. It introduces e-learning, defines it and classifies its types. It briefly describes technological aspects necessary for a creation and management of an e-learning course. Further, it presents e-learning in Deaf education in general. It incorporates deaf teachers' findings and experiences with blended e-learning teaching of common subjects at the primary school for the Deaf, high school for the Deaf and university, in particular Masaryk University. The paper refers to several e-learning courses of various high school subjects and university language courses (in Czech and English); it also deals with their specifics regarding needs of deaf students. Based on a research conducted among deaf students at Masaryk University and a similar research at the National Technical Institute for the Deaf, Rochester Institute of Technology, the paper discusses advantages and disadvantages of the ICT usage in many areas of Deaf education, primarily in the field of language learning, as well as the importance of e-learning for future education of deaf students.

The results of these investigations clearly show that the use of e-learning unquestionably improves the quality of Deaf education. This fact is seen as salient enough to remain in the centre of our focus.

1 ICT and the Deaf

The paper deals with the role of e-learning in the education of deaf students and the relationship between ICT and deaf students. It presents the importance of e-learning for the education of deaf students. Some of its parts follow up a paper presented at the CVHI 2009 conference in Wroclaw.

Information and Communication Technologies (ICT) are under a dynamic development and they also influence the Deaf. The scope of the use of ICT by deaf users is wide. In their everyday use of ICT, the Deaf primarily communicate via video-chat, send text messages (such as e-mail), and search for information. The common opinion is that the Deaf are not disadvantaged when using the PC and browsing the Web. The reality is different, however. There are problems based on the language barrier and the limited ability to communicate in Czech, both passively and actively.

2 ICT and the Deaf in the educational process

The Deaf perceive (access) information primarily by visual perception. ICT in education offers a high level of visualization of information (in the forms of a static image, animations and video), as well as a possibility to edit materials, visualize language and work with text. ICT comprise a number of teaching aids in current use. The Internet can be seen as a source of information as well as a channel of communication.

3 What is e-learning

The definition of e-learning is not unequivocal due to its historical development and to the diversity of opinions.

The European Commission defines e-learning as an application which uses "new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration".

3.1 Types of e-learning

It is possible to distinguish between two basic types of e-learning, on-line and off-line. Off-line e-learning does not require Internet connectivity. Students have access to their study materials on a PC, as the materials are stored on a CD-ROM, DVD-ROM or other media.

On-line e-learning requires Internet connectivity. We distinguish between synchronous and asynchronous on-line e-learning. In the case of the synchronous e-learning, a direct communication between the tutor and the student via the Internet is common. In the asynchronous form of e-learning, a tutor and students send various materials and messages to each other via discussion boards, virtual mailboxes or e-mail.

Blended learning is a combination of the synchronous and asynchronous approaches. For example, students and a teacher meet in a classroom, but they work with an e-learning application or in an e-learning course, and they communicate in the form of a chat, or a discussion forum.

3.2 Technical aspects of creating an on-line e-learning course

For running an e-learning course, it is necessary to have a server, Internet connection with a sufficient capacity and a Learning Management System, an application for administration and organization of e-learning which integrates various tools for management of studies, communication, and work with materials, databases, and archives. Among the best known LMS, there are Moodle, Dokeos, ATutor and eFront.

3.3 E-learning and the education of the Deaf

Deaf students experience problems with perception and production of both spoken and written majority language. E-materials in the form of texts in sign language help to create a higher level of independence when working with such materials as well as a better understanding in general.

Visual perception is the primary source of information for deaf students and the e-learning concept of education offers, by its nature, suitable conditions for the use of visu-

ally oriented materials. ICT, the Internet, e-learning systems, and the whole technological development in general offer new possibilities of creating optimal materials for the Deaf, such as textbooks adjusted to the needs of deaf users.

3.4 E-learning at primary schools

E-learning has been used at primary schools as part of the project Eliška, www.eliska.cz. E-learning has only gained wider use as far as homework is concerned. Digital materials offer more understandable and more effective distribution of information to school children, but e-learning is not considered as the main material for education at primary schools. Among its problems are practical issues regarding the control of an e-learning course (this problem concerns both teachers and pupils), more effort required from the teacher who prepares the materials, and the lack of a portal or technical background.

3.5 E-learning at high schools

Several e-learning courses have been created as part of the project "Integration module of secondary education for students with sensory impairment." For example:

- Information technologies – animations,
- Czech – video-presentation,

Thanks to flash animations and practical examples, students' understanding of the functioning of computer components improved and their independence in computer usage was enhanced.

3.6 E-learning and language teaching

For the Deaf, it is often impossible to fully communicate in the majority society, and electronic communication seems to be the best solution. At universities, the ability of deaf students to independently produce scholarly texts in the majority (official) language (or in a world language) is required; without a focused Czech (or English) language teaching, it is impossible to achieve results comparable to those of hearing students.

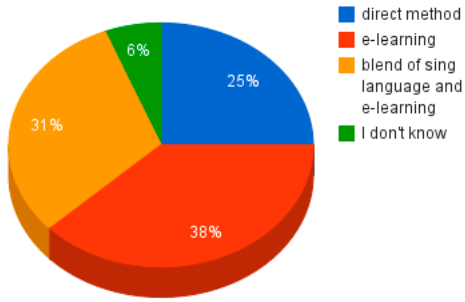
4 E-learning courses at Masaryk University

E-learning courses at Masaryk University are used for blended e-learning, a combination of direct tuition in sign language and e-learning. They are included in both full time and distance studies. They are based on the platform Moodle, which is an LMS developed by MU, and other platforms such as SignOn. Currently there are more than 70 e-learning courses.

4.1 Deaf students' experience with e-learning at MU

A research of deaf students' experience with e-learning has been carried out, focusing on:

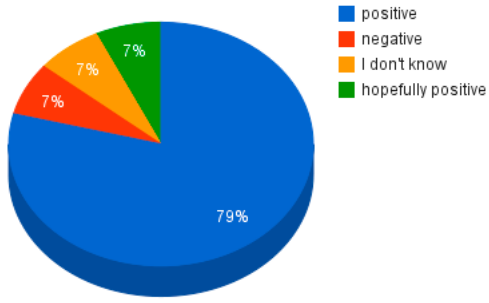
- preferred teaching methods
- reasons for the choice of teaching methods
- influence on deaf students' linguistic skills
- advantages and disadvantages of LMS Moodle at MU



[Chart 1] Preferred teaching methods

4.1.1 Preferred teaching methods

The research has shown that e-learning is preferred in language teaching for the following reasons: chatting offers many opportunities to learn and consolidate sentence patterns, to improve in stylistics, as well as communicate in a written language (Czech, English and others). E-learning provides a simple access to homework and its completion. It offers opportunities for the development of vocabulary, and receptive and productive linguistic skills. The reason for the preference of combining Czech sign language and e-learning, i.e. for blended e-learning, was the possibility of explications of new topics in Czech sign language followed by exercises in the electronic form.



[Chart 2] E-learning and its impact on linguistic skills

4.1.2 Examples of courses

- Czech for the Deaf III (a Moodle course)
- Computer networks (a Moodle course)
- English for the Deaf (a SignOn course)

4.1.3 Research results

The research has shown that e-learning offers wider possibilities of work with information, study materials and references, and that it provides new opportunities for the use of

electronic communication for the purpose of consolidating sentence patterns and developing semantic, grammatical and stylistic components of language. This type of tuition requires the necessary technical equipment (and its continuous improvement – such as in the case of filming videos).

5 Advantages of e-learning

From the technical point of view, the advantages of e-learning are, for example, the following:

- free access to study materials, including previous lessons,
- the Forum can be used to contact and share information with teachers and other students,
- the use of chat,
- the possibility to repeat exercises,
- automatic saving of exercises and subsequent assessment with points,
- automatic correction of cloze and multiple-choice exercises.

From the linguistic point of view, the advantages of e-learning are, for example, the following:

- vocabulary development,
- adoption of grammatical phenomena,
- consolidation of sentence patterns.

6 Disadvantages of e-learning

The disadvantages described further are relative. They depend on technical possibilities and other aspects of particular courses.

- crashes of LMS,
- Internet connection failures,
- permanent contact with a monitor screen (medical and psychological aspects),
- students engaging in other activities (chatting with friends, surfing the Web) and their subsequent lack of concentration
- the teachers' lack of control over whether or not students do their homework independently,
- quick chatting,
- confusing outcomes of chaotic discussions,
- texts and exercises in the Moodle format are difficult to print.

7 Research of the National Technical Institute for the Deaf

At an international symposium called Technology and Deaf Education, a team of co-authors from the National Technical Institute for the Deaf, Rochester Institute of Tech-

nology, published results of their research based on their experience of on-line courses (e-learning) at RIT. The research compared standard tuition (face to face) with e-learning based tuition of deaf and hard of hearing students who attend courses with their hearing peers (integration).

The results showed that tuition based on e-learning is more effective than face to face tuition. Students in this type of tuition produced better academic results, and their answers revealed that they preferred this type of tuition.

The students said that they gained more information and knowledge from these courses and that they also learned more from one another. They also appreciated that communication with their peers and teacher was more frequent during on-line e-learning courses than in standard tuition. Last but not least, they said that on-line courses contributed to their ability to communicate in English and their ability to express their ideas in this language.

8 E-learning portals for the Deaf

- http://www.acm5.com/signonone/index.html
- www.vibelle.de
- www.erher.no

9 Adapting LMS for the Deaf

It is necessary to create a platform which enables to present information bilingually, i.e. as text and in sign language. It should include tools for uploading and editing videos, a tool for a video-forum and video-conferences, as well as an integrated dictionary of sign language related to the concerned topic.

10 Future of e-learning and blended learning

Blended learning as the basis of education of the Deaf at all levels of education is ideal as a multimedia textbook and exercise book based exclusively on sign language. A tablet instead of a notebook and an interactive board instead of a blackboard may all be interconnected via a wireless network in the LMS.

Integration of deaf students into common study groups may be an issue, too. E-learning helps to overcome language barriers but the ability of the Deaf to use Czech is dubious as it is in fact a foreign language.

The results of these researches show clearly that the use of e-learning undoubtedly helps to improve the education of the Deaf. This fact is so important that we should not leave it aside.

TV Subtitles as a Tool for Enhancing Language Skills for Deaf Persons

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Abstract

The paper presents the results of a survey held in the Slovak Republic in 2006. The research investigated relationship of adult deaf users of sign language to TV subtitles. The investigation also dealt with subjective opinion of deaf Slovak respondents and whether watching Czech subtitles on television helps them learn Czech language.

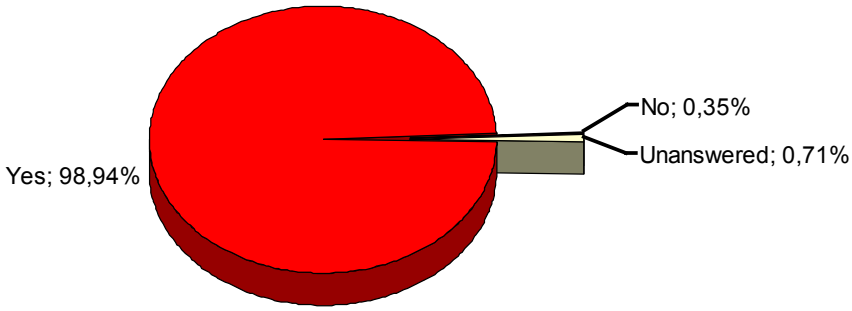
1 The relationship of deaf sign language users to captions

Some people believe television subtitling is not very useful to deaf people oriented to using sign language. We received very different information from deaf sign language users.

We evaluated a total of 1104 responses. Of the total number of adult respondents with various level of hearing impairment, we chose 851 deaf sign language users and analyzed their responses, to determine whether they need subtitles when watching TV.

[Tabel 1] Deaf Slovak sign language users who need subtitles when watching TV

Do you need subtitles when watching TV?	
Yes	98.94 %
No	0.35 %
Unanswered	0.71 %



[Chart 1] Deaf Slovak sign language users who need subtitles when watching TV

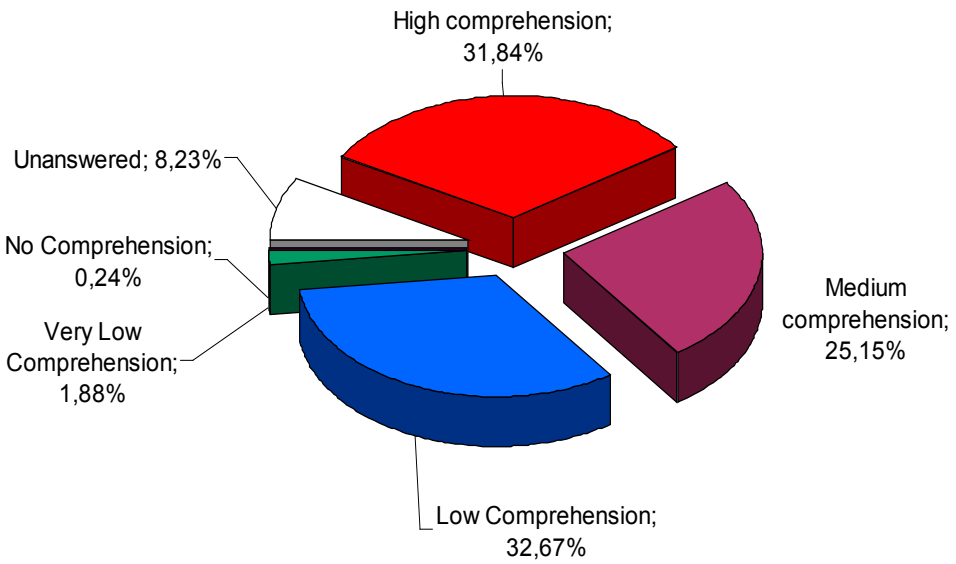
The results showed that almost 100 % of deaf users of sign language need subtitles when they watch TV programmes. In written comments of deaf sign language users it is clear that they usually do not follow a movie without subtitling because they do not know what is said in the movie.

2 Deaf users of Slovak sign language and Czech subtitles

This survey had a unique background. There was almost no subtitling in Slovak TV stations until 2006. So if Slovak respondents wanted to watch subtitled programmes before 2006, it had to be on Czech television stations. We took advantage of this situation and asked deaf Slovak sign language users whether they comprehend the meaning of text in Czech subtitles.

[Tabel 2] Comprehension Czech subtitles by Slovak Sign Language users

Do you comprehend Czech subtitles?		
YES	High comprehension	31.84 %
	Medium comprehension	25.15 %
	Low Comprehension	32.67 %
NO	Very Low Comprehension	1.88 %
	No Comprehension	0.24 %
	Unanswered	8.23 %



[Chart 2] Comprehension Czech subtitles by Slovak Sign Language users

Let us notice there is a far greater number who believe, to a certain extent, they comprehend the contents of the text than those who feel they do not comprehend. We were expecting a much lower level of comprehension. From this perspective, the results were a positive surprise for us. However, we are aware that this is a subjective evaluation of those interviewed and the level of comprehension may actually be lower.

Both languages, Czech and Slovak, are related. However, when we evaluate the outcome, we must take into account that many people deaf from birth, who are oriented to

sign language, tend to have problems understanding written text of their national language.

In this case there is not only a different language involved, but also the text regularly broadcasted on TV disappears from the screen quickly and cannot be replayed. Compared to reading the press, the conditions for watching text in TV subtitles are much more difficult.

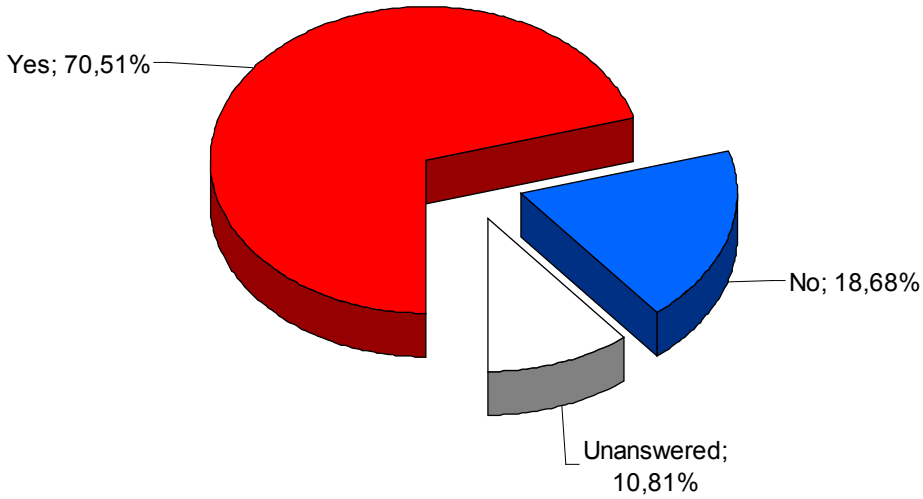
On the other hand, the connection of the text with video obviously plays a big role. It is widely known the majority of congenitally deaf people who prefer sign language are usually not avid readers of books. They are discouraged from reading by language they do not know very well, but most enjoy watching movies. When using subtitles, they are exposed to written language, which they can learn spontaneously and by a pleasant way.

3 Does watching of subtitles help people to learn language skills?

Reading Czech subtitles is very difficult for many deaf Czech people who prefer sign and for deaf Slovaks in particular. We asked Slovak users of sign language, in their subjective opinion, whether Czech subtitles help them become more familiar with Czech language.

[Tabel 3] Improvement familiarity with Czech language of deaf Slovak sign language users by using Czech subtitles

Do you think that watching Czech subtitles improved your familiarity with Czech language?	
Yes	70.51 %
No	18.68 %
Unanswered	10.81 %



[Chart 3] Improvement familiarity with Czech language of deaf Slovak sign language users by using Czech subtitles

The results clearly show more than half of the respondents watching subtitles feel their own competence in the language increased, at least in the passive layer. In the comments some of them also mentioned active acquisition of Czech language. Others complained that they learned more Czech language than Slovak language and they needed to learn Slovak, not Czech.

We believe increasing the amount of subtitles in Slovak broadcasting since the end of 2006 is helping deaf people acquire Slovak language.

4 Conclusion

From comments of respondents, it is clear that even though subtitles often result in comprehension problems, subtitles are very important for deaf users of sign language because subtitles help them guess what the show is about.

Moreover, subtitles provide deaf people a written – thus visible – form of the language connected to video. This enables them to expand their vocabulary and learn expressions and grammatical patterns of spoken language, including common phraseology.
In this context captions are a valuable tool, not only to access TV programs, but also as an informal way to increase reading skills and learn spoken language in written form.[1]

References

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1 Proofreading of English version by Melodie Licht.

A Wireless System for Real-Time Distribution of Visually Accessible Synchronous Transcription (Speech-to-Text Reporting) Targeted to Larger Group of Users with Hearing Impairment in Environment of (Not Only) Tertiary Education

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Keywords: speech-to-text reporting, hearing impairment, distribution of transcription

Abstract

Masaryk University provides supporting services for approx. 100 students with severe hearing disabilities. One of the means of the provided services is a visually accessible synchronous transcription (speech-to-text reporting) of spoken language. Increasing number of students utilizing this service has created situations when a larger group of students has to follow the same educational event, hence to follow the same source of transcription.

A transitory solution applied at Masaryk University in the past was based on a multiplication of a display of a speech-reporter's computer, which did not meet requirements and expectations of either students or speech-reporters.

To enhance the method of providing this service, Masaryk University has developed its own system for real-time and wireless distribution of synchronous transcription named Polygraf that is presented with this paper. In the system, the speech transcript typed by a speech-reporter on his/her computer is continuously transmitted to and displayed on any number of handheld displays which are used by those who has to follow the transcript. Transmission of the data between a computer of the speech-reporter and handheld displays takes place within a closed wireless network provided by any portable access point independently on local technical conditions. Additionally, the system allows the transcript view customization on side of the handheld device user, and features supplementary text messaging between users and a speech-reporter.

1 Introduction

The Support Centre for Students with Special Needs at Masaryk University, the Czech Republic, provides hearing impaired students (typically, hard of hearing students that comprehend written Czech) with a speech-to-text reporting service, when a reporter records a speech (a lecture or a seminar in a university environment or even any similar event outside of a university environment) as a text on a computer by the means of a simultaneous typing, and a student is reading the report on a screen at the same time.

As the number of students that are dependent on this type of service and who attend classes together has been increasing, the Centre tried to find a satisfactory solution to situations when groups of three or more students needed to follow a text at once and provide them with a comfortable access to the report. In the past, the issue was provisionally solved in two ways:

1. A secondary screen was connected to a reporter's laptop so that some users could follow the report directly on the laptop screen and some on the external one. This solution was dependent on providing the connection between the laptop and the external screen and a separate power line to it. This was not ideal for reasons of organization, time and, after all, even aesthetically.
2. A wireless network for the distribution of a video output from a reporter's laptop to small laptops available to users (using a *VNC* application) was set up. The distributed image was an exact copy of a reporter's laptop screen which was not always appropriate or desirable and also this system did not allowed any customization of displayed text neither returning back to previously written parts of the text on the side of the shared report user.

Even though both of these solutions were satisfactory in terms of distribution of the text in real-time, they turned out to be unbearable when there were more than three students to follow the transcript. Furthermore, the initial procedure – the interconnection and set-up of all components – was not simple and its success was quite dependent on users' technical skills or on presence of our technicians in the place.

2 Requirements for speech-to-text system

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

- Simple and quick technical preparation. The goal is to eliminate the need of presence of a technician in the place of the text reporting. Even the eventual troubleshooting should be made easy by providing an extensive help document. Better said: make the set-up as simple so that the reporter could be the technician.
- Independence on a local technical infrastructure. Mainly a computer network is meant here. As the reporting system will be used in many different places with different and uncertain network configuration, it should be independent upon its conditions.
- Speech-to-text report must be synchronized with a reporter's typing. This is a crucial need. In order to give the visually and hearing impaired the same opportunity to follow the speech as the normal hearing people have, the delay between the speaker and the reported text has to be minimized.
- The look of the reported text should be customizable. As each person has different needs, the visual style of the text presented on the user devices should be individually customizable at least in terms of text colour, background colour, font family, size, and style.
- A possibility of a two-way communication. There needs to be a way to allow visually and hearing impaired people to communicate in the opposite direction, too, mainly when they are asked or have any remark to the topic. To type a message which the text reporter will read out loud to the audience seems the most natural way in this kind of reporting.
- Support for Czech and English languages. We need to support text reporting in Czech and English languages at least, as both of these languages are usually spoken in lectures, often mixed together.

3 Available solutions in speech-to-text transcription

We divided the different approaches to speech-to-text reporting which are used these days into two main groups. The first is the use of automated speech recognition systems, the second one is human.

The automated speech recognition systems are still in heavy development and unfortunately according to our experience they're not sufficiently accurate yet. The requirement for these systems to work well is high quality sound input in terms of voice clarity and no background noise. Its accuracy can also be well improved by training of the algorithm for the vocabulary and the voice of the speaker. But both of the requirements are difficult to fulfil in the target use cases of university courses, occasional meetings, conferences etc.

Examples of the automated speech-to-text reporting systems may be *Dragon Naturally Speaking* for English and *Newton Dictate* and *SpeechTech MegaWord* for Czech language. Because of the difficulties mentioned above, these technologies are hard to be applied for our needs of text reporting but Masaryk University is in contact with authors of these systems to be available for further cooperation.

The centralized speech-to-text recognition systems utilizing human text reporters but situated on places dislocated from the event are always dependent on the interconnection between these places. As the connection between the speaker and the text reporter is typically established through the Internet, there is a need of a reliable and stable Internet connection in the place of the event. And this cannot be granted in each case.

Even though the reporters are working separately in controlled and pre-set conditions, their only connection to the presentation room is the audio channel. Therefore they lack the direct contact with the speaker, the presentation slides and the audience – the users of the reported text.

And still the setup of this type of speech-to-text reporting is non-trivial, as at least two technically trained people – one at each of the locations – are needed for the reporting to work reliably.

Examples of this type of speech-to-text reporting are *Bee Communication* services for English and *eScribe* for Czech. Google Docs could also be put in here, as in cooperation with any Voice over IP service, they can work similarly.

4 Our approach

For the reasons mentioned in the previous paragraphs, **Polygraf** system has been developed at Masaryk University. It meets all the requirements listed above and presents a technical solution to all these issues. It is based on a technology which can be used independently of commonly considered technical parameters of an environment such as a wireless network signal coverage. The only requirement is access to electricity. All this makes it quite a universal text reporting system.

The key benefits are:

- 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 relies on auto-configuration technologies to make the set-up experience seamless.

- It is compatible with Microsoft Word environment commonly used among many speech-to-text reporters.
- It uses the iPad as a text display to ensure the basic user comfort: a touch-screen user interface including supplementary information in the sign language, long battery life, portability and quick start-up and uninterrupted operation.
- The reports are available in the environment of native iOS application and are also accessible via standard Internet browsers.
- It enables two-way communication: reporter to user and also user to reporter by simply typing the 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.

4.1 Hardware

There are three key hardware components and two software components which Polygraf consists of:

1. A 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. This is the computer for the reporter.
2. Any device with the iOS operating system. Typically, an iPad, iPhone or iPod Touch. There can be many of these user's devices used as a handheld displays to follow a report.
3. A Wi-Fi access point to create a wireless network connecting all previously mentioned devices together and transfer of the text between them. There is no need of Internet connectivity for this wireless network.

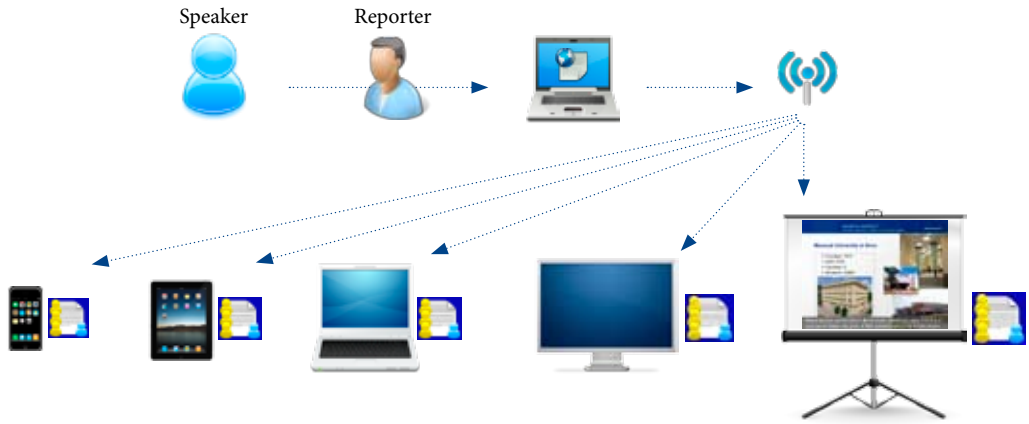
[Fig. 1] Example of three key hardware components together

4.2 Software

There are two mandatory and one optional software components for the system to work:

1. The application component for the reporter's computer – Microsoft Word AddIn. This is installed separately alongside the Word, and its purpose is to "read" the text out of the Word documents and share it to the users' devices.

2. The application component for the handheld displays handles the reception of a text report and its continuous updating and displaying according to a custom setting of the user.
3. The application component 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. The advantage then is that a speech-to-text report and a speaker's visual presentation are shown together on one screen.



[Fig. 2] Polygraf system basic scheme

4.2.1 Communication Protocol

There was an intention from the very beginning to develop a system as user friendly, easy to set up and independent on the local infrastructure and network settings as possible. Therefore we chose to use a zero configuration service discovery using MDNS (better known as Bonjour – Apple's MDNS implementation). Bonjour is available on both Windows and Mac OS / iOS and implementation for Linux, BSD and other POSIX systems is also available, called Avahi. Other similar services (SSDS, LLMNR and SLP) were either more resource demanding and/or proprietary, therefore not widely usable, which would impose too big compromise on the system.

The use of zero configuration service discovery allows the system to work without requirement of Internet connectivity, any initial predefined network set-up, or its own additional server as it is usually needed by other client-server applications – therefore it can be moved to another or foreign environment with very little effort.

The next step, when the list of documents available on the network is known, is to connect to one of them and continuously transfer its content updates. Again, the design goal was to enable wide audience of users to be able to follow the reports and therefore to use standard and open protocol to transfer the text which could be easily adopted by client software. The most suitable solution found for this was HTML through HTTP. Going this way, any device with web browser installed is allowed to connect and follow the reports.

The Word AddIn therefore embeds an HTTP server serving specially formatted HTML documents which are able to continuously update the content when displayed in any standard Javascript-enabled web browser. But it still leaves space for developing a special application for the users' devices, which would display the content in its own way customizable by the user or according to other needs and with more features not available in default web browser.

4.2.2 The application component for the reporter's computer

There is only one software component which is mandatory for system to work. It is the Microsoft Word AddIn, which "reads" the text from currently opened Word document(s) and makes it available for the users' devices to connect to, transfer it and display.

The AddIn starts in the background alongside the Word. There are just two main options reachable through the AddIn's system tray icon:

1. To share all automatically currently opened documents with users' devices, or to choose them one by one.
2. To share the documents just in plain text or include the documents' formatting. The reason behind this options is to speed up the Word environment, as with longer documents or on slower computers we experienced the additional workload imposed on the Word by the AddIn being uncomfortable to the reporters.

4.2.3 The Application Component for Handheld Displays

When looking for suitable device for the text users, we had mainly reliability, lightness and long battery life in our mind. Of course also the Wi-Fi connectivity and reasonably big display were our requirements. Opposed to a standard laptop computer, the keyboard was not a need here, as the users for the most of the time only read the text. That narrowed down the choices to quite small group: Apple iPad or Amazon Kindle. Because for the Kindle there is no possibility to develop custom applications, and its display is slow for continuous scrolling of text, the Apple iPad had became our choice.

Although in iPad's standard web browser it is also possible to view shared documents, there were needs which would be not available while using it – one of which is the web server discovery using Bonjour. These additional feature needs and also the need of the ease of use of the whole system, i.e. addition of the help text and sign language translations, were the reason to develop special application for these users' devices.

The application component for the handheld displays is a universal iOS application capable of running on both Apple iPhone/iPod and iPad. In the application, the user is presented with an introduction screen, a button for opening the help, and the list of the document available to follow. All document views can be customized in the meaning of font size, family, style, line-spacing, colours. The welcome and help texts are additionally accompanied with sign language videos (currently in two languages) which will play inside the application itself.

VGA or TV-out is also supported with this application. This allows to display the report also on the bigger screen when needed.

4.2.4 The Application Component for the Presenter's Computer

It is often suitable to display the transcript just in the form of closed captions at the bottom of the presentations screen. That way it is easier for the user to follow both the slides and the transcript in the same time. For this reason we developed the Polygraph Captions application for Windows.

In basics, this application component works similarly to the one for the handheld displays. It features a shared document browser and a customizable floating window which continuously shows several last lines of the chosen shared document. There are options to configure the number of lines displayed, the size, family and style of font used.

[Fig. 3] Close captioning of the presentation slides

5 Usage and Practical Experience

Polygraf was used in the fall semester at the Faculty of Informatics and the Faculty of Pedagogy at Masaryk University. There was one session to adapt the reporters to the new system they were supposed to get familiar with. Even to our surprise, the system was very well adopted by both reporters and students and even when we counted to still have our technical staff present in the lectures, they soon became unnecessary.

Polygraf will be also used for text-reporting and close captioning of presentations and keynotes at Universal Learning Design Conference in Brno, 2011. The text transcript will be available to the audience through LCD displays situated on both sides next to the speakers podium as well as to any user of the iPad handheld device which will be available to borrow. On ULDC there will be running four text-reports simultaneously – one report for each of two languages in each of two conference rooms.

6 Future development

Even though the Polygraf software components are in constant development, several more features are considered for further implementation.

- Embed a VNC viewer into the iOS application to allow users to follow not only the text transcription but also the presentation screen on their devices.

- Expand to other platforms than iOS (Android, Windows Phone).

The Polygraf iOS application and Polygraf WordAddIn will be soon made available for wider use.

7 Conclusion

Polygraf was primarily developed for speech-to-text reporting for hearing impaired university students (consequently, it is typically used at **lectures** and **seminars**). However, given the fact that requirements for a technical equipment on a location where the reporting takes place are minimal, it can also be used outside of school facilities (such as at **presentations** and **business meetings**) when participation of hearing impaired persons is expected.

Polygraf meets all goals we set in the beginning of the development:

- near real-time speech-to-text reporting for a larger group of users,
- simple and quick set up,
- independent on local network conditions and Internet connectivity,
- customizable look of reports displayed on user's devices,
- it allows reporter to user communication as well as user to reporter.

Thanks to open standards and the protocols used, there is a lot of space for further development as well as cooperation with or contribution to others similar systems in use.

Visualization of Spoken Language by a Visually Accessible Synchronous Transcription, Speech-to-Text Reporting, and Other Systems of Communication for Persons with Hearing Impairment Usable in Tertiary Education

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Keywords: speech-to-text reporting, hearing impairment, systems of communications, vizualization of spoken language

Abstract

The paper summarizes main theoretical foundations, legislative measures, as well as technical and organizational specifics of a visualization of spoken language by a visually accessible synchronous transcription at universities. It further deals with other mechanisms of providing access to spoken language. It analyzes current rules for note-taking at Masaryk University and summarizes main positive and negative experiences based on rich practice.

A visualization of spoken language by a visually accessible synchronous transcription has been a well-established service in the world for many years, known as CART (Communication Access Real-time Translation). In the Czech context, this service became more prominent in 2005 when it was used at Masaryk University and the public sector at the same time.

The visualization of spoken language by a written transcription was codified by the Czech legislation in 2008. Masaryk University included this service in the Rector's Directive on the Standing of Sign Language and Other Communication Systems for the Hard of Hearing at Masaryk University.

Masaryk University offers visualization for access to spoken language when a person with a hearing impairment understands Czech, but a lecturer's speech is incomprehensible because it is too quick, the speaker's articulation is not distinct, the board is frequently used, or the lecture is so scientifically specific that its unambiguous meaning would suffer from a translation into a sign language. All parties of communication may require the service at Masaryk University whenever a communication takes place between persons with hearing impairment and hearing persons, or when audio-materials are offered.

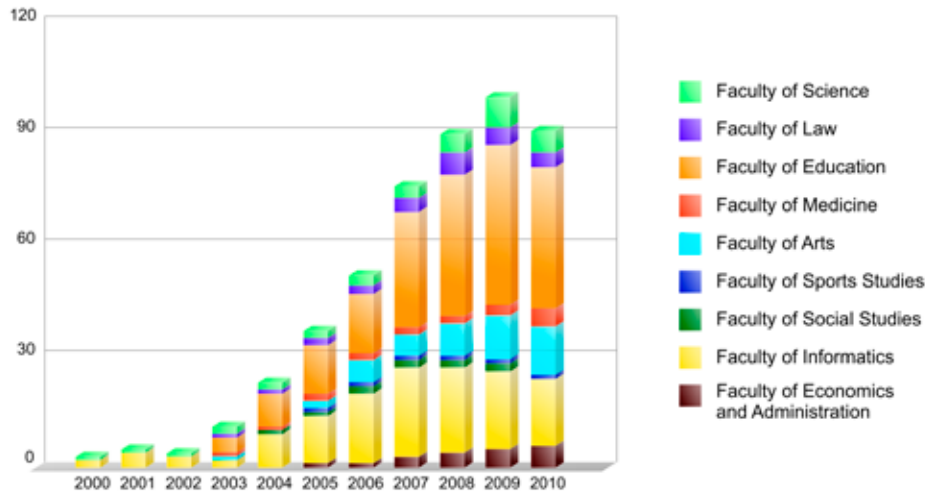
Just as in the case of interpreting into a sign language, the aim of this offered service is to allow a student to participate in the educative process. The way this service is offered and the codes of ethics of visualizators and interpreters into sign language are similar. It is an undisputable advantage of the transcript that it is possible to further edit the created text and use it for future work and study.

1 Introduction

For a start, I would like to say a few words about visualisation/speech-to-text reporting as such and how it is organized; this will give space to my colleagues who will in their paper later today, deal with its technical aspect and technical solutions in situations when speech-to-text reporting needs to be provided to more students at once.

Speech-to-text reporting has become, internationally, a well established service, known as CART (The Communication Access Real-time Translation). In the Czech environment, this service became more prominent in 2005. It was used at Masaryk University and in the public sector at the same time. The reason was that the demand for this service emerged.

At present, there is a relatively high number of hearing impaired students at Masaryk University. Chart number 1 shows the development of number of hearing impaired students from 2000 to 2010. We can see a quick rise of the number of students after Masaryk University, as the only one in the Czech Republic, began to provide a wide range of services, including interpreting to Czech sign language, one-on-one tuition, and possibilities to adapt studies individually. After reaching a peak in 2009, the number of students slightly decreased. It can be explained by the fact that other Czech universities began to offer similar services.



[Chart 1] Development of number of hearing impaired students, 2000–2010

The increase of a total number of hearing impaired students at our university resulted in a broader scale of hearing impairment and also, consequently, necessary services providing accessibility to students.

2 Definition of speech-to-text reporting users

Masaryk University offers speech-to-text reporting to hearing impaired persons who understand Czech, but who cannot understand the speaker, because he speaks too fast, doesn't articulate properly, often writes on the blackboard, or when a lecture is too specific and it would suffer from a translation to a sign language.

All communication parties may require this service at Masaryk University when there is communication between hearing impaired and hearing persons, or when audio materials are offered.

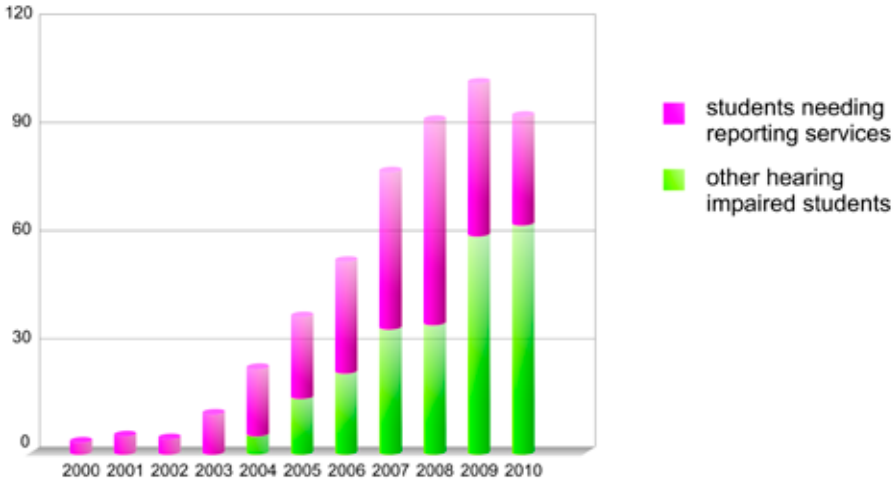
The range of users of these services is quite varied.

Speech-to-text reporting is primarily provided at Masaryk University as an alternative to sign language interpreting for:

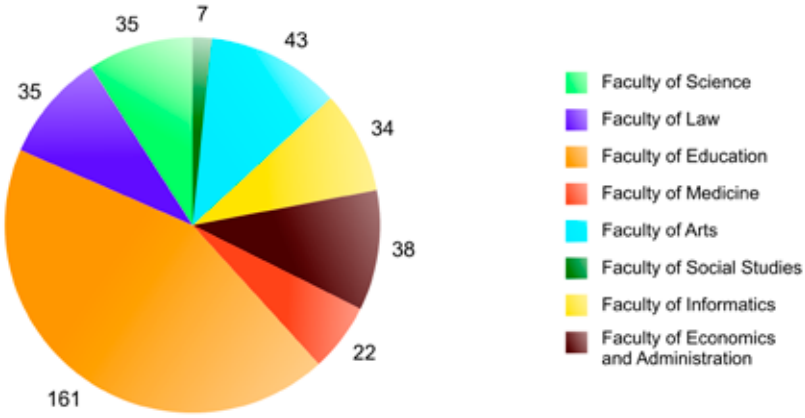
- the hard of hearing,
- the Deaf who prefer communication in Czech,
- the deafened.

Ability to lip read and receive speech (with hearing aids) and to understand written Czech is important. Impaired students who themselves cannot take notes for various reasons (the Deaf who follow a sign language interpreter and the mobility impaired with motor impairment of the upper limbs) are also among the users.

Another chart (number 2) shows the development of the total number of hearing impaired students in comparison to students who use speech-to-text reporting in classes to some degree. It is clear that the number of such students grows both in absolute and relative numbers.



[Chart 2] Development of ratio of students needing reporting services and all hearing impaired students at Masaryk University



[Chart 3] Ratio of reportings at faculties (in hours)

The extent of the service grows together with the number of its users. Currently, we provide 375 hours of reporting during a semester. Some classes are in English, German, and French. The Chart number 3 shows reported classes at different faculties. Most classes are reported at the Pedagogical Faculty, which corresponds with the total presence of hearing impaired students there.

3 Technical equipment

Speech-to-text reporting is done with a keyboard connected to a personal computer or laptop. The typed text is displayed on a laptop monitor screen. In case more persons are present, it is displayed on more monitor screens at once or on a projection screen, which is visually accessible to all. When speech-to-text reporting is provided for a group of users at the university, the possibility of two-way communication is preserved, as it is a condition for an active students' participation in classes.

4 Speech-to-text reporting (visualisation) and the Czech legislation

Visualization of spoken language by a written transcription (in other words, speech-to-text reporting) was codified by the Czech legislation in 2008, when Act No. 384/2008 on the communication system for the hard of hearing and deafblind persons came into force, amending Act No. 155/1998 on the communication system for the hard of hearing. Speech-to-text reporting is included in paragraph 6 among communication systems based on the Czech language, as are signed Czech, finger alphabet, mouthing, Lorm's alphabet, dactylographics, Braille alphabet including the tactile form, tactile lip-reading, and Tadoma vibration method.

Masaryk University included this service in the Rector's Directive on the Standing of Sign Language and Other Communication Systems for the Hard of Hearing at Masaryk University.

As in the case of sign language interpreting, the purpose of this service is to provide a student with the opportunity to participate at the educative process. Also, the way this service is provided and the reporter's or sign language interpreter's code of ethics are similar. What differs is the technical aspect and its serviceability. The possibility to further edit the report and use it for further work and studies is an indisputable advantage of speech-to-text reporting.

4.1 Types of reports

Practical experience showed a necessity to differentiate between various types of records and their anchoring in the Directive.

- **speech-to-text (visualization)** – it is performed *simultaneously*, *in real time*, and it is equal to signed Czech or mouthing, it is not corrected or edited and it is not archived;
- **registration** – this type of record the most frequent at the University. It is *simultaneous, but not necessarily in real time*, it can be archived for some time and serve as the basis for a content or orientation record – in these cases, it is corrected and edited. A student is expected to make his/her own notes from this record and use them for studying for exams;

- **content** – it is used for studying and it is created from a registration record after a comparison with other available sources;
- **orientation** – it is used for studying and it is created from a registration or content record which is reduced by familiar passages or passages replaceable by other sources.

5 Tertiary education specifics of speech-to-text reporting and their possible solutions

Speech-to-text reporting takes place in the environment of common university lectures or seminars, which leads to the following limitations and specifics:

specifics of a reported situation:

- reporting can only take place with a teacher's agreement with a recording of a lecture
- the service may distract a teacher (external keyboard noise), a teacher may banish the service from a class
- pace of a teacher's speech and, usually, his/her behaviour cannot be altered in regular classes
- there are distractions caused by the lecture progress or students
- reporters need to alter during long classes (especially when it is a block-class), which can disturb the class as well as the reporting
- it is favourable (and desirable) when a teacher gives out materials in advance, which leads to a reporter's better preparation and performance in class

specifics of lectures and seminars:

- in seminars, more often than in other cases, speakers and information sources alter
  - reporter must choose and note only one information source available
  - when video and sound are available to choose from, sound has a preference
  - when information sources change, it is necessary to note this change in a standard way
  - it is also necessary to record who the speaker is
- a lecture may be disturbed with seemingly irrelevant teacher's or students' comments
  - a reporter must record these comments (for example, using different font type, such as italics)
- a teacher may refer to previous topics or repeat well known information
  - a reporter does not make selections, it is up to a student to process this information

problematic issues of reported materials or situations:

- teaching based on work with non-linear texts (mathematics, chemistry, etc.);
- seminar discussions with a chaotic alternation of speakers;
- teaching based on work with computers or other multimedia;
- work in laboratories in general;
- in these cases, alternative access to tuition, interpreting on the spot or one-on-one teaching are considered;
- in case speakers or information sources alter, it is necessary to follow clear guidelines saying how to report and what to prefer.

reporting in special seminars such as therapeutic groups dealing with introspective techniques:

- good reason to refuse reporting
- in these cases, visualization (real time speech-to-text reporting) is only provided upon an agreement with seminar participants

6 Requirements concerning reporters

Masaryk University currently employs approximately 45 speech-to-text reporters as external workers. University students and graduates, as well as court reporters become speech-to-text reporters.

We focus on these criteria during the admission process:

- ability to type fast and correctly (a text full of typos can be illegible),
- good knowledge of the reported language,
- ability to use a word processor, and
- good qualifications.

Ideally, reporters attended the reported class in the past or they are graduates of the program of studies. Reporters can influence their performance by further preparation, such as studying materials in advance and continuous self-education in the subject/field.

Section 3

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

Universal Accessibility of Documents: Workflows and Tools for Efficient Service Provision

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Keywords: Accessible document, accessible formats, eLibraries, service provision

Abstract

This paper will outline the need for efficient workflow support for service providers to address the diverse needs of diverse end users with disabilities using a diverse set of end user devices and software including Assistive Technologies. A special focus will be given to get access to documents from right owners highlighting the recently archived "Memorandum of Understanding on access to works for dyslexic or visually impaired readers" [EU].

1 Introduction

The ICT and multimedia revolution leading to the "information or knowledge society" brought forward a number of new opportunities for enhanced accessibility as well as more efficient provision of documents in accessible formats. The digital source allows a) accessing the information using different (multi-)media channels, in particular allowing people with sensory and cognitive/learning problems to access information and b) handling the document using a broad variety of end user devices what support in particular people with motoric problems. For both aspects, Assistive Technologies (AT) have been developed over the last decades allowing more comprehensive, higher quality and more efficient access to information.

But each step in introducing new mainstream multimedia technologies and opportunities also increased the set of challenges regarding accessibility. The traditional focus of "pure document oriented" library services has emerged and includes a broad variety of issues like

- accessible alternative formats including Braille, adapted printing, audio, video, easy2read, sign language and electronic documents incorporating a divers set of accessibility features into "design for all" (e.g. Daisy, www.daisy.org).
- accessible Web based online information provision and online/desktop systems and services following elaborated and accepted guidelines, methodologies and techniques (e.g. [W3C/WAI])

2 Workflow Support

Analysing this ICT/AT based revolution and taking into account the potential of ICT/AT for people with disabilities and the need for **eAccessibility** in society, service provision for students with disabilities and service providers are challenged with an increasing complex set of requirements. The new potential of ICZ/AT challenges the workflow and day to day practice. Considerations how workflow tools (e.g. [DocWorks[e]]) could

support service providers in answering the needs and demands from a more and more diverse group of students with disabilities using more and more diverse Assistive Technologies. Workflow tools could allow exploiting the potential of ICT/AT for the different target groups and also support an efficient use of constant (or even decreasing) amount of resources for an increasing number of clients. Starting from

- a complex set of requirements and needs of different target groups ("profiling"), over
- changing routes of access to resources of information/document (publisher, open content, web, eLearning platforms, authors/lectures, classmates,...), which includes questions like e.g. copyright and secure delivery of protected documents over
- a growing number of tools for
- digitisation and accessible design of documents
- accessible authoring or re-design of information available in digital formats and
- storage in to accessible formats (e.g. Daisy) over
- an increasing number of conversions and productions of end user oriented, personalised formats for students with disabilities
- an enriched number of delivery mechanisms for diverse formats including (accessible) mainstream channels (e.g. eLearning platforms or Learning Management platforms (LMS)) towards
- embedding these mechanisms into holistic approaches of service provision for students with disabilities including other aspects like social inclusion, counselling, psychological support, AT and other specialised training, awareness raising and job search support.

3 Access to digital resources

All these services are run in the context of publishing and a complex legal and administrative situation making access to document and in particular exchange between service providers difficult.

Special attention therefore will be given to the recently achieved "Memorandum of Understanding on access to works for dyslexic or visually impaired readers" between the *European Blind Union and the Federation of European Publishers* [EU].

Since the ICT/AT revolution has been offering enhanced possibilities to access, use and produce information for people with disabilities, the question of overcoming copyright and security problems has been on the agenda. Many efforts, both at political and interest group level and at day to day service provision level had to be made to be able to exploit the potential of digital document in terms of

- getting access to digital originals and
- getting the right to digitize or convert documents ("negotiation with publishers, authors or other rights owners")
- getting the right to distribute documents in electronic formats.

With this agreement a big step forward can be made to enable more efficient services and exchange between stakeholders. This agreement was facilitated by the European Com-

mission through its digital agenda and promoted by the European Accessible Information Network [EUAIN]. This agreement, when signed accordingly by the member states, will grant a general right to produce accessible formats to so called "trusted intermediates". This should allow a more flexible and efficient production of alternative formats and in particular the exchange on accessible versions in Europe. This agreement should be signed by publishers' organizations in member countries to implement this general agreement and allow an according easier and more efficient service provision.

This agreement asks for attention and co-operation to outline:

- the potential impact and how to make best use of it,
- the need for advocating for ratification at national level and,
- how the practical implementation should work using so called "trusted intermediates".

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Access to Maths and Science for Print Impaired People

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Keywords: Accessibility to Mathematics, Mathematical Braille, Speech synthesis, Braille Transcription

Abstract

Access to Mathematics have always been a problem for print impaired people. The problem is not in the understanding of Mathematical semantic, but in the access to the mathematical content through non visual modalities. Indeed the graphical layout helps a lot sighted people to understand the mathematical semantics, while print impaired people need to memorise a whole expression to catch its overall structure, and as well to do calculations. Another help for sighted mathematicians is the possibility to draw lines and graffiti around expressions, which cannot be done with non visual modalities. Unfortunately this situation leads to a lack of mathematical literacy by print impaired people, and consequently prevents them to access to a large range of scientific studies and therefore forbid them a lot of employment opportunities.

Since a couple of decades, a number of projects have been carried out aiming at overcoming the difficulty of accessing mathematical content via non visual modalities. A first series of works dealt with the problem of generating mathematical content in Braille or speech from mainstream formats, and vice versa. Later interactive systems have been designed to facilitate understanding of mathematical content in Braille or speech, and we assist now to a new challenge: doing mathematics, that is providing support to actually perform calculations, problem solving.

In this paper we will discuss the main difficulties encountered by print disabled people to access mathematics, then we will review the state of the art of researches carried out in this domain, and present the current existing technologies that can be used by pupils and students who need to learn mathematics and to people who need mathematics in their work. Finally we will introduce the ICCHP Summer University on Maths, Sciences and Statistics, which aims at providing students with hands on workshop to actually learn to use these tools and assistive technologies.

1 Introduction

Access to Mathematics have always been a problem for print impaired people. The problem is not in the understanding of mathematical semantic, but in the access to the mathematical content through non visual modalities. Indeed, even if it is far from the majority, a number of blind individuals have been nevertheless successful in mathematical studies. Actually the difficulty is greater for them than for the rest of the population. We will show in the next section how the graphical layout, and the ability to draw lines and graffiti around expressions, helps a lot sighted people to understand the mathematical semantics. Meanwhile print disabled people need to memorise a whole expression to catch its overall structure, and as well to do calculations.

Therefore only the brightest students are able to overcome this difficulty, and most others have no or very little knowledge in Mathematics, while most mainstream students manage to reach an average level. Unfortunately this situation leads to a lack of mathematical literacy by print impaired people, and consequently prevents them to access to a large range of scientific studies and therefore forbid them a lot of employment opportunities.

Since a couple of decades, a number of projects have been carried out aiming at helping print impaired people to access mathematical content via non visual modalities. The section 3 will present the state-of-the-art of the domain, including the current existing technologies that can be used by pupils and students who need to learn Mathematics and to people who need Mathematics in their work.

Finally we will introduce the ICCHP Summer University on Maths, Sciences and Statistics, which aims at providing students with hands on workshop to actually learn to use these tools and assistive technologies.

2 Where does lie the problem?

2.1 Structure

The graphical bi-dimensional structure of mathematical expressions help sighted people to understand their semantics. Considering the very simple fraction (1), the reader perceives at the first glance that it is a fraction, building an abstract mental representation that will be supplemented a bit later, when the details of the numerator and the denominator will be read. The same expression written in a linear form (2) needs to be processed in another way. First the details are read, and symbols are memorised one after the other, building the corresponding mental representation, with the need to be continuously rearrange it depending on the next symbol. Indeed it's only after reading the sixth symbol that it can be noticed that we are reading a fraction, which changes the mental representation from a sum to a fraction with a sum as the numerator. Then it's only at the end of the reading that it is confirmed that this fraction is the main operation (an additional term, like "+1" would change again the main structure and could not be anticipated).

In addition the graphical representation counts 7 signs while the linear version needs 11. This is a very simple expression, it can be easily imagined that when dealing with a more complex expression the length of the expression increases dramatically.

In case of a speech output, the perception of structure is very difficult as showed by

$$\frac{x+1}{x-1} \quad (1) \qquad (x+1)/(x-1) \quad (2)$$

the experience reported in [KG03]. Students were asked to speak mathematical expressions on the phone to other students, who had to write them on the paper. The results are described as "*very interesting, and a bit disturbing*". The error rate was rather high and the authors conclude that "*It is no wonder that teenagers who receive their math homework over the telephone don't get good grades*". Indeed the previous expression (1) would be read out like "*x plus one over x minus one*", and could be understood as well in the three following ways:

$$x + \frac{1}{x-1} \quad (3) \qquad x + \frac{1}{x} - 1 \quad (4) \qquad \frac{x+1}{x} - 1 \quad (5)$$

Of course structure tags, like parenthesis, could be added, but this solution is very penalising in the case of long and complex expressions [BF10].

2.2 Graffiti

Sighted people use a lot some additional symbols and drawings, that we will call graffiti, to better understand mathematical meaning as well as to do calculations. It can be lines, circles, strokes, etc. which do not belong to the main writing modality. For instance in order to develop the product (x+1)(x−1), we have been taught, in school, that the best way is to link together the terms of each factor in order to forget none of them, and then to strike the ones which cancel each other out (6). In a lot of other situations one can circle, cross out, underline a term or a factor.

$$(x+1)(x-1) = x^2 - \cancel{x} + \cancel{x} - 1 = x^2 - 1 \qquad (6)$$

Not using these graffiti means that the whole expression has to be memorises at each step of the calculation. This is of course possible for some of the students, as said above, but keeps it to only a few bright students.

2.3 A permanent workspace immediately available

The sheet of paper constitutes a workspace immediately available to sight, and serves as a support for thinking. It plays the role of a supplementary memory, making it not necessary to memorise every detail. All symbols remains permanently there, accessible in a glance. When a calculation is complex, involving very long expressions, we would copy term after term, substituting some of them by the result of the calculation, without having to memorise the whole. Then using graffiti we can circle the parts that go together or strike the terms already processed.

$$(x+y+2) \times (2x-3y-1) = 2x^2 - 3xy - x + 2xy - 3y^2 - y + 4x - 6y - 2 \qquad (7)$$

$$= 2\cancel{x^2} - 3\cancel{xy} - x + 2\cancel{xy} - 3\cancel{y^2} - y + 4x - 6y - 2 \qquad (8)$$

$$= 2x^2 - 3y^2 - xy \ \ldots \qquad (9)$$

Additionally the layout of the symbols on the page can act as a guide, simplifying some tasks, as the search of specific item. For instance in the expression (10) it is very easy to spot the values which must be multiplied: they appear clearly at the top and the bottom of the fraction bars. If the same calculation is presented in a linear way it's more difficult to find out which must be multiplied by which, because they are interleaved (11).

$$\frac{2}{3} \times \frac{4}{5} = \ldots \qquad (10) \qquad 2/3 \times 4/5 = \ldots \qquad (11)$$

In the following case, the numbers which cancel each other appear clearly on the bi-dimensional version, unlike in the linear one.

$$\frac{3}{5} \times \frac{7}{2} \times \frac{2}{3} = \ldots \quad (12) \qquad 3/5 \times 7/2 \times 2/3 = \ldots \quad (13)$$

3 State of the Art

Since about 20 years, various research projects have been carried out aiming at facilitating access to mathematical content by blind and partially sighted people, and more recently to print impaired people. [ASFM07] presents a comprehensive state-of-the-art paper, including relevant projects and products, after an introductory part presenting in detail access methods.

We propose to classify the works in this domain according to 3 categories:

- **Accessing:** to produce accessible mathematical content;
- **Understanding:** to help the understanding of mathematical semantics through non visual modalities;
- **Doing:** to support manipulation and editing of expressions, in order to actually do calculations.

3.1 Accessing

During the first half of the XXth century, a number of specific Braille codes for Mathematics[1] have been designed. This can be explained by the fact that Louis Braille did not like Maths (he was a musician and there is a unique international Braille code for music, but he never created a code for Mathematics). At this time when social networks or smartphones did not exist, the codes have been developed in an isolated way, leading to some interesting similarities as well as very important differences. These differences are very cultural and therefore very linked to the linguistic philosophy of each language (e.g. German being very formal, French using a lot default values for the most used symbols and American, designed the latest, very pragmatic). [MA04] proposes a comparison between the various Braille codes for maths in the perspective of designing a multilingual conversion tool (see below).

As mentioned, the process of linearising expressions leads to dramatically long representations. The length is even increased due to the fact that only 64 different symbols are technically possible with 6 dots Braille, which leads to the necessity of using several Braille characters for a single mathematical symbol. The main aim of specific Braille codes for Mathematics is to reduce the length of expressions. They all used context free grammars and actually are very complex. This is a problem for students who need to learn them, as well as for production of documents.

Most early assistive technology works in this domain have been focusing on the Braille production of Scientific documents. [BMS98], [CLMB04], [SK06] present transcription tools for mainstream documents (namely LaTeX or MathML) respectively towards Marburg (German code), the Dutch Braille code and *Nemeth* (US English code). On the op-

1 Extensive documentation about most mathematical Braille codes, including references and specifications, can be found at http://chezdom.net/mathematicalbraillecodes

posite direction, [AGG+03] describes a system allowing to scan, transcribe to LaTeX and print paper Braille documents including Nemeth mathematical expressions, allowing a sighted teacher who cannot read Braille to access to the works of a blind pupils.

The *Infty*[2] [SKOY04] consists in an Optical Character Recognition suite specialised in Scientific documents. It allows to convert source documents (scanned or in PDF form) into a number of formats, including MathML, LaTeX, HTML, HRTEX, KAMS and the Japanese Braille code.

* * *

In the recent years it appears that transcription to Braille is a central task in a lot of applications, including transcription applications, but also more complex software that will be presented in the next subsections. A lot of these applications have limited use because they can only produce one specific Braille code. In a collaborative approach with the main research teams working in this domains, we started to work on a *Universal Maths Conversion Library*, the *UMCL*[3] project [AFG+04], which aim is to to provide a programming library encapsulating various converters for various Braille codes in a single library usable through a simple and unique API. UMCL is an open source project, developed in standard "C" and has wrappers to different programming languages (like Java or Python).

To make it possible without growing the complexity, it was necessary to adopt an architecture based on a central representation of expressions and to develop input and output modules for this central representation, called *Canonical MathML* [AM06], which is subset of MathML (which mean that all Canonical MathML documents are valid MathML, so it can be used with common tools which handle MathML). Based on the study of various Mathematical Braille codes [MA04], Canonical MathML is an attempt to unify MathML structures in a deterministic way so as to simplify transcription into Braille. All Mathematical structures that are necessary to perform a correct transcription into Mathematical Braille are recognised and rewritten in a unique way.

The library allows developers of Mathematical applications to support several Braille codes instead of only one as it is often the case (the one of the country where the application was developed). The library can be linked as well to extend the scope of transcription tools (allowing them to export into more Braille codes) as for software applications needing real-time conversions (see below).

3.2 Understanding

ASTER (*Audio System for Technical Reading*) [RG94] was the first system aiming at producing audio output from TeX documents, including mathematical expressions. We have seen above that the perception of structure using only voice is very difficult. [Fit06] explored the use of prosody to solve this ambiguity problem and [BF10] introduces a new way of conveying structure by speech, using "*earcons*" (non speech audio) and "*spearcons*" (spoken words accelerated in a way their syllables cannot be distinguished, but they remain recognisable, based on their voicing, like for instance "*Open parenthesis*").

2 http://www.inftyproject.org

3 http://chezdom.net/maths/umcl

The paper also introduces the use of binaural to differentiate the opening and closing of blocks. The *MathPlayer*[4] [Soi05], developed by *Design Sciences*, is an *Internet Explorer* plug-in allowing to enlarge mathematical expressions and to produce sentences that can be spoken by screen readers.

dots plus[5] [GHH+04], developed by View Plus, provides a mixed tactile graphics/ Braille representation. All structure elements (fraction bars, roots, exponents, signs) are conveyed graphically, while numbers and letters remains Braille. This is very efficient to perceive the structure of expressions, but remains limited since it only works on paper. Moreover very big expressions would not easily fit on a sheet of paper. Last but not least, the work on paper does not allow to do edit expressions and then to do mathematical work. On the other side it is the only solution which actually works today to give access to the bi-dimensional form of expressions. Furthermore the progress made recently in the field of refreshable tactile graphics could solve this problem.

* * *

In the section 2.1, we have seen that users of non visual modalities need to build the structure of the Mathematical content while reading the details. [GBKP04] focuses on the way sighted people read a mathematical expression. The study shows, as expected, that the structure of simple expressions is perceived first. Nevertheless it appears that it is not the case with complex expressions. In the experiment students were asked to evaluate expressions like (14). Some of these expressions were presented in the usual way, and some others presented instead in two steps: first the structure (15) and then the actual figures (16). The conclusion of the study is that it is not the whole structure which is perceived first, but only the surface structure. Then the expression is split into chunks and each chunk would be processed separately in the same way.

$$\frac{(14+9)+5}{5} \quad (14) \qquad \frac{(\quad+\quad)+}{} \quad (15) \qquad \begin{matrix} 14 & 9 & 5 \\ & 5 & \end{matrix} \quad (16)$$

From these works, an expression browser, the *Math Genie*, was designed [KGGW98, KGG02, KBS04], in order to improve the understanding of expressions using voice. It conveys the to the structure of expressions as well as its content. It offers Blind students several ways of reading the expressions, from default reading from left to right to an abstract way that highlights the hierarchical structure while "*folding*" away the sub-expressions. The user can navigate in the mathematical structure, moving by way of meaningful "*chunks*". This is based on lexical clues, which represent the structure of the mathematical content. See for instance the expression (17): from the whole expression, user has access (α) to the global structure by folding main branches of the expression, which is then read "*Entity over entity*". Then the numerator can be entered (β); the user can navigate to the denominator (γ) and for instance come back to the main level (δ). This way of folding/

$$\frac{x+1}{x-1} \rightsquigarrow^{(\alpha)} \frac{Entity}{Entity} \rightsquigarrow^{(\beta)} x+1 \rightsquigarrow^{(\gamma)} x-1 \rightsquigarrow^{(\delta)} \frac{Entity}{Entity} \quad (17)$$

4 http://www.dessci.com/en/products/mathplayer

5 http://www.viewplus.com/products/braille-math/dotsplus

expanding branches of mathematical semantic tree can be done at any level, which corresponds to the "*chunks*" mentioned above.

The Math Genie can be used by a Blind student together with a sighted teacher. Indeed the teaching material can be prepared for both sighted and Blind students using any Math editor able to produce MathML. The graphical rendering is synchronised to the audio which makes communication easier with the teacher. It is based on SVG (Scalable Vector Graphics), which allow the Genie to support magnification, in order to give support to partially sighted individuals, and colour-contrasted highlighting, in order to support individuals with dyslexia.

In the MaWEn (Mathematical Working Environment) prototypes [ASB+07], we have extended this idea to Braille: the expression is converted to Braille mathematical code and displayed on a Braille display. Here also the user can browse the expression, explore the global structure or any component. Entities can be represented by descriptors like: "*Sum*", "*Term*" or "*Fraction*" as shows expression (19). Finally, as it is meant to be displayed in Braille, short abbreviations of descriptors can be used instead, see expression (20). The user is enabled to fold or expand any branch of the contents tree. Using UMCL, MaWEn prototypes support several Braille Mathematical notations. The Math Genie was more recently extended to support Nemeth Braille code [SK06].

$$\frac{Entity}{Entity} \quad (18) \qquad \frac{Sum}{Sum} \quad (19) \qquad \frac{S}{S} \quad (20)$$

The MaWEn prototypes are designed to support inclusive teaching environment. Indeed mathematical expressions are displayed as well on the Braille display and on the screen, using standard graphical layout. The two views are synchronised and users are provided with cross-modality pointing feature, allowing to show any symbol in a natural manner (using mouse on the screen and cursor routing keys on Braille displays) on each view, that will be highlighted on the other view as well.

In order to develop these prototypes we have set a new mathematical model, described in [ASB+07], which support synchronised views and cross-modal pointing. This model is based on the *Canonical MathML* used by UMCL as central representation, and a set of MaWEn specific attributes have been implemented. The UMCL has been adapted to support this model so it fully works in any of the mathematical Braille codes provided by UMCL.

3.3 Doing

Accessing and understanding Mathematics is not enough to actually do Mathematics, that is to manipulate and edit expressions, to actually do calculations and solve problems. For this kind of tasks, it is necessary to be able to write and to edit mathematical contents. The problem is that Mathematical input is quite difficult to perform: indeed, even for sighted Mathematicians it is much easier to use a paper and a pen than a computer interface.

A few solutions exist though: menu based solutions (like *MathType*[6], equation editor designed by Design Sciences), coded input using a special input language (for instance

6 http://www.dessci.com/en/products/mathtype

LaTeX or LaTeX-like input, like the *InftyEditor* – part of the *Infty Project* mentioned above –, or the Cmath plug-in[7]) or hybrid interfaces (proposing both menus and coded input, like the *OpenOffice.org* Maths editor). These software are relatively handy to design documents that contain Maths but are not well suited to help people to do Maths, and especially Print Impaired people.

The *Lambda project* ("*Linear Access to Mathematics for Braille Device and Audio-synthesis*") [SBJ+06] developed a system to facilitate reading, writing and processing text and mathematical expressions through a Braille display and speech synthesiser. It has its own Braille code, the Lambda mathematical linear code, where Braille symbols are associated with graphical symbols that can be understood easily by the sighted, even thought it is linear. A multimodal mathematical editor was specially designed to edit the lambda code. The problem is that users have to learn a new mathematical code, based on a 8-dots Braille representation. On the other side it is one of the only operational solution today.

Extending the InftyEditor, which provides a very easy and smooth method to input Mathematical symbols and expressions, (they are input from keyboard using LaTeX commands and displayed immediately in the form of printing style on the display), ChattyInfty [YKKS08] can be used by Visually Impaired users thanks to speech output including verbalisation of Mathematical expressions.

We have also developed MAWEN prototypes that implement support and manipulation functions which intend to compensate the lack of those graffiti described in subsection 2.2 [SMBA05]. The support functions provide help for some specific tasks, like developing a product, without actually do the calculation instead of the user.

4 Perspectives

4.1 Accessible Maths Documents

One of the problems for blind is still the access to documents in the Braille code the students know. Even if some tools now exist to generate these documents more easily, these tools, as well as the browsers and editors described in previous section, will only work with Accessible Mathematical documents. An Accessible Mathematical document is first an accessible document, obviously, containing Mathematical expressions at a format that can be automatically translated to any format usable by print impaired people (avoiding documents including mathematical expressions in Braille).

Indeed a German Braille reader, for instance, used to the Marburg Mathematical code might be able to access English contents, but she/he will need the Mathematical expressions to be converted into Marburg code because she/he don't know the British Mathematical code. Even a British reader – having obviously no difficulty to read an American document – will probably not be able to access to expressions designed with the Nemeth Mathematical code, used in the USA.

Nowadays too many scientific documents that are included in science on-line courses display Mathematical expressions as GIF pictures. As these pictures are mostly in very low resolution, it is impossible to recognise them automatically in order to convert them

7 http://cdeval.free.fr

into an accessible format. The resolution is so low that sometimes even for a sighted reader, the subscripts and exponents can be unreadable! The best way to produce accessible documents is to use MathML to represent the Maths in a document.

* * *

But the strict technical accessibility of an electronic document is sometimes not enough. The way the document itself is designed is important. Indeed whatever the quality of a converter is, it has to be mentioned here that converters can only transform what they are given! This seems obvious but one problem mainly encountered by transcribers is the poor quality of sources.

Most documents come with Mathematical expressions split in parts. For instance, there is often a character or a group of characters in between that are not included in the mathematical object for some reason, maybe only because it looked nicer that way to the author. For instance an equality could be designed with two mathematical blocks, separated by an equal sign in text mode. Visually there is no difference but the Braille representation might be different! On the contrary some Mathematical expressions would include some text which have no reason to be included in the Mathematical block!

Another usual mistake in mathematical documents occurs when a variable of an expression is used in the text, for instance to describe its role. Any part of the expression, even a single character, is supposed to be set in a Mathematical block.

These errors are frequent as well in documents designed using a word processor as in LaTeX documents and they represent a time consuming problem for transcribers as well as a severe limitation to automatic conversion applications. There is an urgent need for designing some "*Mathematical Content Accessibility Guidelines*".

4.2 ICCHP Summer University

Students with visual impairment need to have access and training to the specific tools they can use to work in Mathematics, Science and Statistic. In order to improve their ability, the ICCHP Summer University[8] proposes a selection of hands-on workshops dealing ith the latest assistive technologies in the field of Mathematics, Sciences, and Statistics for visually impaired people. It is a unique place to learn new technologies, or how to use some mainstream software with assistive technologies, to share experiences, to meet with people who experience the same kind of problems. Moreover it is a place for teachers, teachers who train teachers and people adapting learning and teaching materials to discuss on specific teaching methodology for visually impaired students.

8 http://icchp-su.net

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odt2daisy: Preparing Accessible Documents at the DTBook Format with OpenOffice.org

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Abstract

odt2daisy is an OpenOffice.org extension, which enables users to author accessible documents into valid DTBook files and DAISY talking books, with a rich, cross-platform, accessible, free and open source environment. DTBook, part of DAISY, is a standard for storing and exchanging accessible documents. OpenOffice.org allows to prepare accessible documents, using a number of styles which are converted to DTBook tags by odt2daisy. As OpenOffice.org itself has improved accessibility features, odt2dtbook makes it possible for print disabled people to author DTBook documents.

1 Introduction

`odt2daisy` is an OpenOffice.org extension which enables users to author accessible documents into valid DTBook files and DAISY talking books.

1.1 Daisy

Started in 1988, the DAISY[1] project (*Digital Accessible Information SYstem*) [Ker02], aims at building a digital format for audio books on CDs. It became in the last decade the audio books standard for print impaired people. A lot of tools have been developed to produce, handle and use these books. There are portable readers – which look like a Walkman, software readers that can be used on a PC, providing viewing facilities like highlighting of the currently spoken word on the screen.

Practically a DAISY book is set of files including audio files (in mp3 format), synchronisation files and an XML file containing the whole contents of the book, together with structure and semantic information. This XML file, called DTBook – referring to the name of its DTD – allows readers to implement navigation in the structure of the document, full text search, etc. It actually contains all the necessary information to generate a full DAISY book using synthetic speech.

1.2 DTBook

DTBook became a standard for storing and exchanging digital accessible documents dedicated for people with print impairment. Adopted as an ANSI/NISO standard (Z39.86),

1 http://www.daisy.org

it is now developed and maintained by the DAISY consortium. It is nowadays the world's most widely used format for Talking Books for print disabled users. It was adopted by a large number of Digital Libraries for the Blind around he world as a storage format for books (Library of Congress in the US, TPB: the Swedish library of talking books, the French BrailleNet Association, etc.) [Ker06]. In addition, the US format for provision of accessible, alternate format versions of pedagogical documents, in the framework of the Individuals with Disability Education Act, called NIMAS 1.1 (National Instructional Materials Accessibility Standard), is aligned with Daisy.

Therefore it is very important to provide users with a free, powerful and easy-to-use environment enabling them to produce a valid DTBook. This environment can be used by teachers preparing their teaching material as well as by the staff of support centres for visually impaired students or of digital libraries.

1.3 OpenOffice.org

We have chosen to work in the framework of OpenOffice.org for several reasons. One of them is that it offers a rich, free and open source environment. It is cross-platform, which means it works as well on Linux, Mac Os X, MS Windows, OpenSolaris, and other operating systems. Additionally OpenOffice.org itself has improved accessibility features and then can be used by print disabled people using assistive technology.

`odt2daisy` is implemented as an extension of the OpenOffice.org Writer application. It enables OpenOffice.org users to generate easily a DTBook file, and therefore makes it possible for print disabled people to author DTBook documents themselves.

1.4 odt2dtbook and odt2daisy

Initially the extension was called odt2dtbook and was developed at Université Pierre et Marie Curie-Paris 6 [AS09]. It was allowed to export a document in the DTBook format. In September 2008 odt2dtbook received a Gold Award from the OpenOffice.org Community Innovation Programme, sponsored by SUN Microsystems.

In 2009 it was integrated into one of the research lines of the ÆGIS project (Integrated Project), at Katholieke Universiteit Leuven in Belgium [SES10]. One of the main goals of this project is to mainstream accessibility in document authoring and software development, and this work includes contributions to open-source projects. Technical developments in ÆGIS cover three platforms: the desktop, Rich Internet Applications (RIAs) and mobile applications. Thanks to the *DAISY Pipeline lite*[2] the extension now offers the possibility to generate a full DAISY 3.0 book with audio. Then the extension was renamed `odt2daisy`.

`odt2daisy` is free software available under the GNU Lesser General Public License. The source code, as well as installation files for various operating systems, are available on `odt2daisy` website.

2 http://www.daisy.org/project/pipeline

2 odt2daisy

2.1 Design

Odt2dtbook is made of two parts. One is a library that performs the conversion from an ODT file (OpenDocument Text). The other part is the extension to OpenOffice.org itself.

- **The conversion library** was developed in XSLT and Java and it is independent from OpenOffice.org libraries, which makes it possible to link it to a standalone application, or as a command-line tool. It processes an ODT document (composed of a set of various files, including XML files for the content and styles, MathML files if mathematical content is present, images, etc.), and merges all relevant data into a single XML file. A large number of styles are converted to DAISY tags (see below), `<pagenum>` tags are inserted, in order to support page numbering (since the page numbers are not in the ODT document itself but generated by the processing software), and a number of corrections are carried out (such as the removal of empty headings).
- **The extension** itself is Built against the UNO API of OpenOffice.org, it uses the odt2daisy library to convert the ODT file into DAISY 2.02 or DAISY 3.0. It calls the *DAISY Pipeline Lite* to generate full DAISY 3.0 audio books. The extension is using some UNO features that have been implemented in OpenOffice.org version 3.0 and therefore cannot be installed in previous versions.

A set of templates have been designed, including a set of custom styles that are specifically targeted to DAISY specific tags. When creating a document, they are available via the menu *File/New/Templates and Documents*.

`odt2daisy` supports Mathematical contents, which must be inserted in the OpenOffice.org standard way (menu item *Insert/Object/Formula*. It is stored as a MathML code in the ODT file, and the extension inserts it in the resulting DTBook as recommended by the MathML-in-Daisy extension. Let us insist on the necessity of inserting mathematical contents as Formula Object and to avoid absolutely using images since these images are not accessible at all [BA07].

2.2 Installation and usage

Installation is very simple : the installation program installs automatically both the extension and the converting library. The OpenOffice.org extension management systems will check automatically for updates. Once installed a new menu item appears in the file menu: *Export as Daisy*, just below the menu item *Export as PDF*.

Before using this menu item, the user has to ensure that the document is correctly accessible. The presence of structure tags is checked at the beginning of the processing (and will not proceed if none is included).

Then an Export box will request several information from the user : an UID (Unique ID), title, creator, publisher, producer, language. Most fields are auto-completed from information found in the document (which can be overridden if necessary by the user). UID is auto-completed by a generated one (which can also be overridden, for instance if the user needs to have a UID depending on an organisation specific numbering). Lan-

guage is completed from the main language of the document, set in *Tools* > *Language* > *For all Text*). Note that if some paragraphs have different languages, a "lang" attribute will be set for the corresponding element.

2.3 Preparing accessible documents

To use the extension, the user has to give some structure to the document using the ordinary styles of OpenOffice.org (`<heading1>, <heading2>`, etc.). This is necessary to ensure that output document is really accessible [KGA09].

`odt2daisy` recognises a large set of tags (the complete list can be found on `odt2daisy` website): abbreviation, acronym, address, computer code, prodnote, etc. The extension supports as well lists, notes, footnotes, endnotes, links, images. These elements are automatically converted from the original document to their DTBook equivalent. In most cases there is nothing special to do. For instance to insert a footnote, simply create the footnote using the standard *Insert/Footnote* menu item from OpenOffice.org. Only in certain cases some specific information is required. In the case of images, the user has to provide an alternative text, which must be filled in the *Alternate text* field of the OOo image option dialog box. As mentioned above, an additional set of custom styles that have been designed to cover specific features of DTBook.

Page numbering can be included in the exported DTBook. If requested (by checking the *include page numbers* check-box in the export dialog), all pages that have a footer or a header including a *Page Number* field will receive a page number in the exported DTBook. Additionally, odt2dtbook allows to set manually the page numbering, for instance to render the original layout of a document. This may be useful if some references are given to pages, referring to the printed book pages. For instance a teacher in an inclusive classroom may ask pupils to open their book at a certain page.

3 Perspectives

One of the remaining pitfalls for the `odt2daisy` process is the fact that the original source document has to be well structured to produce a daisy book (if not, only an incomplete book will result). Currently, within the ÆGIS project, an OpenOffice.org plug in for checking and improving the initial document structure is under development.

In our opinion an optimal reading experience for talking books is offered by the Daisy system. However several alternatives are gaining success too. One of them is the recent development of electronic books (e-books). Using specific readers such as the *Amazon Kindle* or software readers on computers, smartphones or multimedia tablets, makes it possible not only to read the text in different font sizes but also to listen to it in a spoken version (with speech synthesiser software included in the reader), although often not in an optimal way.

[Eng10] presents the current situation and provides a comparison between audio books and electronic books. These mainstream trends allow definitely to increase the number of applications and books available to print impaired people but problems of copyright, that were minor as long as specialised versions for blind persons were produced, might become a tough obstacle in the future.

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The Hybrid Book – Just One Document For All

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Abstract

There are many ways to perceive desired information from a source that cannot be reached directly due to a type of a user's disability. There are lots of adaptive technologies solving these situations. These technologies are often targeted to a specific group of users, for example visually impaired users. As the number of such user groups grows, the number of adapted versions of the original source equally increases and their management becomes demanding.

The Hybrid book brings a solution for various groups of users in one electronic document. It combines a textual record for viewing and reading by touch via Braille display, an audio record to capture information by hearing, and a video recording of the text translated to a sign language. All these recordings are synchronized and may be simultaneously played and navigated by intuitive navigation functions. A Hybrid book document can contain a variety of record types and a number of recordings of any specific type. Hybrid book documents are primarily intended to be viewed on-line on the World Wide Web.

1 Introduction Adaptive technologies oriented to bring an information access to people with some kind of disabilities and Hybrid book 2.0 as an example of such a technology

There are many ways to perceive a desired information from a source, that cannot be reached directly due to any type of user's disability. There are lots of adaptive technologies solving these situations. These technologies are often targeted to a specific group of users, for example visually impaired users. As the number of such user groups grows, the number of adapted versions of the original source equally increases and their management becomes demanding.

The Hybrid book that is an actual matter of this presentation, is one of those technologies. In its current version, it is really an example of forementioned technology. It combines digital text with an audio recording of the content made by human voice and is complemented with the navigation functions and other auxilliary functionalities. It means that the information that cannot be perceived directly from textual source, is adapted to a speech and perceived by hearing instead of viewing.

In Hybrid book offers another way how to get the source information – reading it using a braille display in tactile form. Braille display, in combination with appropriate screen-reader, may partially be used to control the reader application and to navigate through content of the displayed document. Navigation can be done primarily by mouse or computer keyboard in combination with speech output provided by synthesizer (if needed) as these are standard ways how to control a web browser that is a platform for the Hybrid book reader.

Hybrid book reader in its current version is a web application. The Hybrid book documents are located online and this could bring some limitations: used text format must be web browser compliant, multimedia file quality is depending on the network bandwidth etc. but benefits of online access is considerable.

In its earlier version, the Hybrid book was intended to be distributed on CD media and the software reader was a binary application. This formation is all along, but marginally, in the current consideration of the Hybrid book development team because there are still some distinct benefits of a binary application: from speeding up the application itself, through a comfortable user control, to an user interface tailored to a screenreader use that is a main problem in case of any web application.
Example of a web-based Hybrid book reader: www.teiresias.muni.cz/h_books.

2 Development in progress

The current Hybrid book version is intended to be used by visually impaired people, but it helps in many other instances. Study of languages, for example, may be a great field of activity for Hybrid book producers, because of a favourable position of human voice, which is provided by a native speaker. A problem of voice synthesizers that are not able to generally recognize the language of text, is then solved. Discounting a quality of synthesizer's pronunciation, punctuation etc., human speaker can additionaly put his own appreciation of a sense of the text being read to the recording, and so to make a hardly understandable content more lucid. Synthesizer cannot deal with that.

But Hybrid book also helps in case of dyslexia and other problems of that kind with direct textual content access. A human voice interpretation also solve a problems with interpreting "nonlinear" parts of text – such as tables, schemes and alike structures. Their proper interpretation needs a proper comprehension which is not in course of any screen-reader.

Deaf users are recent remarkable group of interest of Hybrid book developing. We apprehend that the problem of retrieving information from textual source may be similar for deaf users much like for visually impaired users. Especially in study of languages this issue raises significantly, even if the subject of study is a mother tongue.

The idea of the Hybrid book developing team was to complement an audio recording of source text with a video recording of a translation of that text into sign language. The original Hybrid book system appeared to be able to carry that, but the upgrade has been necessary. So the primary idea has finally expanded to a conception of developing an elementary descriptive system, which can keep synchronization information independent on a data format described. So the door to Hybrid book of next generation has been opened.

3 Hybrid book 3.0

The Hybrid book 3.0 is newly defined as a multimedia publication system, capable of producing and reading electronic documents containing various types of records of the original content. These records are synchronized for simultaneous playback and for a hierarchical navigation by an additional data structure.

Each type of record covers certain way of perception – there may be a textual record, an audio record with a speech interpretation of that text, and video record with a translation to sign language.

All these records are synchronized and may be simultaneously played back. They can be also navigated due to natural hierarchical structure of the document content, represented here by a tree-structured list of headings. Other way of navigation is the sequential movement through small pieces of the content.

The content segmentation granularity is variable – in most cases the smallest navigation step is set to one paragraph of used text. Depending of an actual type of document content, the smallest navigation step can be set to a specific part of content, such as an item of an item-list, an entry of a dictionary etc. Coordination between synchronization and navigation system assures that with each navigation step the entire position in the document is set in all of its active records.

Currently, Hybrid book publication system consists of three parts:

- the publication itself (the content and the synchronization data structures),
- a software applications for document publishing,
- a software applications for reading published documents.

4 The Hybrid book: now and future

4.1 Synchronization data recommendation

The synchronization data recommendation is a core of the work of Hybrid book development team in Masaryk University. Starting with an older version of Hybrid book system, we deeply revised its actual data structures and added a capability of including a video record into a document. Next step was to bring a break-up to an erstwhile interlacing between a data structure itself and the reader application. Now, the data structures are definitely independent on the applications for producing and reading document.

The software applications for working with hybrid book may be developed separately and may cover different needs, such as the Hybrid Book Reader that is an example of possible implementation of Hybrid book format coming out from the work of our developing team.

4.2 How to read Hybrid book document

The Hybrid book, as it can simultaneously present all of its content as the ensemble of synchronized records of different type, is not meant to do it this way. The user's priority is not to view and hear all these records together – it is rather to have an equivalent piece of record for every passage of a source content. An that is the real goal of the Hybrid book technology. It does exactly and primarily this: it allows user to switch instantly among various ways of desired information.

The other key feature is gives users with a different kind of disabilities to follow the same document together but each of the users with his own way. It is advantageous, of course, in case of study cooperation. These situations are not as frequent – but is it just due to a lack of suitable technology, is it?

The Hybrid book offers a complex navigation apparatus. The user may step through a document by small steps (usually paragraphs) or, primarily, may use a hierarchical structure of document content represented by a tree-list of headings. He may navigate through all levels of the document outline, or choose a level to step through heading of chosen level only. The number of outline levels is theoretically unlimited.

The navigation controls are reachable via mouse or computer keyboard. There is only a few controls with intuitive functionalities. User may, on one key press, jump to next/previous heading, next/previous heading of the same level, next/previous paragraph or phrase and to a heading of one level up. These few controls fully covers navigation needs and bring very intuitive usability and a quick understanding of document structure only by performing a few navigation steps.
Example of Hybrid book 3.0: www.teiresias.muni.cz/hk3.

5 Conclusion

The Hybrid book data structure itself has these key features:

- It does not change the content of described data files, all the synchronization and navigation information is saved separately in XML format.
- Virtually any type of record – data file – can be synchronized with others; there is only one requirement that it contains a progressively readable data (such as text files, audio and video files, but also a still images, tables, flash presentations etc.).
- Described data files can be stored anywhere.

The core objective of that conception is to offer an independent descriptive system capable of bringing documents in synchronized form from anywhere to a user with a special needs. Documents themselves, or their pieces – the alternate records of their content – can be stored anywhere in a network including the World Wide Web. The library that the user asks for a document, needs only to contain a document description information including proper path to an desired document.

The showed method prefers the way of describing the dependencies between a various records of a document content against to pumping some special data directly to them. This clears up the document content preparation allowing the producer to refer the preparation of particular record to professionals and then to compile their work to a final document. Records made by experts may be used as they are, only navigation and synchronization data is added within separate data files.

The Hybrid book offers a more unified output by keeping a regular work-flow of producers or providers of adapted documents. It may help in case of common accessibility of such documents, especially documents containing a real multimedia content. It is meant as a solution for instances considering the quality of multimedia content and a human input as a key issue.

Searching-by-Hearing: Sonification of the Search Engine WhatsOnWeb through a User Experience Design Process

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Keywords: User experience, Sonification, Accessibility, Usability, Visual disabilities, WhatsOnWeb

Abstract

In order to represent the information usually conveyed through visual interfaces, information representation research has increasingly centred its attention on the development of non-visual ways to transmit spatial data by means of sonification, namely "the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation" (Krameret al. 1997, p. 3). In the present work we applied the Action by Design Component (ADC) sonification model (Zhao, Shneiderman, and Plaisant 2007) to the sonification of the visual Web search clustering engine WhatsOnWeb (WoW) (Di Giacomoet al. 2007; Di Giacomoet al. 2008). WoW is a search engine based on sophisticated graphic visualisation algorithms which conveys the information dataset by means of both semantic correlations and semantic clusters through graph-drawing methods. By following a user-centred approach, we developed and analysed three combinations between visual and auditory features, in this way, we obtained three sonification layouts, (PanAndPitch, VolumeAndPitch and BlinkAndPitch)transmitting both global and particular spatial information through sound events. A usability evaluation of the visual and the sonificated layouts has finally been carried out, with blind and sighted users. The results show similar levels of efficacy, efficiency and satisfaction for both information and presentation modalities. The usability index emerging from the performance evaluation of the two analysed groups seems to be homogeneous, therefore suggesting that the sonification of visual information makes visual content learnable for blind people in a comparable way to a sighted person learning from a purely visual environment.

1 Introduction

As previous studies show (Federici et al. 2008; Federici et al. 2010), the order in which web indexed information is represented by most common web search engines (e.g. Google or Yahoo) does not take into account the quality of the information they transmit. In fact, a flat top down spatial representation highlights the distance between the quantitative order of Web Popularity (WP) rank and the qualitative level of accessibility of the retrieved information (Federici *et al.* 2010). In order to overcome this widespread problem, a web search engine called *WhatsOnWeb* (WoW) has been recently proposed (Di Giacomo *et al.* 2008). WoW represents the indexed datasets by means of both semantic correlations and semantic clusters through graph-drawing methods based on sophisticated graphic visualisation algorithms. In this way, the search results retrieved by means of the *PageRank*

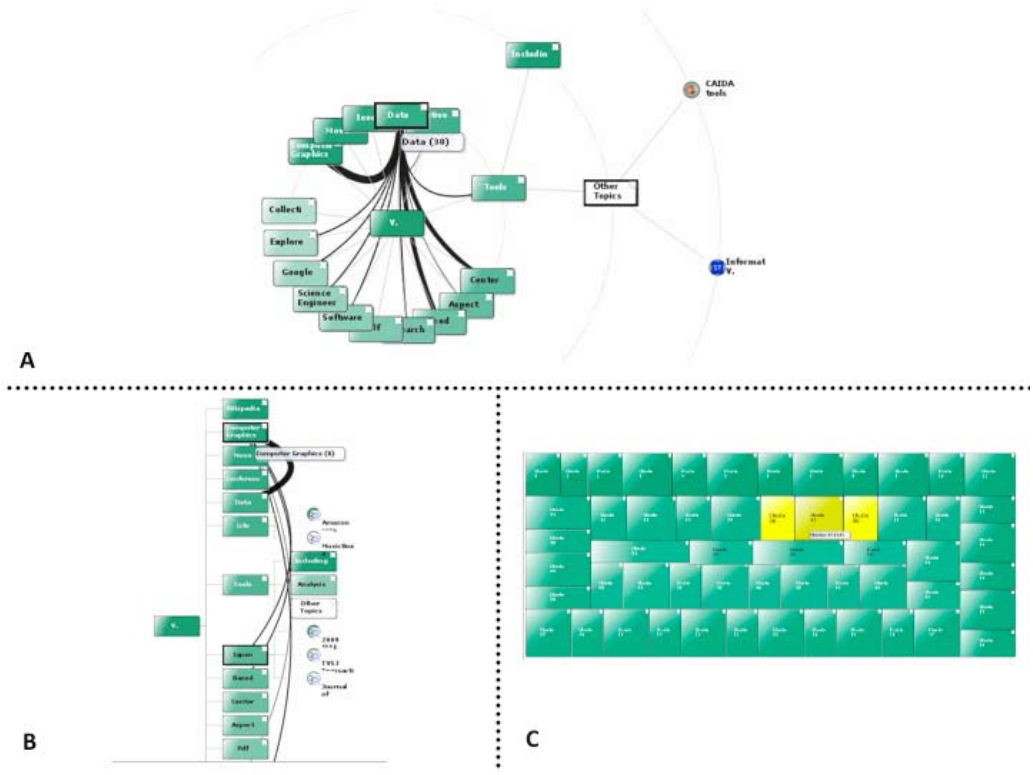
algorithm (Brin and Page 1998) are simultaneously represented in a single page through a semantic network of concepts and sub-concepts constituting an interactive spatial map. By means of WoW, the gap between the quantitative order and qualitative level of Web information retrieved by the most common search engines is overcome through graphical representation, able to facilitate the cognitive information processes organising human knowledge through semantic categorization (Anderson 1993). In other words, the geometrical spatial representation proposed through the WoW search engine should be considered as a *psychotechnology* "emulating, extending, amplifying or modifying the sensory-motor, psychological or cognitive functions of the mind" (Federici 2002; Scherer and Federici in press) able to support and enhance any process involved in the interaction between the user and interface.

The aim of this paper is to show the sonification process of the WoW's visual display carried out under a User eXperience (UX) perspective. The sonification process is "the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation" (Kramer *et al.* 1997, p.3) which permits the transmission of spatial data through non-visual means. The UX perspective, takes into account "how the system works on the outside, where a person comes into contact with it and has to work with it" (Garrett 2004, p.10). As a model of sonification transformation, we used the Action by Design Component (ADC) model (Zhao, Shneiderman, and Plaisant 2007) to transform the visuo-spatial data output into its corresponding audio-spatial output. Moreover, we analysed the differences between totally blind and sighted users while they were respectively interacting with the sonificated display and the visual display of the WoW search engine.

2 The sonification process of the visual web search engine WhatsOnWeb

The analysis of mental representations guided by different non-visual sensory inputs has increasingly been taken into account in the literature on spatial cognition. Many authors observed that the way in which visual, auditory, haptic and kinesthetic sensory information is encoded and processed by the mind in spatial mental images is independent from the nature of the input source (Amedi et al. 2005; Avraamides et al. 2004), thus supporting the amodal hypothesis of spatial representation (Bryant 1992; Bryant 1997). Many of these studies are based on the performance analysis of people with visual disabilities while processing spatial acoustic inputs: findings highlight that the motion ability involved in spatial explorations guided only by acoustic cues is functionally equivalent to the visually guided one. Spatial acoustic inputs are more efficiently processed by blind people than sighted persons (Olivetti Belardinelli et al. 2009). As recently proved, differently from sighted people – who perform spatial tasks by using allocentric strategies – strategies constituting the spatial information elaboration process of people with visual disabilities are related to both egocentric and allocentric frames of corporal reference points (Delogu *et al.* 2010). From a global perspective, all these studies confirm the importance of using sonificated methods and techniques to allow people with sensory disabilities to easily access information. Nevertheless, this can only be possible by representing information in alternative sensory modalities which are independent from visuo-spatial representation.

In recent years, Zhao and colleagues proposed a sonification model called Action by Design Component (ADC): this framework allows users to dynamically interact with the interface and its components (Zhao, Shneiderman, and Plaisant 2007). Taking this model as a starting point, we designed and tested a sonification layout of the visually accessible version of the web search clustering engine WoW presented in 2009 (Mele *et al.* 2009; Rugo *et al.* 2009) in order to transmit the spatial and semantic information of graphical features and their combinations in an acoustic non-verbal way. The visual version of WoW is composed by a customizable layout beneath four different graphic configurations: radial (Figure 1.A), layered (Figure 1.B) and spiral TreeMap (Figure 1.C) whose effectiveness and efficiency was previously evaluated (Di Giacomo *et al.* 2007; Di Giacomo *et al.* 2008). The graphic structure of WhatsOnWeb is organised by semantic correlations among the indexed abstract information. Navigation is allowed by using cluster nodes as semantic sets of results and leaf nodes representing a website or document. Both nodes can be expanded and collapsed in order to allow a single page representation of all the information being searched (Figure 1). Moreover, the nodes are related to each other by means of edges representing their semantic relations.



[Fig. 1] WhatsOnWeb layouts: A) radial; B) layered; C) spiral TreeMap

Starting from Zhao's principles and guidelines we carried out the sonification process by combining visual and non-verbal acoustic features in a univocal way. As shown in Table 1, three different types of sonification layouts were implemented and tested with different combinations of tone, pitch, volume, blinking and grid reference with the z axis repre-

senting the spatial position of the graphic objects of WoW, the web ranking of each node, the level of navigation and the type of node. In this way we obtained three different types of sonification layouts *PanAndPitch, VolumeAndPitch and BlinkAndPitch*.

[Table 1] The three sonification layout prototypes of WhatsOnWeb

	x Axis	**y Axis**	**Ranking**	**Level**
PanAndPitch	Panning	Pitch	Volume	Timbre
VolumeAndPitch	Volume	Pitch	Blinking	Timbre
BlinkAndPitch	Blinking	Pitch	Volume	Timbre

All three sonification layouts share the way in which the navigation can be conducted: i) a first global overview is displayed to users after they press enter to execute their query, by means of the temporization technique (Saue 2000) which allows the information to be transformed from a non-temporal to a temporal domain (i.e. the auditory domain): ii) the navigation through the graph of results is then translated into complex tones corresponding to the paraverbal information of clusters, leaf nodes and their semantic relations (edges): iii) both a reiterable feedback function providing the opening overall preview and a persistent signal during the navigation allow users to orient themselves throughout the interface: iv) a verbal feedback voiced by an integrated synthesizer (or screen reader software) provides the textual information allowing the strengthening of both identification and memorization of data.

3 The user experience evaluation of WhatsOnWeb

3.1 Experimental procedures

As a first step, the usability of each sonification layout has been tested by means of a heuristic evaluation conducted by three experts who applied a readjustment of Nielsen's heuristics (Nielsen 1994) to a simulated user scenario. The results obtained were used to design a single layout composed by the best combination between the acoustic and visual features, the PanAndPitchBlinking sonification layout (Table 2), which conveys spatial information through the z axis by means of the panning technique to represent the position on the x axis and the pitch feature to represent the position on the y axis. Additionally sound blinking represents the rank order of each node.

[Table 2] The PanAndPitchBlinking sonification layout of WhatsOnWeb

	x Axis	**y Axis**	**Ranking**	**Level**
PanAndPitchBlinkin	Panning	Pitch	Blinking	Timbre

Following the heuristic evaluation and the consequent sonification process of the new auditory layout, the UX quality of both visual and auditory displays of WoW was evaluated with four blind users and four sighted users (mean age 28, equally distributed by sex) by using the Partial Concurrent Thinking Aloud (PCTA) protocol (Federici, Borsci, and Mele 2010; Federici, Borsci, and Stamerra 2010) and the System Usability Scale (SUS)

questionnaire (Borsci, Federici, and Lauriola 2009; Brooke 1996). After a description of the experimental tasks and a preliminary exploration of the layout lasting at least 3 minutes, both blind and sighted users were asked to conduct an exhaustive search with WoW by using the keyboard navigation. Respectively, each of the three visual graphic layouts – Radial, Layered and Spiral TreeMap – and the *PanAndPitchBlinking* sonification layout were analysed. The PCTA technique is a new evaluation verbal protocol overcoming the limits found in both the concurrent (Ericsson and Simon 1984; Ericsson and Simon 1987) and the retrospective (Van den Haak and De Jong 2003) evaluation processes among users with visual disabilities. This technique permitted us to identify any usability problems while users were interacting with the interface by means of two evaluation phases: i) the concurrent protocol phase, in which the user verbally explains his or her interaction, and ii) the retrospective protocol phase, in which the user observes and explains his or her recorded interaction performance. After the PCTA evaluation process, the users were asked to complete the SUS survey.

3.2 Experimental results

19 problems, 9 related to visual performance and 11 related to auditory performance were found. The statistical analysis on task completion times for each layout was carried out by SPSS© 18. No significant differences between blind and sighted users or between visual and auditory layouts (Layered layout, $F(1,6) = 4.524$; $p = ns$; Spiral TreeMap layout, $F(1,6) = 0.097$; $p = ns$) were found, except for the Radial layout ($F(1,6) = 13.690$; $p < 0.05$). Furthermore, the analysis of the SUS scores shows no significant differences ($F(1,6) = 0.2729$; $p = ns$) between blind and sighted subjects. These results show similar levels of efficacy, efficiency and satisfaction between sample groups (blind/sighted) and among the two information presentation modalities (visual/sonificated). Therefore a global functional homogeneity between sighted and blind users experience of the WoW search engine has emerged.

4 Conclusions

The way in which information is represented and transmitted by the most common search engines may hinder people with disabilities to access and use indexed data (Federici *et al.* 2008; Federici *et al.* 2010). In particular, people with visual disabilities show problems in accessing all the information content (Jay *et al.* 2007) due to the flat top down visuocentric spatial way in which most of the current web search engines are organised. Furthermore, it is widely recognised that the cognitive representation of spatial information is independent of the way in which sensory data are conveyed. For this reason, designing interfaces which provide alternative sensory modalities of content transmission is a promising way towards user interfaces for all (Stephanidis 2001).

In this work we introduced WhatsOnWeb (WoW), a web search engine representing the web information in a single page through a semantic network of concepts and subconcepts constituting an interactive spatial map. We presented the sonification process of the visual display of WoW carried out by following the ADC sonification model (Zhao, Shneiderman, and Plaisant 2007). Moreover, we analysed the differences between totally blind and sighted users while they interacted with the sonificated display and the visual

display of WoW, respectively. No significant differences between blind and sighted users performance were qualitatively or quantitatively found, thus confirming the functional correspondence between visual and auditory sensory information in spatial representation (Olivetti Belardinelli *et al.* 2009). The fact that its interface is organised through semantic categorizations, WoW is able to facilitate the cognitive information processes which organises human knowledge (Anderson 1993). In this way, WoW should be considered as a *psychotechnology* "emulating, extending, amplifying or modifying the sensory-motor, psychological or cognitive functions of the mind" (Federici 2002; Scherer and Federici in press), able to support and enhance any process involved in the interaction between the user and the interface.

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Automatic Reading of Educational Texts for Vision Impaired Students

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Keywords: education support, vision impaired students, automatic reading of mathematical formulas, text-to-speech

Abstract

The paper presents the current state of the ongoing project "Automatic Reading of Educational Texts for Vision Impaired Students" (ARET). The project aims at an innovation and enhancement of schooling of vision impaired students and also at a facilitation of their self education. The project is solved at the University of West Bohemia (UWB), Department of Cybernetics, in cooperation with The Primary School and the Kindergarten for the vision impaired in Pilsen. Within the project, a specially designed system for automatic reading of educational texts for vision impaired students is developed. Teachers use the system for a preparation, management and administration of educational texts. In order to facilitate the maintenance of the final system, client-server architecture was chosen. The system is based on the Symfony PHP framework. The educational texts are available to students via system's front-end; they are read aloud by means of computer speech synthesis (more specifically, using a text-to-speech engine developed at the UWB). The access to the system is highly configurable; different rights for editors, students and others can be easily set up. With respect to both the purposes of the ongoing project and the main partner (the primary school), the educational texts concentrate on Mathematics and Physics (ISCED 2 level). Hence, the presence of mathematical and physical formulas has to be dealt with, both in the phase of a creation of educational texts and in the phase of automatic reading of the texts. Automatic processing of the formulas, including a transcription of symbolic notations to corresponding word forms and automatic reading of such texts, presents a challenge to the current text-tospeech technology. Despite the current focus on primary-school subjects, the system is capable of reading any texts, including more advanced texts like tertiary level of mathematics, etc.

1 Introduction

The paper presents the current state of the ongoing project "Automatic Reading of Educational Texts for Vision Impaired Students" (ARET, http://aret.zcu.cz). The project aims at an innovation and enhancement of schooling of vision impaired students and also at a facilitation of their self education. The project is solved at the University of West Bohemia (UWB), Department of Cybernetics, in cooperation with the Primary School and the Kindergarten for the vision impaired in Pilsen. Within the project, a specially designed system for automatic reading of educational texts for vision impaired students is being

developed. Teachers use the system for a preparation, management and administration of educational texts. In order to facilitate the maintenance of the final system, client-server architecture was chosen. The system is based on the Symfony PHP framework. The educational texts are available to students via system's front-end; the texts are read aloud by means of computer speech synthesis (more specifically, using a text-tospeech engine developed at the UWB). The access to the system is highly configurable; different rights for editors, students and others can be easily set up. With respect to both the purposes of the ongoing project and the main partner (the primary school), the educational texts concentrate on Mathematics and Physics (ISCED 2 level). Hence, the presence of mathematical and physical formulas has to be dealt with, both in the phase of a creation of educational texts and in the phase of automatic reading of the texts. Automatic processing of the formulas, including a transcription of their symbolic notations to corresponding word forms and automatic reading of resulting texts, presents a challenge to the current text-to-speech technology. Despite the current focus on primary-school subjects, the system is capable of reading any texts, including more advanced texts like tertiary level of mathematics, etc.

The TTS module of the developed system could be viewed as an alternative to a screen reader. Screen reader is a more general software, also based on text-to-speech technology, which can read any text information on a screen (PC monitor, TV etc.). Evidently, any screen reader could be utilized to read the project-specific educational texts displayed on a screen as well. On the other hand, the developed system is a more specialized application tailored to the reading of educational texts related to the ARET project and to the designed web-based application. As Mathematics and Physics are included in the texts, special approaches to the processing of mathematical and physical formulas are developed within the system framework exploiting the extra information about mathematical formulas from the system's backend.

Other similar projects for reading technical documents or mathematical formulas also exists. The problem of reading mathematics has been already solved, e.g. in the system AsTeR (Audio System for Technical Readings) [Raman, 1994] or in the system AudioMath developed at Porto University [Ferreira, 2004]. For the Czech language, the Lambda editor (in which, besides the audio synthesis, the Braille system is also supported) was created at Masaryk university (http://www.teiresias.muni.cz/czbraille8/). Within the presented project ARET, a new system for reading mathematical formulas is being developed.

The paper is organized as follows. In Section 2, the framework of the developed system for automatic reading of educational texts is presented, including both system's backend (an administrative tool for creating and modifying educational texts) and system's frontend (a public web interface for displaying and reading educational texts). The text-to-speech technology used for reading the texts aloud is briefly described in Section 3. Special issues related to the solved project and the text-to-speech technology are depicted in Section 4. Finally, conclusions are drawn in Section 5.

2 System Framework

The developed application uses many various technologies and techniques widely used among web developers and web designers. Several programming languages have been employed during the development of the final application, such as PHP, JavaScript, JQuery (JavaScript library), Java and Python. The final application is running on an open-source HTTP server *Apache* with *MySQL* database system.

The core of the system is based on *Symfony*, an open-source web application framework for PHP projects. The PHP programming language has also been used for developing other essential web services, i.e. for the implementation of text-to-speech (TTS), TEX-to-image and MathML-to-text conversions (all of them will be discussed in the following sections). The other languages has been chosen due to their specific qualities and used for different purposes, such as parsing the HTML document to extract a text for reading (JQuery), providing a tool for creating mathematical formulas (Java applet) and creating scripts for text conversions (Python).

2.1 Symfony framework

The Symfony framework has been chosen because it meets the essential requirements, such us a simple usage, well arranged source files for future development, and a good performance of the system.

Symfony is very easy to install on any configuration, so applications can be developed on OS Windows and also run on UNIX-like systems. It is also compatible with various database systems. It is aimed at building robust applications with full control over the configuration and customization. This makes it easy to import third-party libraries and plugins. Symfony is also equipped with additional tools for testing, debugging and documenting. Moreover, the Symfony project benefits from an active open-source community, where many guides, tools and plugins can be found. The application takes advantage of several plugins to handle tasks typical for web applications. For example user security and permission management (permissions are highly configurable – different rights for editors (teachers), users (students) and others (public visitors) can be easily set up), validating forms etc. For database management, *Doctrine* is used, which is a PHP ORM (Object Relational Mapper) for PHP. One of its key features is the ability to write database queries in an object oriented SQL-dialect called DQL (Doctrine Query Language).

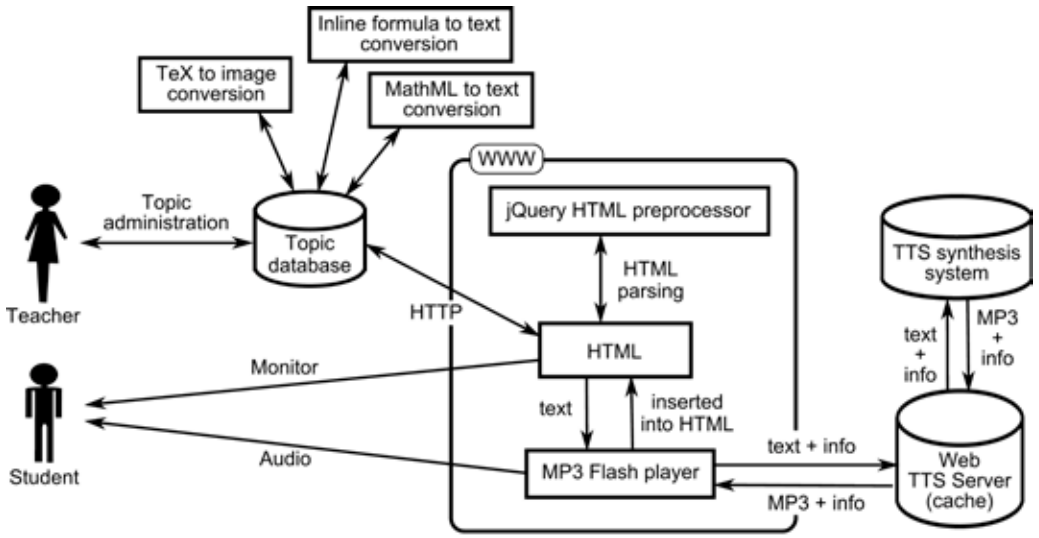
2.2 System architecture

The system is being developed as a web application; therefore it is logically divided into two separate sections: frontend and backend. Frontend serves as a public interface for viewing various educational texts (arranged as lessons, or topics) and, at the same time, reading them. Backend, on the other hand, is an administrative interface, where the lessons can be created or modified. Each of these sections makes use of different parts of the whole system shown in Figure 1.

2.3 Backend

System's backend serves as an administrative tool for creating and modifying topics. The content of a topic is represented by a valid HTML document where all information (in-

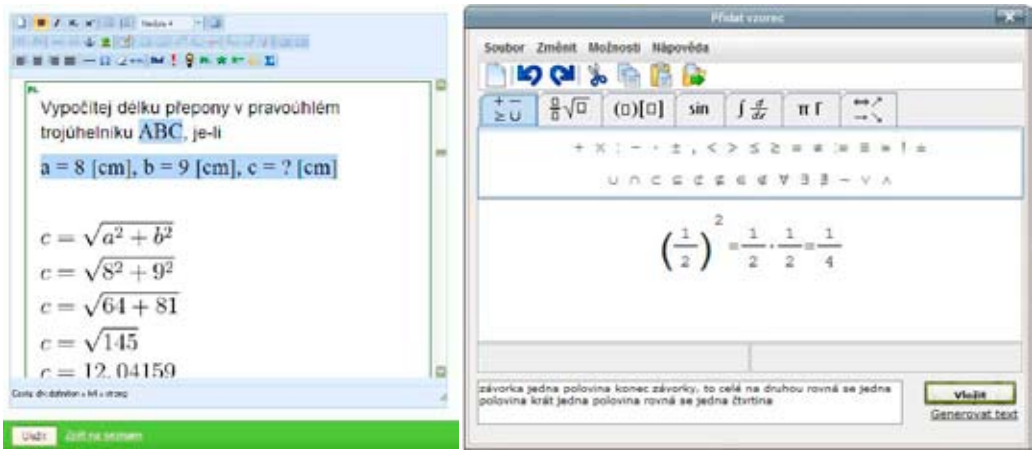
cluding formula transcriptions) needed for reading is stored. All these HTML documents are stored in the main database (Figure 1 – Topic DB). Teachers have a direct access to this database through the text editor (Figure 2 on the left), where they can add or edit the contents. There are some project-specific features added to the text editor for inserting *HTML templates* and formulas. The templates can be used to clarify the meaning of a particular fragment of the document, for example the *Warning* template is for highlighting a crucial information to which the students should pay more attention, or the *Example* template is used to display various examples. Currently, five templates are supported: Definition, Warning, Note, Example, and Solution. As templates help to keep the topic contents well arranged and can enable some extra features in future versions (e.g. template-dependent voices), teachers, the editors of the topics, are encouraged to use the templates.



[Fig. 1] System diagram

Upon finishing the editing and pressing the *Save* button, additional scripts are run to modify the content – adding formula transcriptions or cleaning up the HTML code. There are two different ways for inserting mathematical formulas into the document. The first option uses the *inline formula*, which means marking a part of a text by a SPAN tag assigned with a specific class. This text should represent a simple formula, which can be written in one line of text (for example x + 1). This text is then processed by two scripts for creating a text transcription of the formula for reading and a better formatted notation for viewing.

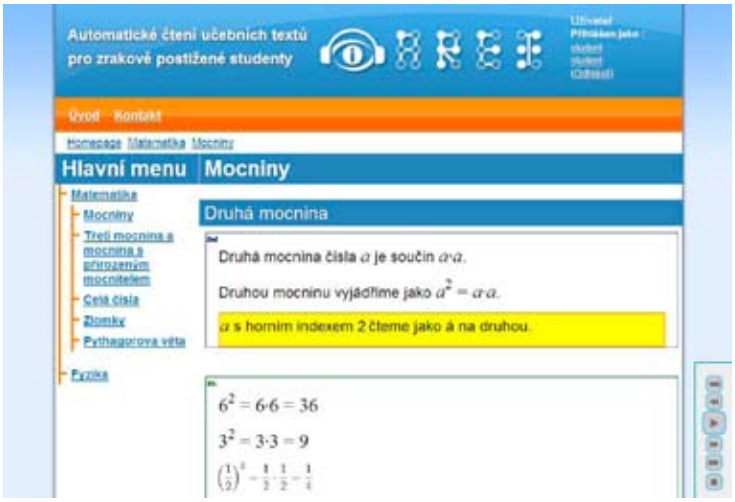
The second option uses the *DragMath* formula editor. This modified Java applet can be used to insert more complex formulas into the document. The applet is able to generate multiple different representations of given formula, for example in MathML or TEX notation. The TEX notation is used to generate an image of the formula and MathML is used for generating the corresponding text for reading. In the HTML code, the formula is then represented by an image with a proper transcription stored in the *alt* attribute.



[Fig. 2] Administration – text editor and formula editor

2.4 Frontend

System's frontend is a public web interface where the topics are displayed and read aloud to the students. Students need to be properly logged in to gain access to published topics. Various topics can be accessed through a menu in the left column of the web page (see Figure 3). Before displaying the web page, the content needs to be adjusted for proper viewing and reading, a proper formatted notation of inline formulas has to be inserted and the document has to be parsed to extract the text for reading. Both of these actions are accomplished using the JQuery library.



[Fig. 3] Web page with TTS – text which is currently being read is highlighted by the yellow colour; MP3 player is in the bottom right corner of the web page

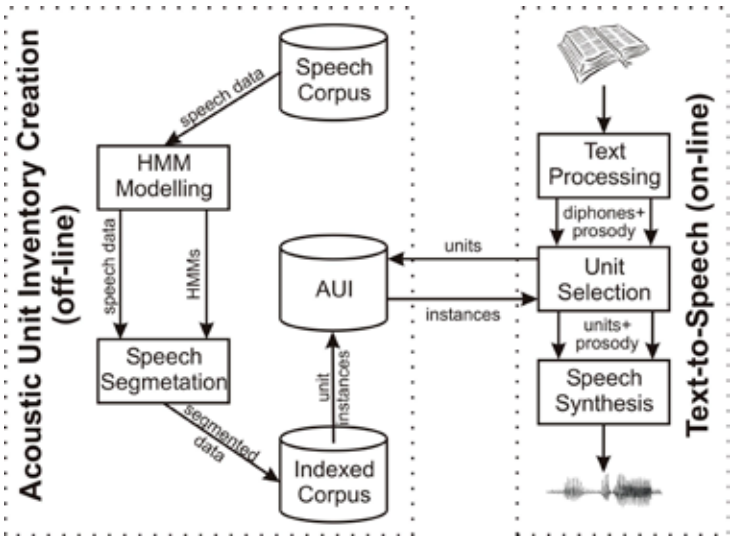
After parsing the document, an array of text segments is created and used as a playlist for MP3 player. In this project, an open-source JavaScript player *JPlayer* is used, which employs Adobe Flash for playing MP3s. This player is inserted into the HTML document

and is displayed on the edge of the web page. It is also possible to control the player by predefined keyboard shortcuts. After creating the playlist, the player starts sending requests to the *Web TTS server*. Server's main function is to store the generated audio files. If the server receives a request for MP3, it tries to look for the proper file or forwards the request further to the TTS generator which generates the appropriate audio file (i.e. an MP3 with speech) from the input text using a text-to-speech technology described further in Section 3. An URL pointing to the file located on the cache server is then returned to the player and thus it can be read to the user.

In the playlist, additional information about the meaning of the text segments is also stored, i.e. which text segment is a part of a paragraph or which is a heading. With these information, the player can either jump to the next or previous paragraph or to the next or previous heading. The text, which is currently being read, is also highlighted. An example can be seen in Figure 3.

3 Text-to-Speech Technology

For the automatic reading of educational texts in system's frontend, text-to-speech (TTS) technology was utilized. The task of a TTS system is to convert an arbitrary input plain text to the corresponding speech. In our case, a Czech text-to-speech (TTS) system ARTIC (Artificial Talker in Czech) [Matoušek, 2006] developed at the Department of Cybernetics, Faculty of Applied Sciences, University of West Bohemia in cooperation with a firm SpeechTech was adapted.



[Fig. 4] A schematic view of the ARTIC TTS system

ARTIC applies a corpus-based concatenative speech synthesis method. Based on a carefully designed speech corpus (a collection of a large number of utterances annotated on orthographic, phonetic and prosodic levels), statistical approach (employing hidden Markov models, HMMs) was employed to perform an automatic phonetic segmentation of the source speech corpus into phones. Based on this segmentation, boundaries

between diphones, the basic speech units used in the ARTIC system, were located. As a result, acoustic unit inventory (AUI), the source speech corpus indexed with diphones and prosodic structures, was built. Beside speech waveforms, glottal signals were also recorded using an electroglottograph and used as input signals to glottal pulses (pitch-marks) detection algorithm. Pitch-marks are used as consistent concatenation points during speech synthesis.

During runtime speech synthesis, phonetic and prosodic aspects of an input text are estimated first. Ideally, input text is a subject of a thorough analysis and processing. Due to a complexity of such a task, current text processing in the ARTIC system is somewhat simplified to four main steps:

- text normalization of "non-standard" words (digits, abbreviations, acronyms, etc.) – see Section 4.2 for text normalization in the ARET project;
- detailed rule-based phonetic transcription, including pronunciation dictionary of "exceptional" words (mostly foreign words);
- phones-to-diphones conversion;
- prosodic description in terms of prosodic symbols (prosodic clauses, phrases, prosodemes, etc.) using prosodic phrase grammar [Romportl, 2008].

Within the scope of our project, mathematical and physical formulas are treated specially and described with the inline formulas or MathML codes. Such specially marked formulas could be then processed and converted to words (see Section 4.1).

Prosodic analysis includes punctuation-driven sentence clause detection, rule-based word stress detection and symbolic prosodic description [Romportl, 2008]. Symbolic features based on a prosodic phrase grammar, like prosodic sentence, prosodic clause, prosodic phrase, prosodic word, and prosodeme, were used to describe prosodic characteristics and to express prosodic structure of to-be-synthesized texts.

The resulting speech is generated by a *unit-selection* algorithm. Its principle is to smoothly concatenate (according to *join cost*) speech segments (diphones in our case), extracted from natural utterances using the automatically segmented boundaries, from large speech unit inventories according to phonetic and prosodic criteria (target cost) imposed by the synthesized utterance. As there are usually many instances of each speech segment, there is a need to select the optimal (with respect to both target and join costs) instances dynamically during synthesis run-time (using a unit selection technique). To calculate the *target cost*, a prosodic structure of the to-be-synthesized utterance is estimated, and a comparison between prosodic symbolic features (plus some positional features, like position of a diphone in a prosodic word, and contextual factors like immediate left and right phone) in the utterance and in the unit inventory is carried out. Join cost is evaluated as a distance between spectral features and pitch around the concatenation point of two potentially neighbouring speech units. After selecting the optimal sequence of (diphone) speech segments, neither prosodic nor spectral modifications are made in the ARTIC system except for simple smoothing at concatenation points. To cope with high CPU power and memory cost typical for unit-selection systems, a computational optimization was carried out as described in [Tihelka, 2010]. A schematic view of the ARTIC TTS system is shown in Figure 4. More details about text-to-speech synthesis can be found e.g. in [Psutka, 2006].

4 Project-Specific Issues

Text processing is an important part of a TTS system. Generally, text processing in a TTS system depends on the type of texts that are likely to appear at the input of the system. In the ARET project, educational texts (currently the texts of Mathematics and Physics at ISCED 2 level) are expected as an input of the TTS system. In this section, text processing issues related to the ARET project are described.

4.1 Automatic Reading of Formulas

Reading of mathematical formulas in the Czech language is a very complex task. Especially if the problem is supposed to be solved generally, i.e. there is no limitation for the complexity of the equation structure. Indeed, any final system will be naturally limited by the definition of expected mathematical operations, types of operands, etc. However, the system should be simply extensible by additional definition of reading rules, e.g. for new operators.

As mentioned in Section 2, two different representation of mathematical formulas are employed in our system. Simple formulas with a linear structure can be written and stored as a simple text. For the creation of more complex mathematical expressions, the special editor DragMath is employed and their structure is represented by using an MathML format. In both cases, thanks to a special syntax or marking of the formulas in the HTML code, no detection of formulas is needed.

The problem of reading formulas can be divided into several steps:

- transcription of a formula to its corresponding word form
  - hierarchical decomposition of a MathML code or text representing the formula
  - selecting suitable transcription rules for particular operations
  - applying the selected rules (including inflection of particular operands)
- text-to-speech synthesis
  - after transcribing formulas to their corresponding word forms, the formulas are handled as any other text, and, as such, they are sent at the input of a TTS system (or, a web TTS server, respectively)

For each mathematical operation, several transcription rules can be defined. They differ by their activation conditions, i.e. in various mathematical contexts, for various values or types of operands, different transcription rules can be selected. For most operators, one basic rule and several additional rules for exceptional cases are defined.

Each transcription rule contains a text template for the resulting expression together with the corresponding grammatical form for each operand (case, number, gender, cardinal or ordinal form etc.)

A simple example of one transcription rule for power operator (in YAML notation; YAML is a recursive acronym for "YAML Ain't Markup Language"):

```
POWER:
– condition: { operand_2_type: [ number, variable ] }
  operands :
```

– { type: cardinal, case: 1, number: S, gender: F }
– { type: ordinal, case: 4, number: S, gender : F }
template: '{ operand_ 1 } na { operand_2 }'
expr_type: expression

It is quite easy to define a new set of transcription rules or extend an existing one with rules for new mathematical operations or with additional rules for some rare linguistic exceptions. The conversion of formulas to text is shown in Figure 1 in blocks "Inline formula to text conversion" and "MathML to text conversion".

4.2 Text Processing

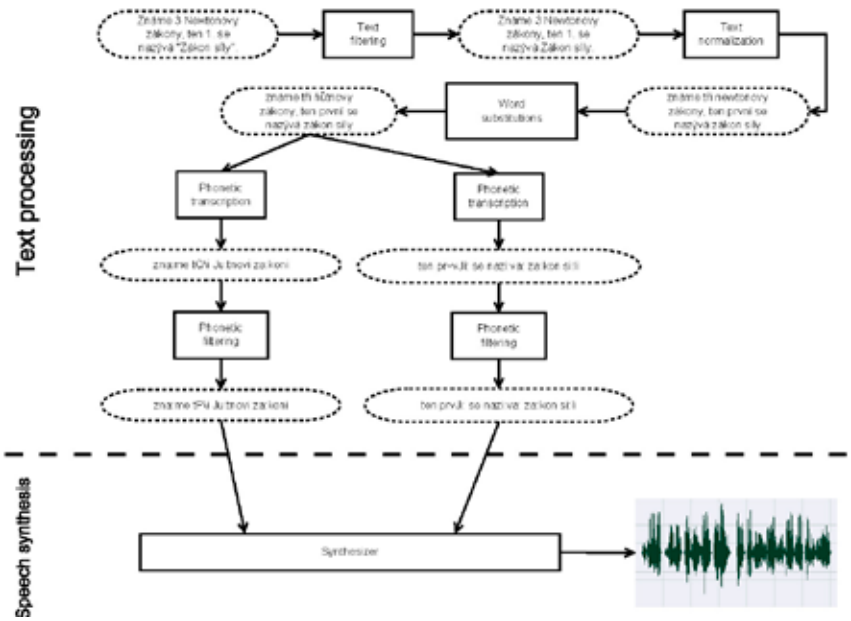
In Section 4.1, the processing of specially marked formulas was described. In this section, analysis and processing of all input texts (i.e. the contents of web pages with topic-arranged educational texts) are briefly described. The whole process of text processing consists of several steps shown in Figure 5 and further described in the following subsections.

4.2.1 Text Filtering

Since the texts are coming from HTML web pages, some unwanted "garbage" characters present in the HTML codes can occur. These characters have to be removed or replaced before further processing. The list of garbage characters includes but is not limited to HTML tags, HTML entity characters, quotation marks, etc.

4.2.2 Text Normalization

Normalization is a process of converting "non-standard" words (digits, abbreviations, acronyms, etc.) to their extended and grammatically correct forms.



[Fig. 5] A block diagram of text processing within the ARET project (the upper part)

At first, the non-standard words have to be detected in the input text. So far, we are able to detect all numbers, most of symbols for physical units and currencies and also some abbreviations that are used in a common text.

The next step is to determine the grammatically correct form of the detected words. This is one of the most difficult tasks for the Czech language, since Czech is very flexible and a single word can have many various forms. The form of a particular word in a particular sentence depends on the syntax and the meaning of the entire sentence. Thus, an exact determination of the correct form is not possible without an extensive semantic and syntactic analysis. Therefore, an estimator is supposed to be used for this purpose. At present, we are using TnT tagger, a very efficient statistical part-of-speech tagger that has been trained on a large Czech corpus already tagged by morphological tags beforehand. However, this tagger still works with some errors and this process needs to be improved.

4.2.3 Word Substitutions

Words that cannot be transcribed using standard Czech phonetic transcription rules have to be processed in some other way. For this purpose, we use "dictionary-like" system in which a single word can be replaced with a corresponding "phonetic-friendly" transcription of the word (or even with a sequence of phonetic-friendly transcriptions). This is useful for foreign words, names, proper nouns or abbreviations that are not caught during the preceeding normalization process. This dictionary can be easily modified, so adding new exceptions is very simple. Support for inserting new substitutions was also incorporated to system's backend where an editor of a topic can mark a word as a "pronunciation exception" and, using a special tag "Read-as", can write the proper pronunciation of the word.

4.2.4 Phonetic Transcription

The transcription is a process in which an input text in an orthographic form is transformed into a form represented by phones. As mentioned in Section 3, this process in our system is rule-based since the conversion is almost always unambiguous in the Czech language. The pronunciation exceptions (foreign words, etc.) are handled as described in Section 4.2.3.

4.2.5 Phonetic Filtering

The transcribed text can contain some characters that are not supported by the speech synthesis engine. Therefore, a final replacement of these characters is needed. At present, all unsupported characters are omitted.

5 Conclusion and Future Work

In the paper, the current state of the ongoing project "Automatic Reading of Educational Texts for Vision Impaired Students" (ARET, http://aret.zcu.cz) was presented. Since the project is solved at the University of West Bohemia together with the Primary School and the Kindergarten for the vision impaired in Pilsen, it currently focuses on primary-school students of Mathematics and Physics (ISCED 2 level). Nevertheless, the system

framework has been designed to be general and flexible enough to cover other kinds of educational texts (or topics), including more advanced texts like tertiary level of mathematics, etc.

Although the ARET project is still being worked on, the first educational texts are already available on http://ucebnice.zcu.cz. There are some sample topics available to public, other topics are available to the students of the partner primary school upon logging in.

Future work will be focused on three main areas:

- Topics. The number of topics will be continuously increasing in order to cover the intended goal of the ARET project (subjects of Mathematics and Physics at ISCED 2 level).
- System functionality. System functionality (both the backend and the frontend) is also planned to be enhanced. For instance, automatic reading errors caused by the TTS system will be corrected, other rules for reading formulas will be added, etc. We also plan to personalize the system for each user by allowing him/her to change the layout of web pages with topics (e.g. colours of fonts, templates, etc.) or to change the voice used for reading.
- Compatibility with other tools for the vision impaired. We will also try, in cooperation with the partner primary school, to make the developed system more compatible with other tools and systems that vision impaired use. For instance, we will optimize keyboard shortcuts. Moreover, problems with undesirable concurrent reading of educational texts by the embedded TTS system and by a screen reader a student is used to utilize for reading other information will be solved.

6 Acknowledgements

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Possible Uses of a Multi-User Virtual Environment in the Education of Persons with Special Needs

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Abstract

The paper focuses on the issue of a multi-user virtual environment (MUVE) and its role in the contemporary educational process. It analyzes possible uses of MUVE in the education of persons with special needs and describes experiences with the use of a 3D multi-user virtual environment Second Life which was utilized in the teaching of the subject New Media and Cyberculture at the Philosophical Faculty of Palacký University in Olomouc.

Creation of information takes place in such a large extent that they may actually create a virtual reality, which enters into their consciousness. One such limit exists on virtual reality and the natural world. (Gabriela Obstová)

1 Introduction

According to statistics, approximately every tenth citizen of the Czech Republic suffers from some type of disability (Chvátalová, 2010). Recently, the great opportunity for an elimination of the mitigation of impairments which can lead to real life constraints in specific situations, offer information and communication technologies (ICT). Currently, compensation devices are on the high level, even blind people can now send e-mails, chat or download information. There are many examples of possible uses of ICT for people with special needs – people with hearing disabilities can use the portal services such as Helpnet.cz which is project coordinator for the Czech Union of the Deaf. Another possibility is the transcription of speech. In cooperation with The Czech Union of the Deaf was established mediation centre of simultaneous transcript (http://www.prepis.cz). The opposite option is to convert written text into speech – e.g. http://www.oddcast.com/home/demos/tts/tts_example.php?sitepal (also available in Czech). The portal http://www.prace.cz offers some services for people with disabilities, as the portal is divided into two units; one is designed for people with disabilities. The fact that interest of Czech scientists to look at the use of ICT for people with special needs is currently growing also reveals a number of research projects that were implemented in the Czech Republic in the last decade. Examples of such projects are *Communication with the database information systems for disabled and handicapped people on the basis of natural language* (project GACR, project leader prof. Ing. Pavel Slavik, CSc.), *Adaptive navigation of blind user in a virtual environment* (Higher Education Development Fund Project, Project Manager, Ing. Vladislav Nemec), *Acoustic presentation of scenes for virtual navigation in real environments using visual reality for visually impaired users* (University Development Fund Project, Project Manager Ing. Adam Sporka), *Inter-*

action of visually impaired users in virtual environment enhanced by surrounding sound (CTU project, leading Project Ing. Vladislav Nemec), *Interactive creation and viewing graphical information by visually impaired users* (CTU project, project manager Ing. Zdenek Míkovec), *Graphic communication with blind users* (University Development Fund project, the project leader prof. Ing. Pavel Slavik, CSc.) etc.

The above named projects implies a similar direction, which is now moving in the field of ICT in common communication situations, i.e. a shift from traditional 2D to 3D virtual worlds are starting to show even the world of people with special needs.

2 A Virtual Reality

As ICT is improving and communication through real-time is easier than it used to be, the users' interest to maximize the approach to network to real world is increasing. Therefore, at present experience in the field of increase of social networks, the communicators enabling instant sharing (Twitter, etc.), communicators enabling video streaming (Skype, ICQ etc.), portals offering information in multimedia form (television sites such as iBroadcasting of Czech Television, the BBC and others), portals offering information based on sharing video (YouTube, Google Videos, etc.) and finally also multi-user virtual environment (Active Worlds, Second Life, etc.).

Virtual Reality (VR) represents everything that really exists, but it is a form of simulated electronic media. This is the user interface designed to be as much as possible closer to reality computing environment, as captured by our senses (American Books, 1995). Current applications are able to incorporate all senses into the user environment wit,h not just sight, hearing or touch but also smell and taste (Vrtiška, 2009). To simulate the visual stimulus is a spatial three-dimensional (stereoscopic) image. Special glasses are used to view (like in 3D cinemas or on TV 3D) or stereoscopic displays (one for each eye or a miniature LCD screen) built into helmets. In fact, special optics for the widest field of view reaches about 120 degrees from 180 degrees (American Books, 1995). In the helmet is also included computer sensor transmitting information about the position of the head and eyes, changing their position in the computer in real time, generating a new image and displaying it on screen. For the sound simulation an independent stereo audio source to each ear is built into the helmets. For the perception of touch a special data suit is used (usually a data glove), which both informs the computer of user's movement in VR and provides the user with feedback in the form of tactile and force information about the properties of space. For the perception of smell sensations are integrated tube into the nose into the helmet, through which the user receives smell information. According to Vrtiška (Vrtiška, 2009), the latest technology is able to make people feel "as if they had something in their mouth." These experiments are still in a research stage.

VR is currently in practice often used as a simulator of realistic situations such as driving a car, an aircraft, spacecraft, practicing emergency situations, accidents, medical procedures, etc. In this architecture are possibilities of three-dimensional models, the design in three dimensions, such as CAD (Computer Aided Design). Another possibility is virtual travelling (e.g., a GPS (Global Positioning System), Google Earth, etc.). In medicine is used to simulate medical procedures, the modelling body organs or in certain diseases cure. E.g. for people with impaired spatial orientation (especially elderly and people with

Alzheimer's disease) were used cognitive maps of virtual environments on the basis of which were studied usied navigation routes. (Vlcek, 2008).

Currently, there are several degrees VR. B. Brdicka (American Books, 1995) characterize them as follows:

1. **passive applications** – they work like a classic movie. You can see and hear this environment, but you can not influence it in any way. Example may be stereoscopic (3D) film.
2. **active applications** – you can see, hear in this environment and it is also possible to move freely and explore it from all sides. But you can not modify it in any way. It is unable to move objects and manipulate them. Example may be simulations in aircraft simulators.
3. **interactive applications** – an environment that has all the characteristics of active applications, plus you can also modify the environment. It is possible to take virtual objects in your hand, move them to work with virtual instruments etc. Example can be a virtual training operation which the surgeon may repetadly do on the model of an organ.

2.1 Virtual Reality and Education

Virtual learning is a teaching in an educational environment where teacher and student are separated in time or space (or both) and the teacher provides course content through control applications, multimedia resources, Internet, video conferencing, etc. Transferring this method of communication in 3D virtual worlds is still an innovation in teaching and learning, which, however, still offers many opportunities which was not fully recovered until now. If students spend their free time in a virtual environment the use of traditional teaching methods usually become less motivating for them. Using of Virtual Worlds can give the teachers the opportunity to gain a greater involvement of students as learners who are not only put into the role of passive recipient of information transmitted – a virtual world offers many options for creative collaborative work that could be limited in the real world in classes such as borders, or the number of participants who can work at the moment.

The advantages of virtual learning include time and spatial flexibility, the ability to dynamically grow and adapt the needs of users, possibility of feedback, work on tasks that are not often possible in the real world due to constraints of time or space. Virtual worlds allow cooperation which is not limited by boundaries of physical space, significant strengths include the vast majority of cases, low costs and easily upgradeable teaching materials. The disadvantages can be categorized mainly into health reasons, as the current generation of student spends too much time on ICT, which has a negative impact on both eyes and on the human musculoskeletal system. Frequently repeated arguments are also sense of alienation, because human beings do not communicate directly (face to face), but by machines which can have an impact on social skills. The virtual communication is also losing body language and other personal aspects.

One of the first projects using VR for teaching was one of the virtual worlds Whyville which formed the base of 3 million members. Gradually, a growing number of universities and other educational institutions began to expand their offerings into the possibil-

ity of learning in a virtual environment where the student moves by the avatar. Virtual universities are global in nature, the study offered outside their geographical area prevails distance education for students with disabilities, language barriers or students with limited time and space. Currently, there are several hundred universities around the virtual world; the oldest include the Clyde Virtual University of Glasgow (Scotland). The most common type of learning in virtual worlds is the language of instruction. Many universities, language institutes and private language schools use the 3D virtual environment to support the teaching of languages. Virtual worlds are now also used in the business environment for staff training and have a significant status for them.

2.2 Multi-User Virtual Environment

Multi-user virtual environment (Multi-User Virtual Environment, Muve) is defined as 2D or 3D virtual environment representing a simulation of real space (American Books, 1999). It represents the integration of the previously used forms of online communication and becomes the medium through which it is possible to create social interaction and very close communication in real space. According to D. Riha efficiency of communication increases when the characteristics of the media is in accordance with the communication process – that is, the immediacy of feedback, variability of symbols (number of possible ways of communication), testability (make adjustments before shipment), replicability and others. (Riha, 2006). In such collaborative hypermedia environment as MUVE, most of the above named aspects meet – these are object-oriented systems, where communication takes place in real time, such as through an audio or video conference or in direct interaction via its 3D graphical representations (avatars). Unlike previous types of communication (e-mail, text or video), which are mostly used for isolated communication, communication in all these types of MUVE integrates and enhances the effect of online communication. User moving in MUVE can monitor communications of individual participants; can move to a specific participant in time, the work of which would be much complicated in the real environment. MUVE facilitate mutual cooperation, it helps work on joint projects to physically remote users whose cooperation would be difficult and expensive in the real world. Unlike an online education support, which represent the learning management systems, websites or blogs, MUVE allows students to simulate real situations where they can learn for example to work with objects and demonstrate just mastered the material the virtual space, they can participate in activities and processes that would not be available for them in the real space (e.g., formation of molecular structures of the airplane, etc.).

Since its creation, MUVE appeared in different visual forms – from a purely textual form to today's multimedia 3D virtual reality. Well known projects include The Active Worlds (http://www.activeworlds.com), TappedIn (Teacher Professional Development Institute), Inter Space (http://www.ntts.com/interspace/) etc. Projects like Whyville.net or text environment Moose Crossing, The Palace (http://www.thepalace.com) are focused on children.

2.3 Second Life

The largest and currently most famous project is the 3D virtual world Second Life (SL) (http://www.secondlife.com). Currently, there are registered more than 17 million users

and it can make money exchangeable for real currency (SL, 2008). Users can communicate in real time via avatars, they can build their own environment, can be educated, entertained, do shopping (open daily, users will spend more than 30 million CZK) etc. SL is a "new dimension" of social interaction. Users create the SL community based on common interests or language basis. Czech community in SL has created several Czech locations, the most famous, largest and the most organized is Czechoslovakian town named Bohemia, which has a city council, holds regular events in the SL and Czech users are regularly informed about events on the portal http://www.secondlife.cz. Also, some institutions in the Republic have purchased virtual land in SL, allowing them to present their activities, make contacts and start to try innovative ways of doing business (eg IBM's Czech Republic, Czech Radio, Police, Raiffeisen Bank, O2, etc.).

2.3.1 Education in Second Life

Education is very progressive area in SL. Meeting people from all over the world, different nationalities and social status allows the creation an entirely new type of community and sharing knowledge and experience is easier than in real space. Many universities have discovered the way which SL provides to them here and create virtual campuses, presentation rooms and organize training courses. We can find here virtual versions of more than 60 American universities, such as Oakland University, Ohio University, the University of Plymouth, Coventry University, Montana State University, the University of Tennessee, Ball State University, Missouri State University, Bradley University, but also e.g. Harvard University Law School (on-line credit courses are attended by students from China, South Korea and other countries). Some faculties of Czech universities have already presented themselves in the Czech virtual environment in SL (in the Czechoslovakian town Bohemia) – Faculty of Economics and Public University of Economics in Prague. Faculty of Education University of West Bohemia, Faculty of Social Studies Masaryk University in Brno and the Philosophical Faculty of Palacky University in Olomouc.

[Fig. 1] A virtual classroom in Second Life

Teaching in MUVE is provided in virtual schools which are equipped as classrooms (some of which are in buildings, some in open space or under sea level). Students in schools can move like the real world – they can come into school, browse the classes, go to the library, sit at a table, etc. Teachers can build special class facilities according to the needs of their subjects. Teacher in the classes may occur in the form of avatar and by this communicate with their students. Communications may take the form of text or audio or video in its actual form. Students in this class can be directly given the educational materials and related links. Students can practice the material on particular objects they can work with and cooperate with each other to create these objects according to instruction of teachers. The teacher might have the board available in the classroom which can work just like a real board – it is possible to write notes on it, delete and that can be read by any user.

[Fig. 2] Working with tables in Second Life

During the courses in MUVE it is possible to make a video – this feature is useful for the preparation of lectures and training. Teacher may return to them later. Students can also create objects (devices, objects of their own imagination, teaching aids, animals, etc.) and thinking about their descriptions.

[Fig. 3] Working with educational objects in Second Life.

The SL you may pass through a virtual environment simulating different periods of time – such as the ancient world, Shakespeare's time, you can see replicas of real places (Globe

Theatre, the Sistine Chapel, etc.) can participate in discussions with authors and attend the concert bands, while operating in the real world. Students can place in MUVE their own literary works and respond to works of others. They have the opportunity to visit the electronic library, lectures, a leading industry expert (without having to travel anywhere) and the ability to find the desired person, lecture, building or an area where it is possible to instantly teleport themselves (which makes work with finding information easier in comparison with the search in the environment of traditional portals and search engines.). Students can solve their tasks together with their classmates or work on a project with classmates from school which is randomly distant.

[Fig. 4] Sample teaching in Second Life

The possibilities of virtual connection independent of physical space open up new opportunities, particularly language teaching, either in the form of teaching in the virtual environment of individual schools or individual commercial and private courses. Courses can be organized by different institutions in SL and find by client (Search) who selects Events. Client use the teleporter to pass to the required course. A number of language courses in SL is free but there can be found also projects focused on professional language teaching, such as LanguageLab (LL). Teachers of LL are native speakers from Great Britain and the U.S., certified instructors, who also teach English in real life. Classes take place in the language lab, where it is necessary to have fast Internet connection and high-quality headset for voice communication.

Teaching in Second Life brings the user a positive effect because – instead of a text environment (enriched with multimedia) of the conventional e-learning environment – it takes place in areas that are familiar to users from the real world – teaching can take place in traditional classrooms with the usage of a blackboard, but can be enriched with such methods of teaching that are not feasible in real life, whether for financial or time reasons. An example is the coactions of two schools from different countries (Italy and Netherlands), which cooperated in the SL synchronously and asynchronously on the project Euroland (Holubcova et al., 2010). Virtual world can also be used with a virtual learning environment, as in the case of Sloodle project, which aim is to interconnect the Second Life and the Moodle Learning Management System.

2.3.2 An example of practice – our experience with teaching in Second Life

The virtual world of SL is used in the seminars of new media and cyberculture, which is implemented as an optional subject in the field of media studies on the Department of Journalism at the Faculty of Arts and at the Faculty of Education, both belonging to the Palacky University. Teaching in this environment is also the part of the course on media education, which is determined for teachers of primary and secondary schools and which was created within the ESF Courses ICT in teaching teachers, registration number: CZ.1.07/1.3.00/14.0011, project coordinator is PhDr. Hana Marešová, Ph.D.).

Work in SL is a part of practical exercises in virtual reality theme. The aim is to show the students the MUVE environment, teach them how to move in this environment and to explore the possibilities that this area offers for further education. Students were acquainted with the issue of MUVE through the electronic presentation. Access to the SL was created on each computer in the computer lab. Students created a unique approach to SL, then their avatars and met in SL at the square of the Czech town named Bohemia. After that they were asked to search and teleport into the virtual classroom of Palacky University in Olomouc:

[Fig. 5] Building Palacky Olomouc in SL

For helping students to move in virtual reality through avatars, they were asked to fulfil a few simple tasks focused on orientation in virtual environments (e.g. finding well-known buildings – such as the Villa Tugendhat, the IBM booth, home of some well-known foreign universities etc.). To get accustomed to communication through the avatars, they were tasked to communicate together – such as to seize and hold their hands, to create a circle on the field before the classroom, to circulate in the roundel, to try walking, running and flying in cyberspace. Only after mastering of the basic training, they were asked to solve the tasks related to teaching itself – for example, to the W. Shakespeare theme, they were asked to find a replica of the Globe Theatre (where his plays were performed) in the SL in the shortest possible time, to get on the podium of the theatre and try to interpret the passage of his stage works. For solving this kind of tasks, it was necessary to work with the other online resources – in the case of lack of knowledge about the topic;

they had to learn the necessary information first to be able to reach the target. From the reactions of students, it was clear that "living" in a virtual world (the possibility of non-traditional meeting with classmates and teachers, and creative cooperation on the unusual tasks) was a new experience for them in the learning process. Thanks to the good skills in working with computers and previous experience of playing computer games, most of them were early successful in these tasks, which represented a significant aspect of the motivation for further learning. According to the fact that we concentrated only on the teaching of the theme in SL and there was no systematic long-term online learning, we cannot assess the effect of long-term systematic studies in the MUVE at this stage. In the future, we are planning to convert a part of our online education from the traditional Learning Management Systems (Unifor, Moodle) to SL.

3 Possibilities of MUVE use in the education of people with special needs

The above learning opportunities in the MUVE are fully applicable to people with special needs because the movement in a virtual environment effectively adjusts most of the physical disabilities (including any kind of mobility disability because there are appearing first technologies nowadays that allow controlling the computer through thoughts (Jahoda, 2009)). ICTs are seen by these individuals as a positive aid. Virtual learning is beneficial for students with disabilities because it forms more equal conditions than teaching face-to-face. Virtual worlds allow users with special needs having access to teaching and learning materials directly from home. It can help them to keep abreast of relevant information and also a sense of belonging to common study groups where it would be more difficult to implement in the real environment. Opportunity to participate in the virtual world through the presentation from home or the workplace offers these users a comfortable environment. The flexibility of virtual worlds significantly improves their opportunities for education and business cooperation.

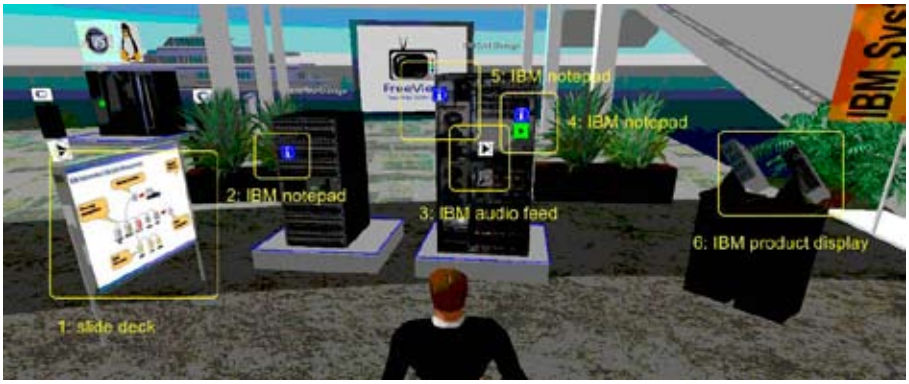
SL environment can be one of the convenient options for the education of people with various forms of disability – such as people with lower levels of visual perception, who can use voice chat, while the deaf can enjoy classical chatting, people with disabilities may move (walk, run, fly) in the SL through their avatars equally with other colleagues, and do so at the level of a given social group without the feelings of differences. Creating social communities in these environments can stay free from traditional prejudices encountered in real life. Apart from the training, it is possible to use SL as an information platform for communities of people with special needs, for conferences and lectures.

There has already appeared the first group of projects for people with special needs in SL. IBM has launched a project called AIRA (Accessible Rich Internet Application), which is based on the possibility to add information and labels to objects in SL that can be interpreted by the screen reader to the blind user.

Another example is a tool for the blind users created by L. Later. This is reader which can convert Braille into text in the SL. This tool is said to be used in conjunction with the Czech SL product EVA, bi-directional converter between text and voice chat (Iceberg, 2008).

Various communities focused on people with different medical diagnoses (multiple sclerosis, autism, cancer, etc.) can be found in SL, example is AVESS (Amputee Support

Virtual Environment Space) environment for amputees. The project aims at providing peer-to-peer support services for amputees and their families. This environment can help them to reintegrate into the society and improve their physical and mental health.



[Fig. 6] Projects in Second Life IBM

One of the most important projects in SL is currently the Virtual Ability Island (Island of virtual capacity), aimed at people with different disabilities. It is possible to find here e.g. Cape Able – a place for deaf, hard of hearing and people with disabilities. There are available art galleries that exhibit the works of deaf and disabled artists. In addition, there is the first café for the deaf, who can regularly meet here. Cape Able also offers a service centre, provides links to sources of support in the SL and in real life, provides transcription services from voice to written presentations and vice versa. To support the education, Virtual Ability offers lectures and presentations, discussions and short activities.

Other centres include The Accessibility Centre – a public museum in the HealthInfo Island. One of the objectives of the business is to create awareness about the second life of people with various disabilities. Four floors of the centre are focused on different aspects of accessibility (vision, hearing, mobility and learning disabilities). One floor offers information on supportive groups for people with disabilities in the SL.

[Fig. 7] Projects the Virtual Ability Island

[Fig. 8] Virtual Gallery on Virtual Ability Island

4 Conclusion

With further improvement of MUVE, other options that enable successful usage of the rapidly developing "worlds" for education, or at least that from time to time enrich the teaching process, will be certainly added. The boundaries of what is possible for educational use are not in technology but in the imagination of the teacher, who decided to take advantage of the virtual world to train students to be adequately prepared for life in the information society. Virtual world can allow people with special needs an easier perception of reality, especially in the interpersonal communication. In the virtual world, these people may choose any form that is usually not limited. But they should not forget that in real life, there are now many good possibilities of how to be included in the society despite of a certain handicap and therefore the virtual world should become for them only one option but not a fundamental communication tool which is drifting them away from the real world.

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"Guidelined" and "Principled" Web Content Accessibility – What It Means in Practice of Universities

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Keywords: e-learning, accessibility, blind, visually impaired, deaf, hearing impaired

Abstract

This paper reflects the most inflected web content accessibility standards (primarily WCAG 2.0) in the practise of environment of tertiary education. The paper contrasts universality of accessibility guidelines and principles to the state-of-art of educational environment experiencing large variety of types of educational study materials, its structures, forms, complexity and variety of technical settings for publishing and distributing them. Moreover, the current tendency of educational environment that study materials no longer dominate in printed form published with standard procedures and manners but they are electronically issued and distributed to students, paradoxically does not cause immediately higher accessibility of documents for students with disabilities. These problematic aspects of digital content of educational environment are analyzed, and demonstrated on real examples emerged in practise of Masaryk University. The last part of the paper presents particular and practical means of non-trivial interventions/accommodations realized by Masaryk University to make study materials and environment more accessible which we can generally consider as applying the general web content accessibility guidelines.

1 E-learning and Printed Materials

The subject of the Masaryk University Rector's directive No. 3/2002 *Accessibility of Masaryk University Publications to Persons with Special Sensory Needs* is the provision of accessibility of all works published by the university for persons with special sensory needs, such as with visual impairment precluding a common perception of published information and hearing impairment hindering understanding of this information. The directive assigns to the Support Centre for Students with Special Needs a task to store a copy of all publications by Masaryk University in a format accessible to persons with sensory impairment in a nationally accessible digital library. Although the actual number of the provided digital copies of works (currently 271) is lower than the total number of titles published by Masaryk University, the tool offers a solid basis of digital resources for work with study materials in an accessible form.

Within the six years that have passed since the issue of the Directive, a substantial change has taken place: in the educational context, printed materials seize to be understood as a published work, while digital materials begin to be viewed as such as a rule. We can observe in practice that although the form of a material is digital, the level of its accessibility for persons with specific sensory needs is lower for the following, most substantial reasons:

- the number of distributed study materials is not limited (the digital world has almost no physical quantitative limits)

- there are too many technical formats in use
- authors have a lesser tendency to correct and edit their writings (works printed in the official way undergo editorial procedures)
- the direct distribution of documents between their author (a teacher) and a student has limited the possibility to control their accessibility
- materials are distributed via an e-learning application

We have reacted to this situation and, besides other things we have prepared and published guidelines[1] for the public, especially for teachers and creators of e-learning courses, which are not conceived as a complex manual for the creation of perfectly accessible courses but which sum up the basic rules and information that should primarily prevent unintentional appearance of barriers in digital materials and courses.

2 Definition of E-learning

In the following text, we deal with e-learning in the widest sense and possible application, i.e. as an application or a group of applications using digital tools for teaching purposes. Primarily, this means:

- the distribution of teaching materials as such in any technical format
- interactive teaching tools (tests, evaluation, means of communication between teachers and students, study administration)
- interconnectedness of the above

We will, however, limit ourselves from the technical point of view to teaching applications designed in the **world wide web** environment, which is statistically most common and which can be viewed in the following structure:

- basic web based environment of the e-learning application (usually based on HTML or a related technology)
- content of courses (materials) in HTML and related formats
- content of courses in other formats (audio, graphics, video, interactive objects)

3 General Principles of Accessibility

It is possible to say in general that principles providing disabled persons with the highest possible level of accessibility of an e-learning course even at the moment of its creation are to a large extent identical with general requirements:

- exact and clear course structure corresponding with clearly defined educative aims
- clear and correct use of language which is complicated to an extent corresponding with the educative aim (not more complicated than necessary for the given aim)
- correct technical treatment, i.e. in correspondence with valid source code norms

4 Specific Principles of Accessibility

As the title of this paper suggests, the main target groups of students considered in relation to accessibility of e-learning are students with **visual and hearing impairment**. This

orientation is a result of our experiences that the issue of accessibility of (digital) study materials is the least trivial problems for students with these types of impairment as well as the fact that they statistically represent the largest group of students with special needs at Masaryk University. It also holds that unifying the needs of both groups is difficult and often impossible – what meets the needs of accessibility for the visually impaired creates a barrier for the hearing impaired and vice versa.

When formulating the specific principles of accessibility (further below in the text), we followed these basic propositions:

- principles of accessibility result from sensory needs of both groups
- accessibility of data as such (visual for the blind, audio for the deaf)
- applications for work with the data must not collide with tools on which the sensory impaired student depends

4.1 Accessibility for the Visually Impaired

A visually impaired user relies on the help of assistive software – a screen reader, which detects alphanumerical characters on the display and interprets them by either an electronic voice synthesiser (voice output) or special hardware (a Braille display). It follows that the accessibility of e-learning documents depends primarily on technical parameters, that is to say on technical principles of accessibility according to various guidelines and methods. Nevertheless, it is necessary to list several basic and typical limitations on the psychological-perceptory level:

- voice and tactile outputs are both linear; it is never possible to simultaneously follow several pieces of information, but exclusively as a character by character sequence
- voice and tactile outputs do not allow for making accessible graphical objects (such as scientific symbols) and not at all objects where spatial imagination is necessary for understanding

Possible solutions:

- change of structure
- supplementary verbal commentary
- adaptation
- tactile graphics
- models

4.2 Accessibility for the Hearing Impaired

The common denominator of these rules is the fact that for persons with heavy hearing disability, it is the **sign language** which is their natural tongue and not the **majority national language** (such as the Czech language). The impossibility to perceive a language with the same frequency and readiness leads to a lack of linguistic experience. Besides, the Czech sign language for example typologically and structurally differs from Czech (the word Czech in this case refers to the area of distribution and not to linguistic conno-

tations) to such degree that the native speakers have problems with analysis and formulations of texts in Czech comparable to other linguistic foreigners using a typologically completely different linguistic code. As a result, it is difficult for the hearing impaired to receive information in the spoken as well as written textual form.

Possible solutions

- A course as a whole and primarily its textual part must have a **rigid structure**.
- It is recommended to provide a course with **visual and interactive elements**. (On the other hand, this usually presents an insuperable obstacle for the visually impaired, so there is no format suitable for both types of impairment.)
- In case a text includes marginal vocabulary expressions or infrequent scientific terms which are not explained as part of the course, it is suitable to include some form of **dictionary** into the course.
- **Inductive method of instruction** should take priority over deductive methods where this is possible according to a topic and nature of a subject matter.
- Key passages in a text (for example definitions and propositions in mathematics) and extended text passages should be accompanied with a **translation to a sign language** (i.e. with a video recording of an interpretation of a given text into Czech Sign Language by an interpreter).
- **All sound recordings need to be supplemented with a text alternative**, or at least with a brief description of the audio file. Furthermore, if the recording is crucial for understanding the subject matter, it is highly recommended to provide subtitles or an equivalent (transcript, description, explanation) in the sign language.

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The Guide to Accessible Digital Content

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Keywords: accessibility, alternative formats, inclusive education

Abstract

This paper presents a joint initiative of the University of Lleida and the University of Barcelona promoting inclusive education in the university by the adaptation of materials.
The initiative was formalized in a set of 13 guides "Guidelines for accessible digital content" (in Catalan and Spanish) that present detailed information to create digital documents accessible to people with disabilities. The guides cover common content editing tools (Microsoft Word, Open Office Writer or Microsoft PowerPoint), the conversion to PDF, and the publication of accessible web content via the FCKEditor available on LMS such as Sakai, Moodle or OpenCMS. The initiative also includes the creation of supporting material like accessible templates for common document types in teaching.
The main audience of the guides are university professors who must meet accessibility standards in their e-learning environments. However, the guidelines may also be useful to anyone who has the obligation or the desire to have their digital documents and publications on the Internet made according to the principles of Universal Design.

1 Introduction

Nowadays, it is universally accepted that information access is a crucial start point from which we build individual and collective knowledge. For individuals to grow in their apprenticeship the provision of information is a necessary condition. Learning and education would not be possible without it.

On the other side, it is also well known that the right to education can be restricted by different barriers to access to information. In order to ensure and guarantee this right people involved in document creation or selections has to have a proactive aptitude towards accessibility. Universities in particular, must ensure the equality in the learning process for all students and they should provide different means to access knowledge.

The Universal Declaration of Human Rights[1] states that "everyone has the right to education" (article 26) and that "higher education shall be equally accessible to all on the basis of merit". Furthermore, in 2006 the United Nations Convention on the Rights of the Persons with Disabilities[2] agreed that State parties shall take appropriate measures "to en-

1 Universal Declaration of Human Rights. (last access on december 2010)

2 The United Nations Convention on the Rights of the Persons with Disabilities. (last access on december 2010)

able persons with disabilities to live independently and participate fully in all aspects of life". In the education context, many countries regulated how higher institutions like universities, colleges or other public institutions related to them must take the appropriate measures to ensure access to the information for every student. In Spain basic legislation in this arena are LIONDAU, the Real Decree 1494/2007, LISI and LOU.

In order to reach this goal for several subjects and disciplines in the digital environment a good knowledge and use of the Information and Communications Technologies (ICTs) is in many cases essential. In addition, in last years it has become common to use e-learning environments or more simplistic web sites to publish documents or educational resources as the basis or as a complement to teaching. Accessing this type of information has become a necessity for all the students. Another trend in higher education institutions are the continuous growing number of people with disabilities which engage in a career (Guàrdia y Vilà, 2009). Universities face the challenge to respond the specific educative needs and provide the necessary support to these new students as well as to be competitive, offer quality and function with reduced budgets.

In this way, the Spanish universities University of Lleida (UdL) and University of Barcelona (UB), had created an unit and specific programs dedicated to the attention of students with disabilities. The main goal of these programs is to promote equal opportunities and full integration of people with disabilities into university academic life. Specifically, the UdL unit called "University for All"[3] (UdLxTothom) and the UB program "Fem Via"[4], offer services supporting the best attention to people with special needs.

In the context of the different actions that both programs have developed, they found some weaknesses on the creation of digital and accessible documents by teachers, due to a lack of knowledge on how to do it and in a lack of resources supporting it. The initiative called *Guide to accessible digital content* was born with the aim to provide those necessary resources and the needed skills to people who want (or need) to create digital and accessible educational contents. The accompanying templates were created in the context of an project for innovation in teaching.

Thus, Griho Research Group was commissioned to develop a set of thirteen guides which present specific guidelines, tips and advices to create accessible digital documents. These guidelines were made available to all teachers of both universities, and are now completed with a set of templates for most common document models. The guides offer general guidelines that help authors to create accessible digital documents such as textual documents, slides or web content. In a complementary way, a group of researchers in Barcelona University developed the templates to show practical examples, a structure and tools for personalizing the presentation that teachers or authors can use as a basis for their contents.

These guides and templates are based on the "Universal Design" methodology (Seale, JK, 2006). The Universal Design in the Learning Process has been defined by Orkwis and McLane (Orkwis, R. & McLane, K. 1998) as the design of material, resources and activities for the learning. This learning objectives are reached by people with vast differences in their abilities to toss, hear, move, speak, write, understand, attend, organize, partici-

3 "University for All" (UdLxTothom) University of Lleida website.

4 "Fem Via" University of Barcelona website.

pate and remember. It is then important to remark that the accessibility and the usability of a document will be different for every student and context of use.

The *Guide* is developed with the best intentions to be open to everybody, as a living instrument to change and readapt to every context. It is published under Creative Commons License. The development process has been realized by GRIHO Researh Group. This group has extensive experience in the accessibility and usability field (Ribera, M., 2008) (López, JM & others, 2009) (Oliva, M. & others, 2010) (González, M. & others, 2009). The templates and guidelines are in testing state. They are offered to every teacher of the UB who are interested in create digital and accessible documents. Furthermore, the user feedback will improve the material to specific needs of the students and users in the different contexts of use and it will make it possible to promote a satisfactory user experience for all.

2 Accessibility and usability in digital documents

The W3C defines web accessibility as "[it] means that people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web."(Henry, 2006). This definition can also be applied to the accessibility of digital documents. A digital document is accessible when a person with a disability can successfully access its specific content. To guarantee a greater accessibility of digital documents and web pages we should ensure that these are perceivable, operable, and understandable to people with disabilities (Chisholm, W. & others 1999) (Caldwell, B. & others, 2009). The tools used to access digital content do it by following accepted standards on structure and format of the information. This allows a proper interpretation of the data, provided that the contents implement certain aspects of accessibility. For example, any image or graphic that is relevant in the context of the document must contain a text alternative that describes its meaning.

As in the web, making a document accessible affects its overall usability and therefore results in a general benefit for everybody, considering the wide variety of circumstances and environments in which users read and interact with digital content. This implies that the development of a document according to certain aspects of accessibility benefits all users as it means an improvement in usability (Iwarsson and Stahl, 2003) (ISO 9241-11), and this reverts on an optimization in the search, access, and understanding of the contents of that digital document.

The publication of a document serves a purpose and a specific audience, and when an organization plans it, creators should prioritize the type of disability of the target audience and the main uses of that specific document. On that basis, it is necessary to consider the document format best suited to each context. On one side, documents created with a word processor (like Microsoft Word or Open Office Writer) are ideal for editing and don't imply a big investment in the creation phase; on the other side documents oriented to make slideshows are very useful to present an outline of the main ideas, and its strong graphic component made them very recommended for audiences with cognitive disabilities. Secondly, documents in PDF format provide digital signature options, they offer many options in digital forms, PDF documents are very robust in cross-platform environments and standardized allowing portability between different computers and

systems, besides being very faithful when printed. Web pages, on their turn, are a simple way to allow access to diverse content uploaded by teachers in LMS (Learning Management System) platforms.

When planning the creation of a document produced through a word processor or a presentation tool we should consider accessibility issues related to the structure and content from the very beginning of conception. For example, it is essential to organize content in such a way that users can quickly navigate to every part of the document, and to put the contents in a clear hierarchy that make it easy for users to move fast between the various chapters or sections of the document. The use of a clear typographic family, caring about text and images contrast, writing with clear language and the existence of alternative explanations for visual elements are prerequisites to create an accessible document with your word processor. In addition, you should pay particular attention to elements such as tables, links, images, videos and sounds, which -if incorrectly included- can cause severe problems to accessing the document.

3 The Guide to accessible digital content

The creation of accessible digital documents makes the conversion of formats or presentation easier, and allows a multichannel publication policy to suit the capacities or preferences of a diverse audience. In this regard the creation of the *Guide to accessible digital content* and accompanying templates can greatly contribute to content publishers in their publication strategy.

[Fig. 1] Example of labeling the language of a text in Microsoft Word 2003

The *Guide to accessible digital content* is composed of 13 guides that have detailed information on how to create accessible digital documents in Microsoft Word, Open Office Writer or Microsoft PowerPoint to be used in their original form or transformed to accessible PDF format. They also describe how to introduce content to the FCKeditor in Sakai and OpenCMS, platforms used by the teachers' community of the University of Lleida

as their online campus and web content manager tools, respectively. The orientation of the *Guide* is very practical, with recommendations for immediate implementation. As an illustration, Figure 1 shows an example of the contents of the *Guide* where you can see which steps are needed to define the language of a document in Microsoft Word 2003.

The set of documents that make up the *Guide to accessible digital content* are intended to support authors and publishers. They are designed to give step by step information on how to structure, format and lay down a content into digital format, for it being accessible by users with disabilities with the help of assistive technologies. The various guides are organized according to different types of documents that teachers use in their courses and the tools used for publishing content on the web:

- Text Documents: including a guide on Microsoft Word 2003, another on Microsoft Word 2007, a third on Open Office Writer, and finally two guides to convert documents to PDF, one for Microsoft Word and another for Open Office.
- Slideshows: including a guide on Microsoft PowerPoint 2003 and also a guide to converting Microsoft PowerPoint documents to PDF.
- PDF Documents: A guide to using Adobe Reader, and another on repairing PDF documents.
- Web Pages: three guides on the use of OpenCMS LMS, Sakai LMS and FCKeditor Web editor.

Templates, in turn, act in two directions, giving guidelines on the recommended structure of teaching documents (including for example a title page, a summary, header and contextual information, a bibliography and references section), and also setting an example on the semantic structure of each type of element (lists, images, headers). The templates are customizable in a way that starting from a basic model which follows the standards of presentation of each university, the end user can adapt it to a preferred display with enlarged font, a more accessible color scheme or clearer typographic families, among other aspects. Templates are designed primarily for content creators and their creation was based on original documents collected from the teachers.

The *Guide to accessible digital content* is itself accessible and the templates illustrate the accessibility recommendations in its structure and marking, and every action taken in its dissemination has been made with accessibility concerns in mind. All materials developed are fully accessible to blinds and people with low vision, which are the most common types of disabilities among college students, but it is considered that the applied techniques will also be helpful for people with other disabilities.

Different sources were consulted during the writing of the *Guide* to describe more appropriately the steps authors should follow. These sources were mainly the following: JISC TechDis[5], JISC Digital Media[6], CATEA access e-learning[7], WebAIM Techniques[8],

5 The JISC TechDis Accessibility Essentials Series (last access on december 2010)

6 JISC Digital Media, "Adding Closed Captions To Flash Videos" (JISC Digital Media).

7 CATEA access e-learning.

8 Techniques de Webaim.

Inteco[9], Adobe Accessibility[10], Microsoft Accessibility[11], Sakai platform[12], WCAG Accessibility Guidelines 1.0 and 2.0. The *Guide to accessible digital content* can be downloaded in digital format from the website UdLxTothom[13].
The templates were developed following the guidelines indicated in the *Guide* itself. Afterwards, the templates were validated with the collaboration of the Centre for Education Resources (CRE) in the ONCE (national blinds organization of Spain) using the most common assistive devices for people with disabilities. The templates will be available in the following months from the SLCUB[14] web.

4 Conclusions and future work

The initiative of producing the *Guide to accessible digital content* is a particular action within a framework of promoting inclusive education, and making teachers active actors of it. The *Guide* shows teachers how to create textual documents, PDF documents, slides or web content in an accessible way to eradicate possible access barriers.
The already published guides and templates are a first version of tools to reach this objective, and they are publicly offered to open a dialog between users and authors which make it possible to improve digital documents and reduce problematic elements in them. The authors' objective is to continue working in this field and to offer a wide set of tools which promote digital accessibility.

Finally, we have to remind you that this first version has been published in Catalan and Spanish, and that the translation to other languages is a future possibility as well as the creation of new guides and templates in order to cover new digital formats which can appear or be common in the creation of teaching resources.

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Perceptibility and Understandability of Documents in the Internet

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Abstract

The paper focuses on accessibility principles crucial for creation of documents and presentations published on the web with educational and other aims.
The World Wide Web Consortium (W3C) recommends for an accessible web content WCAG 2.0 a new, but more direct and more universal concept of accessibility, which this paper explains. WCAG 2.0 is based on four principles of accessibility. Principles 1 and 3 are decisive for a creation of document content and web presentations:
Principle 1 – Perceivability: "Information and user interface components must be presentable to users in ways they can perceive."
Principle 3 – Understandability: "Make text content readable and understandable."
The paper presents guidelines included in these two principles. The most important principles will be supplemented by explanations of techniques from the related document Techniques for WCAG 2.0 which helps to deal with success criteria for accessibility implementaion in practice.

Introduction

The paper focuses on accessibility principles crucial for creation of documents and presentations published on the web with educational and other aims. In the following text, what we call a document is a specific case of such a web page, which presents a static textual content with inserted objects such as images, videos and sound recordings. Although such a document falls under the guidelines formulated by the World Wide Web Consortium (W3C), and specifically in our case of the Web Accessibility Initiative (WAI), solutions discussed below are more or less applicable to any document disregarding its file format. This is possible due to the platform and technology independent concept of the Web Content Accessibility Guidelines (WCAG) 2.0, which we will discuss in detail.

1 Comparing methodology of WCAG 1.0 and 2.0

1.1 WCAG 1.0

W3C Guidelines for web content accessibility in version 1.0 is quite heavily dependent on the context of the late 1990s with their limited possibilites of assistive technologies in access to web content and lack of experience with practical accessibility. WCAG 1.0 can be seen as a list of guidelines leading to elimination of problematic concepts of an implementation of such web pages which cannot be managed by common assistive technologies. Its disadvantage is its relation to specific technologies applied in web creation and evaluation of their accessibility. For example, WCAG 1.0 states that:

1.1.1 Checkpoint 6.3

"Ensure that pages are usable when scripts, applets, or other programmatic objects are turned off or not supported. If this is not possible, provide equivalent information on an alternative accessible page. [Priority 1] For example, ensure that links that trigger scripts work when scripts are turned off or not supported (e.g., do not use "javascript:" as the link target)."

The view of Javascript as inaccessible technology developed over time due to a radical improvement of assistive technologies and transformation of their purpose. The checkpoint quited above lacks impact from today's perspective because it has become clear that there is no such thing as an absolutely accessible or inaccessible technology.

1.2 WCAG 2.0

Deficiencies of WCAG 1.0 became apparent rather shortly after publication -WCAG 1.0 with its recommendation status was issued in May 199 and it was followed by a draft of WCAG 2.0 only one and a half years later. First versions of the WCAG 2.0 draft already include the division into four principles, but the development of the final guidelines was difficult and took a long time. The length of the WCAG 2.0 drafts was growing together with new experiences with practical accessibility with time till they became unbearable. Finally, the document was edited and transformed into a comprehensible, well-arranged form which is now known as the W3C guidelines from 11 December 2008.

WCAG 2.0 comes up with a concept of **usable accessibility** independent of a particular technology. The user and his/her skills and familiarity with an assistive technology become the principal accessibility factors. WCAG 2.0 methodology is followed by documents with more specific guidelines which are designed to help users who wish to understand better accessibility issues and implement accessibility in practice.

WCAG 2.0 is based on four principles of accessibility. Principles 1 and 3 are decisive for a creation of document content and web presentations:

- Principle 1 – **Perceivability**: "Information and user interface components must be presentable to users in ways they can perceive."
- Principle 3 – **Understandability**: "Make text content readable and understandable."

These principles are further divided into Guidelines and each of the Guidelines includes one or more success criteria. The success criteria make a reference point for testing of the guidelines and they are assigned with one of three priorities.

The following chapters introduce guidelines which follow the first principle assuring that the reader can perceive a document content in the largest possible number of cases.

2 Perceivability

The purpose of this principle is to make sure that information and user interface are perceivable by users. The document content should be perceivable by all relevant senses – sight, hearing and/or touch. The perceivability principle consists of four guidelines:

2.1 Guideline 1 – Text Alternatives

"Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language."

This guideline has the highest priority and its purpose is to make sure that all non-text content is available in a text form. What we understand as text here is digital text, not visual text. Text has a great advantage against other means of information presentations. It is possible to present text in more ways -visually, by speech and in tactile form – and these ways are even possible to combine. A text in digital form may be easily enlarged, read by a speech-output, or transformed to Braille. A user with specific needs can modify it so that he/she can perceive it independently of other persons' help. For example, a blind user can use a speech-output to read the text and, at the same time, he/she can read it in Braille on a Braille display.

Each non-text content presented to a user should be accompanied by a relevant textual alternative. However, there are many exceptions where non-text content does not include a text alternative, or where it would even cause more trouble than help.

If the primary purpose of a non-text content is to mediate a sensory experience such as a symphony recording, photograph of the setting sun, a work of art, etc., it is very difficult to describe the purpose in words. What should be a relevant text alternative to Dvořák's New World Symphony? Yes, we can describe it, but we can never mediate the same with a text description and music. A text alternative of such content should at least describe its character and purpose.

Another example of a content where it is not necessary to define a relevant text alternative are tests or exercises that cannot be transformed into a text form with the same functionality, such as tests requiring hearing (e.g., a dictation) or sight (e.g. a geometry exercise, color perception test). It would be very difficult or impossible to realize a text alternative in such cases and it is therefore sufficient that a text alternative at least describes the character and purpose of the test or exercise.

The last exception is a life broadcast of audio and/or video. Again, it would be very problematic to provide a text alternative. In such cases, a descriptive text alternative explaining the typef of non-text content is sufficient.

All other cases such as graphs, diagrams, sound recordings, images, and animations must have their defined text alternative with an equivalent information value as the non-text content. A definition of a text alternative must follow the following guidelines.

- It is not always necessary to define a text alternative as an alternative description. In many cases this would be quite counterproductive. For example, it is sometimes better to use a chart with graph source data as a text alternative to a graph rather than describing the graph.
- An alternative text description of an image can change according to context in which the image is used. One image can have various text alternatives depending on whether it is used as a decoration (in such case it does not need it) or even in the form of the above mentioned chart.
- **Less may be more** – users appreciate short and clear description of the meaning or sense of a non-text content rather than a long, complicated description.

2.2 Guideline 2 – Time-based Media

"Provide alternatives for time-based media."

Presently, multimedia are a suitable complement to presentations and documents, which is often more illustrative and difficult to describe in a trivial text form. Unfortunately due to various impairment, not all users have a full access to information presented by multimedia – a blind person does not have access to a film which only includes with not soundtrack, and a deaf person cannot listen to an mp3 with audio recording.

Multimedia can present information in a way that a user can perceive by several senses at once (image and sound), and information presented by the video and audio tracks can differ or complement each other. A definition of a relevant alternative to multimedia thus belongs to the most difficult aspects of accessibility regarding the content as well as technological solution. It is often hard to decide which alternative is the best and what it should contain (i.e. which information is relevant and needs to be dealt with and which is not). As far as the technological solution is concerned, developers are confronted with issues of a simple – and preferably machine-processable – way to define alternatives to multimedia features. Presently, a definition of multimedia alternatives is seen as extra work for these reasons, which is reflected in their implementation.

Let us now focus on success criteria with the highest priority – these will be the most interesting and meeting them will lead to the best accessibility.

A note: please remind that the title does not explicitely mention text alternatives, because alternatives to multimedia features may also be defined in other ways (audio description, sign language).

2.2.1 Audio-only and video-only (prerecorded)

The first success criterion requires that an audio-only or video-only multimedia feature is provided with with a relevant alternative for a user.

In the case of audio-only, information is presented in a monological or dialogical form, or by spoken word in general as well as sounds -natural and artificial. A user who cannot listen to the recording can only access information contained in the recording if there is a text document with the same content as the audio recording. The document includes all relevant information transcription of the spoken word as well as a description of sounds relevant to understanding of the message.

A video-only recording can include a number of visually presented information -animations, graphics, landscape, people and animals in various situations and with a variety of expressions, etc. An alternative can be defined in two ways:

1. A **text document** is created which provides an equivalent story as the video recording. The document serves as a complex description of the video recording and it contains all important information including descriptions of environment, action, expression, etc., which are a part of the presentation and are important for its understanding.
2. An **audiotrack** is created with a description of what happens in the video recording.

2.2.2 Captions for prerecorded audio

The purpose of the second success criterion is to provide the possibility to watch films (i.e. synchronized video and audio) to hearing impaired persons. According to WCAG 2.0, captions should include dialogues as well as information about who is speaking, descriptions of sounds, music, laughter, etc. Presently, there is **no simple, publicly accessible and automatic** way to add captions to prerecorded audio. The preparation is manual and time consuming. Furthermore, it has become a simple task for anyone to download video from a camcorder or mobile phone and implement it in a presentation, but it is beyond a common user's competence to provide it with captions. Fortunately, there are "glimmers of hope on the horizon" in this area and technologies of automatic speech recognition are more and more accessible. For example, there is a solution presented by Google as a beta – some YouTube channels have automatic video captions.

2.2.3 Audio description or alternatives for prerecorded multimedia feature

The purpose of this success criterion is to provide blind users with access to information presented in visual form in multimedia, which cannot be derived from the audio track. Again, there are two possible solutions:

1. **Audio description** – in this case, commentaries are inserted in between dialogues. They describe environment, characters or scene changes, which are important and not described or mentioned in the primary audio track.
2. **Text with all information included in a multimedia feature.** We can imagine it as a script. Its advantage against an audio description is that it is not limited to pauses in dialogues and it can be provided in synchronicity with the multimedia feature.

It is not necessary to define an alternative in the above mentioned cases if a multimedia feature already presents an alternative to a text web content and is properly marked as such.

2.3 Guideline 3 – Adaptable

"Create content that can be presented in different ways (for example simpler layout) without losing information or structure."

Document readers have various needs and preferences. Many readers customize the view and use various alternative devices and assistive technologies (screenreaders, magnifying software, Braille displays). So, they do not need to view the document content in the form created and intended by the author. In order to provide access to web documents to as many users as possible, it is necessary to make sure that users can perceive them with various senses – sight, hearing, or touch.

In order to meet this goal, we have to present the document information in a programmable way. Assistive technologies of users with special needs will be able to work with the document and its structure will be preserved when copying the web content to a word processor. The purpose of Guideline 1.3 is to make sure that information is accessible in a form perceivable by all readers and readable by a speech-output, displayed on a Braille display or in a simplified form without a loss of meaning. The guideline consists of three success criteria with the highest priority.

2.3.1 Info and Relationships

"Information, structure, and relationships conveyed through presentation can be programmatically determined or are available in text."

Users commonly perceive structures via various visual stimuli -headings are often writeen in a larger font than the body text, listing items are marked by dots and indented, important words are highlighted by bold type, italics or different font family, etc.

This success criterion thus deals with preservation of information and relationships marked visually or auditively even in case a user changes the presentation form. Use of a screenreader, Braille display or replacement with user's preferred predefined styles serve as examples.

Preservation of information in a document and the relationships may be reached primarily by the presence of semantics and use of appropriate text editing tools. Particularly in the HTML web page format this may be reached by marking those elements, which primarily carry a semantic information and are in accord with the presented content. In practice:

- headings contain information about their level (<h1> to <h6> HTML elements) and they are hierarchically structured.
- Listing bullet blocks are logically associated (<ul>, <ol> and <dl> HTML elements) and they carry information about the listing type and formatting. Each item on a list has a clearly defined beginning and end (<li>, <dt> and <dd> HTML elements).

Presentation of information in charts presents one of the most difficult aspects for screenreaders users because data in charts are in 2D while screenreaders present them linearily. It is necessary to create charts in a simple way and when it is necessary to create a complex chart, it must follow several guidelines:

- each cell includes only related information,
- secure meaningfullness for reading charts by lines from left to right,
- use appropriate tools to mark headers of lines and columns,
- secure unequivocal relationship between cells and their headers (id and header HTML attributes) when a cell has more than one header and their identification is not unequivocal,
- use appropriate means to define a summary description of the purpose of the chart as such and its layout (summary HTML attribute).

It must be noted that correctly formatted documents which separate content from layout do not help impaired users only, but everyone who needs to further work with them -either manually (copying information from a web page to an application) or with a program (generating table of contents based on correctly defined headings). The contribution of this rule is thus much wider than to needs and requirements of impaired users.

2.3.2 Meaningful Sequence

"*When the sequence in which content is presented affects its meaning, a correct reading sequence can be programmatically determined.*"

The purpose of this criterion is to allow an alternative sequence of reading a content of a page while the message remains preserved. Any content which does not meet this success criterion can cause troubles to, for example, assistive technology users to whom it is presented in a wrong, thus meaningful, reading sequence.

A sequence of presented information is meaningful when it cannot be changed without a change in meaning. For example, when a document contains a collection of several independent articles, the reading sequence does not affect the meaningfulness of the content. The articles themselves must have a meaningful sequence (to make sense), but the superior element which includes them does not need to meet the meaningful sequence criterion because individual articles are not interdependent and it makes no difference which one we learn first or second or the other way round. An example of a violation of this criterion is a situation when a table is used for formatting view and a screenreader does not interpret it correctly due to the way it works with tables.

2.3.3 Sensory Characteristics

"Instructions provided for understanding and operating content do not rely solely on sensory characteristics of components such as shape, size, visual location, orientation, or sound."

The purpose of this criterion is to make sure that all users understand instructions for work with content although they cannot perceive shape, size or placement of a particular object due to their impairment. Is some cases, authors of documents rely on readers' capacity to perceive visual aspects and they give instructions such as, "Give the correct form of words in red". Such instructions can be meaningless to users who cannot perceive and understand them – due to their impairment or a device they use to view documents.

The purpose of this criterion is not to discourage the use of such instructions for work with documents because they present a much successful approach for some users, but they should be supplemented with another type of information meaningful and accessible to persons who cannot perceive these aspects.

2.4 Guideline 4 – Distinguishable

"Make it easier for users to see and hear content including separating foreground from background."

Impaired users can experience problems with distinguishing among pieces of information when working with a web page. While some WCAG 2.0 methodology rules are focused on creating a web content in a way that enables presentation in alternative ways, the guideline 1.4 focuses on the easiest possible distinguishability of the web page primary version content for impaired visitors. The key aim of this guideline is to make it possible for users to separate information in the foreground from information in the background. This means sufficient contrast between foreground and background in visual presentations, and sufficient volume level difference between foreground sound and background noise in audio presentations. Again, we will focus on criteria with the highest priority.

2.4.1 Use of Color

"Color is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element."

This success criterion deals specifically with color perception. Guideline 1.3 covers other forms of perception and it is discussed in the previous chapter about adaptability. Color is not used as the only visual means to convey certain information, indicate a specific action, express a demand for a response, or distinguish a certain visual feature. Use of colors to distinguish various pieces of information on web pages and in everyday life is very common. Our elementary school teacher used to correct our mistakes with a red pen to notice it immediately, traffic lights colors have their functions, etc. However, not everyone is lucky enough to perceive colors as defined by an author of a document. A blind user cannot perceive them at all as a consequence of their impairment, a color-blind person cannot for example distinguish red or green colors or various color combinations, and a senior citizen can experience problems with color perception as such. For this reason, it is necessary to avoid using color as the only way of conveying information. Information should also be conveyed by some other means. To use the above mention traffic lights case as an example, it is also the position of the lights that are important alongside the colors. Even a color-blind user can learn when the red, yellow, or green light is on. Use of color as the only bearer of meaning of information presents complications for users with a color-sensitivity impairment as well as blind users and monochromatic device users (black and white printing).

2.4.2 Audio Control

"If any audio on a Web page plays automatically for more than 3 seconds, either a mechanism is available to pause or stop the audio, or a mechanism is available to control audio volume independently from the overall system volume level."

An automatic playback of an audio recording while working with a speech-output can cause displeasant situations for screenreader users. The situation is even more complicated as the same function is often used for screenreader and audio track volume control. When the volume of an audio track is lowered in the Sound volume control panel, it also automatically lowers the speech-output volume that a blind user necessarily needs for work (let us leave aside a situation when a Braille display is used at the same time which can solve the situation somehow). For this reason it is necessary that in case an audio starts playing, the interface must enable the possibility to turn off the audio track. If an audio track starts playing immediately after opening a page in a presentation, it can strongly influence a user's ability to find a mechanism to turn off the audio playback (the situation can often be even worse when the feature for turning off the audio is inaccessible). This is why the WCAG 2.0 authors strongly recommend to presentation authors to use the technique of automatic audio playback as little as possible (ideally, not at all) and progress in the other direction, which means that the audio playback only begins when a user demands it.

3 Conclusion

We have introduced the first four guidelines of the World Wide Web Consortium WCAG 2.0 that belong to the first principle – perceivability. Although this methodology is primarily aimed at web page authors, it is obvious that its universal concept can do a good service in other environments for document creation such as word processors and pres-

entation creative tools. It is necessary to realize in the global context of accessibility that accessible content of created documents is not everything and that it is necessary to take some measures concerning content creation tools as well as access tools. Content creators need simple, easily available and usable tools to create accessible content. To define accessibility guidelines is not sufficient, it is also important to make sure they can be applied without greater problems. Otherwise the defined accessibility guidelines and content creators's possibilities diverge, which can lead to negative results concerning real accessibility of documents. Other workgroups of the Web Accessibility Initiative of the World Wide Web Consortium deal with these issues. They create particular accessibility guidelines, specifically for content creation tools (Authoring Tool Accessibility Guidelines – ATAG) and access (User Agent Accessibility Guidelines (UAAG). It is also important to provide instructions and examples of correct or possible solutions to concrete situations serving as clues to content creators about concrete cases of accessibility implementation. It was not the ambition of this contribution to propose a complex solution in the area of accessibility, but to mention difficulties that can arise during document creation concerning accessibility and to propose possibilities which do not make accessibility an extra cost but rather something which is useful for everyone and especially for those with special needs.

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Section 4

Specific Learning Disorders and Other Types of Neurodiversity in Tertiary Education and Compensation Devices

The system I4Control® – Hands-free Interaction with a Computer

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Abstract

The system I4Control® represents a novel type of computer periphery (an assistive technology), which enables handicapped people with various disabilities to control of a personal computer through movement of eyes or head. Since it emulates computer mouse, it provides its user by a unique chance to communicate with all installed SW applications by means of his/her eye movements. The system is based on the video-oculographic method of recording eye movements with a tiny camera, which catches up to the frame of spectacles. It is a simple, non-invasive and accurate method for monitoring eye movement. This solution does not require fixing the head.

There are several alternatives for the control of the computer cursor. However, neither of them enables direct gaze control, i.e. placing of the computer cursor at the observed spot on the computer screen. The basic control option is direct continuous control of the computer cursor in an incremental mode. In this mode, the user controls continuous movement of the cursor by deviating from the idle position. The actual eye position therefore has no direct effect on the position of the cursor on the computer screen; instead, it determined the direction and duration of the cursor motion (similar to the joystick). The system can control both a single and double clicks. Both functions are activated by an eye blink with a specified duration, filtering out natural blinking of the eye. Users can modify numerous settings prior to each launch of the I4Control® application. Another alternative of computer cursor control is a discrete control in an incremental mode. In this case, the cursor movement is controlled in the same manner as in the previous alternative, only the cursor moves on the screen differently. In the first case the cursor moves continuously, while in this mode, the cursor performs discrete jumps.

1 Introduction

The term supportive or assistive technology could be applied to any item, device or a system employed in order to maintain and/or improve motor capabilities of disabled individuals. Such disability may include disorders, illness, and limitations of motor capabilities or participation in social activities. The assistive technologies represent a selection of auxiliary instruments designed to aid in completion of tasks that would be difficult to perform otherwise. The assistive technologies enable individuals with various physical disabilities to perform daily activities, help with communication, studying, work duties or leisure time activities. In essence, these technologies help their users to achieve a greater degree of independence and quality of life.

2 Information and Communication Technologies

Nowadays, information and communication technologies (ICT) play a key role for many people in Europe. An active use of ICT often means improved work opportunities, access to information and level of social relationships. During the last decade, computers have become an indispensable part of everyday life and many cannot do without a personal computer even away from their jobs. The Internet as a mean of communication and accessing information can be viewed as one of compensating aids utilized by a broadest spectrum of people with various limitations and disabilities. Where physical limitations may be in the way of traditional socialization, a fast digital connection to the world replaces it. On the other hand, many people battle with insufficient accessibility of computer technology. As the core assumption for participation of an individual in the information society is both access to suitable ICT, and the ability to use it. Standard computer peripherals may often be unsuitable for people with motor disabilities as their handicap prevents them from using hands to control the computer mouse and the keyboard.

In many cases, a computer may represent the main means of communication for disabled clients with their broader surroundings. It is also an indispensable aid in education; it helps to a development of senses, memory or even speech capabilities. The available selection of computer peripherals is therefore an essential issue, governed not only by the specific type of disability and accessibility of the necessary peripherals, but by financial constraints as well. The market offer is quite broad – from simple electro-mechanical switches to special trackballs or keyboards to special devices controlling the computer cursor.

3 The System I4Control®

The system I4Control® is a compensating aid for a motoric handicapped computer user, which with help of running programming equipment, completely replaces regular computer mouse and keyboard. In some types of physical disabilities, the eye muscles are the last remaining group of muscles under the person's conscious control. For this reason, the system is based on the video-oculographic (VOG) method of recording eye movements with a camera. It is a simple, non-invasive and accurate method for monitoring eye movement.

This is a contactless control of personal computer with help of eye movements, possibly head movements. If you move with head, simultaneously you move also your eyes, but in the opposite direction. The reason is fixation of eyes on the object of interest. This device is intended especial for motoric handicapped users, who after some injury or disease can not use the common computer peripheries. For instance, injury related to head injury, injury of spinal cord originating paraplegia or quadriplegia; or patients after amputation of upper extremities. When talking about diseases, it is concerned mainly to amyotrophic lateral sclerosis, cerebral palsy, multiple sclerosis, muscular dystrophy or spinal muscular dystrophy. With respect to end user, this device was designed with simplified and intuitive control. It is of small dimensions, which implies very good portability. It does not limit user in his movements neither a fixation of the head is needed. Another advantage of this solution is a significant universality with modular structure, which permits flexible customization for concrete needs of each client.

3.1 Device Structure

A camera installed in the rim of the eyepiece monitors the eye and its movements from a very close range. In present, it is attached to the right hand side of glasses (the camera scans right eye). There is no technical problem to connect the camera to the second side (there is no influence of the chosen side on a function of a device). The video signal obtained is forwarded to the control module. The main task of this component of the I4Control® system is to provide sufficient security. The control module conveys data directly to a personal computer, via a USB and video cables, for processing.

Another important factor is scene lighting. To secure an independence of surrounding light conditions, there are four infrared diodes to light an eye. The diodes are placed in the corners of the camera module. Consequently, the monitored eye movements are processed and modulated to the computer cursor movement. Due to the camera location, the eye position is scanned regardless of system of coordinates and the user is not therefore limited in own movement.

[Fig. 1] The System I4Control®

3.2 Types of Computer Cursor Control

There are several alternatives for the control of the computer cursor. However, neither of them enables direct gaze control, i.e. placing of the computer cursor at the observed spot on the computer screen.

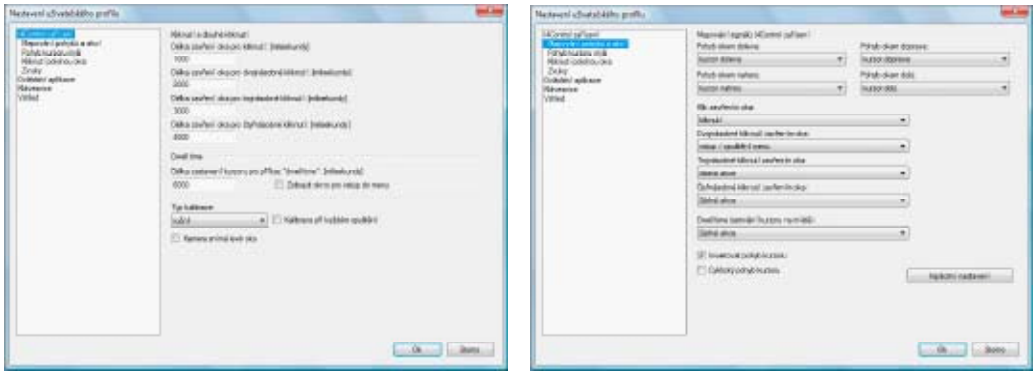
The basic control option is direct continuous control of the computer cursor in an incremental mode. In this mode, the user controls continuous movement of the cursor by deviating from the idle position (direct forward gaze). The actual eye position therefore has no direct effect on the position of the cursor on the computer screen; instead, it determined the direction and duration of the cursor motion (similar to the joystick). The system processes the current eye position and determining a position within or outside the idle position zone sends a continuous stream of commands for the cursor to move in the desired direction (according to the eye position relative to a coordinate system of

the camera or specific settings), until the eye returns to the idle zone. Movement of the computer cursor is thus terminated either by the return of the eye to the idle zone or by an attempted click. The system can control both single and double clicks. Both functions are activated by an eye blink with a specified duration, filtering out natural blinking of the eye. The double click differentiates from the single click by the time setting, determined by the user (recommended values are: single click = 1 second, double click = 2 seconds).

Another alternative of computer cursor control is a discrete control in an incremental mode. In this case, the cursor movement is controlled in the same manner as in the previous alternative, only the cursor moves on the screen differently. In the first case, the cursor moves continuously, while in this mode, the cursor performs discrete jumps. This form of movement is advantageous in adapted applications, where the discrete motion is preferable, e.g. when controlling an application keyboard (the cursor moves directly from key to key) or when playing the Minesweeper.

3.3 Device Setting – User Profiles

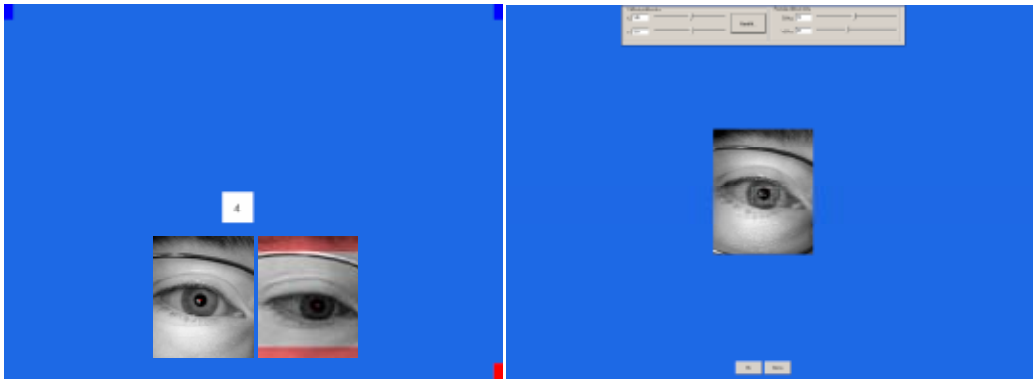
Before start working with system I4Control®, the user can configure several parameters, with which the device can adjust to fulfil his concrete requirements. All the settings are done in so called user's profile and each user can have several profiles. This is advantageous in cases when user is not yet tired and he decides to use full control of computer cursor and in cases when user is somehow tired and he can then take advantages of tools used for simplified control. In respective profile dialogs the user can set individual time constants, speed of the cursor movement, type of calibration, mapping of movement and actions, tools for simplification of the application control, several types of keyboards or application looks. Value of all time constants is set in milliseconds and it determines always the time segment on which is performed certain instruction which is set in the mapping dialog of movements and actions. For example, as a replacement to left or right click mouse, it is used closing of eye for certain period. The user has at his disposition from one click through two clicks till four clicks. It is possible also to assign to different eye movements different actions. This is useful for handicapped users, which are not able to move their eyes to all sides.



[Fig. 2] The User Profiles

3.4 Device Calibration

Through calibration the system can be adapted especially for concrete user. Each user has different physiognomic parameters, i.e. different form or distance of the eyes and different nose size. Calibration is needed to be done only once when starting working with the system. To the system are composed two types of calibrations. Automatic calibration is done without need of user interference. In the other hand, using manual calibration the user can set several parameters himself. In the first step of automatic calibration it is limited the area for processing the image and in the second step it is defined the transformation to correct movement of the computer cursor. In the screen it starts gradually to blink and move four small squares. The user's task is to follow the movement of the squares. In case the square in the corner becomes to have blue colour, the calibration was successfully completed. However, if the square becomes red, it is need to perform the calibration once again. Manual calibration allows to directly setting individual parameters. This feature is very important because there are users, which can not with their eyes cover all the area of the screen. By clicking the button "Measure", it makes blinking the square, which user follows. Automatically it generates a rest zone, which dimensions can be afterwards modified as needed.



[Fig. 3] Automatic and manual calibration

Mouse Substitution

Movement of the cursor is controlled by deviation of rest zone. As far as user moves with eye to the right, the detected pupil deviates from rest zone also to the right and computer cursor moves to the right. Similarly if user moves with eye to the left, the detected pupil deviates from rest zone to the left and the computer cursor moves to then to the left. On the contrary, the state of eye (its opening or closing in certain time interval) induces initiation of respective action. This control is possible to compare working with a joystick. Images illustrate individual directions of movement during control by eye or head movement.

[Fig. 4] Cursor moves up – controlling by eye movement

[Fig. 5] Cursor moves up – controlling by head movement

One of supporting mouse function is a possibility to centre the computer cursor (placing the cursor to the middle) and placing the cursor to the concrete quadrant. It is useful to use this tool when the cursor gets out of the monitor and the user is not sure with its position. It is easy to return the cursor to the required position with this function.

The I4Control® completely replaces the traditional computer mouse. With help of a special application, besides allowing individual directions of movements of a computer cursor, it allows to replace one click and double click in left button of mouse, the right button of mouse, the function drag & drop, the scrolling wheel, the triple, four click function and dwell time. Drag & drop function simulates pulling of computer cursor when you press the left button. The user by closing eye to one second he firstly marks the initial state (choice of the object) and then the final state (e.g. change the size of the object). Function of scrolling wheel is of great advantage especially when used while surfing on the Internet.

3.5 Simplified Control

The special application also allows users to use tools for simplified control. The first option is the dwell time. This option is suitable for user, to whom it causes problem on consciously closing eyes for a certain time constant. The control of the application through option dwell time is done directly by look, i.e. by keep looking in one place during all the setting time period. This setting allows after expiration of the time constant to perform the appropriate action which is assigned to the function. To this option complements the

icon which calls the special menu. This icon consists of two parts – the left part with the eye image represents the special menu, right part with arrow image in turn allows the icon to be displaced up or down.

Automatic scanning is a tool for automatically passing through whole area of the screen. The entire area is divided in four regions and at the end of time interval we can gradually go through them. Closing eye for a certain time constant it makes selection of a square, which is then again divided into four sub-squares and the whole cycle is repeated until finding a particular point. The menu is gradually passed through cell by cell. Automatic scanning is especially useful when writing text, when systematically going through keyboard. First, it is selected gradually all the columns and then by closing eye the user selects a column. After selection of a concrete column it is carried out scanning through each row and the selection is again confirmed by closing the eye (the selected character is automatically sent to active application). In automatic scanning the cycles always take place by three (e.g., after selection of the column it will be three times marked all rows of selected column, before the scanning again returns to the level of columns; all this is in assumption that the user does not take any action). This feature therefore allows control of the application solely by closing of eye.

[Fig. 6] Automatic scanning

There is a tool click by eye position (deflecting eye position from a central position and after certain time constant the instruction command is done). It is another chance of controlling application (running single commands) by changing eye position. This feature is of advantage to the clients, who have problems to close eyes purposely. A command is activated when deflecting eye position out of the central (starting) position. It is useful to use the click by eye position function for giving rise to additional command when working with the tool for simplified (alternative) personal computer control, i.e. automatic scanning, which utilizes only single eye closing in a basic version. In a relevant dialogue window, we choose eye movements we are ready to use for entering commands. We select from the following eye positions: right, left, up, down from the central (starting, actual) eye position. Afterwards, we can assign commands (actions) to the directions. The actions are the same as in case of single, double, triple and quadruple – click by closing the eye: no action; single click; enter/leave menu; emulate right mouse-button click; emulate left mouse-button double click, activate scroll mode, ENTER key. By contrast to a choice click by closing the eye, we have a possibility to define a central position

distance (next to relevant time constant setting).

Another tool simplifying personal computer control is a cyclical cursor movement. It is cursor movement regulation for a purpose of not being limited by a monitor border. When the cursor moves down and gets to a bottom border, it shows again at a top border in the same distance from the left border keeping movement down. It works the same when moving in opposite vertical direction (from down to up) and also horizontal direction (from left to right and from right to left). The cyclical cursor movement is of advantage for clients who are not able to move a cursor to certain direction. For instance, it is complicated to move an eye up for incumbent patient (big eyes fluctuation needed, poor control of the computer cursor), but moving eyes down, right and left is trouble free. The cyclical cursor movement helps patients to compensate problematic eye movement up with less complicated eye movement down.

Supporting application also allows to set various speed of computer cursor facilitated by four partial scroll bars in all four basic directions (up, down, right and left). This movement is not linear for all directions – the move is slower at the beginning and becomes faster at the end. A chance of computer cursor speed setting is suitable especially for clients with uncontrollable disconnecting movements. Such movements are mostly very fast and can be partly compensated by reducing sensitivity in certain direction (speed of computer cursor for the direction). There can be a sound feedback for the particular direction movements. It is also possible to choose the sound feedback for entering actions – clicking (single click – one sound, double click – two sounds etc.).

[Fig. 7] Icons on desktop

Last tool for simplifying the control of PC is the Windows desktop function. This function displays all icons from Windows desktop into dynamic menu and allowing user to their simplified selection and starting of applications.

3.6 Writing

One of the most important applications to work with PC is the software keyboard which replaces the traditional keyboard writing. The selection of individual keys, as well as in menu, is again dealt using a discrete way. Once the user selects the right key by movement of the eye or head and closes his eye, the selected character is sent to the cursor position to the currently active application. The software Keyboard is easily modifiable,

whatever the case, either concerning the distribution of individual keys, or the size and location of the keyboard itself. All user settings are accessible from the submenu.

Based on the Czech language model, we created a number of tools for efficient text input. Frequency keyboard is based on layout of letters according to their frequency. It eliminates unnecessary movements on the keyboard. Predictive keyboard on basis of this model and of built-in dictionary offers the user for writing; the most often used letters, groups of letters and words. Writing text is automatically sent back to the active application. There are among us clients who, for various reasons, can not communicate by spoken language. As one solution to the alternative expression is pictogram keyboard. This is a compensation of speech, for which each symbol is hidden a certain message both in text and in spoken form. This tool is easily modifiable according to specific needs of the client.

Pg Up	!	Esc	w	y	m	g	ť	(	2	9	/
Pg Down	?	Tab	ř	ý	v	j	š	ó	1	8	*
Home	.	f	b	r	t	s	c	č	0	7	-
End	,	p	d	e		o	i	í	↑	6	+
Caps	:	é	ě	n	a	l	u	ú	→	5	=
Ctrl	-	ď	ň	z	k	á	ů	x	←	4	.
Enter	@	Del	←	ž	h	ch	q	)	↓	3	%

[Fig. 8]Frequency keyboard

ze	a	a	b	c	d	e	f	g	h	á	ř	0	1	2	3
z	ve		a		v		z		ch	č	š	4	5	6	7
že	v	z							i	ď	ť	8	9	↑	%
který	se	y	s		p		o		j	é	ú	Esc	←	↓	→
o	být	x							k	ě	ů	←		.	!
mít	na	w	d		n		t		l	í	ý	Del		.	?
do	ten	v							m	ň	ž	Enter		:	Tab
i	s	u	t	s	r	q	p	o	n	ó	@	Shift		Caps	

[Fig. 9] Predictable keyboard

3.7 Dynamic Menu

Especial tools for easier control of computer and its applications are made available to users through a grid menu. The individual menu items are changed dynamically according to the active application. This approach is also used for Web browser, where the menu consists of various tools for its control, including the feature „favorites".

4 Result

As each device, the system I4Control® has its limitations. The core of the device is the detection algorithm for determining the pupil centre, with which is controlled the loca-

tion of cursor. If the algorithm does not correctly works, there is an error, which has to be repaired by relearning the algorithm, i.e. by adaptation of the algorithm on a particular computer user. Another restriction is also the problem with dropped eyelids, where the only solution is to correctly position the client.

The EU laws indicate that this compensatory device belongs to medical device of Class I, and thus defines the required characteristics for the equipment. The proof of their compliance is the obtained certificate and granting of CE mark. To be I4Control system independent of surrounding lights is complemented by four infrared diodes. This radiation safe for human eyes, meets all the requirements defined by EU legislation. The maximum duration of active use of the device during whole day is 12 hours, after which it must follow adequate rest (at least at the same time length as previous active utilization).

Minimum recommended configuration for personal computers to work with system I4Control® is Pentium III with processor frequency 500 MHz, 512 MB RAM and running Microsoft Windows 2000 and later.

The prototype of system I4Control® came into existence within scientific research activities, taken place in the Department of Cybernetics, Czech Technical University in Prague. Later, the company Medicton Group Ltd. obtained license and prepared the equipment for serial production. Since September 2008 it is available on the market.

Techniques of Text Processing by Students with Dyslexia with Regard to Nature and Range of the Disorder

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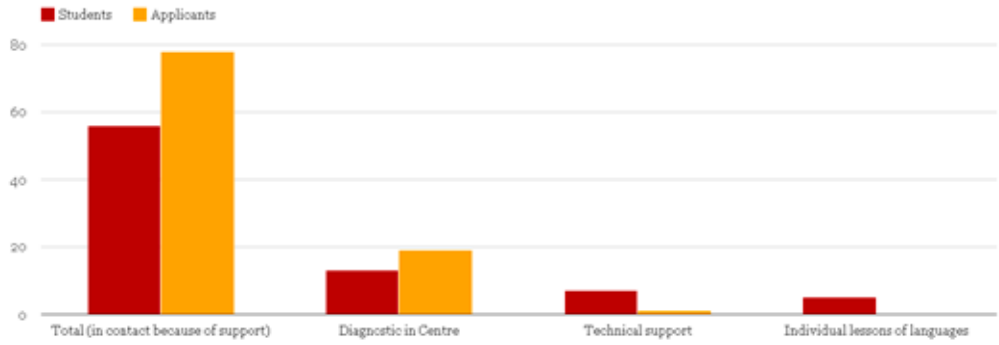
Abstract

The paper outlines possibilities of a better accessibility of a text for a concrete student, based on the diagnostic process and cooperation with the student with specific learning disabilities. It summarizes the whole process, from diagnostics to the choice of the method of text processing.

The paper also speaks about a possibility of distribution of students with dyslexia into groups according to results in diagnostic test and about possible expectations of a preferred way of text processing based on these results.

First, I would like to introduce you to the support of students with learning disabilities at Masaryk University. Records of the Teiresias center show that there were 56 students with learning disabilities in the academic year 2009/2010, who were partially or permanently supported by the Teiresias center. In the same year, there were 78 applicants supported by Teiresias. 13 students and 19 applicants were also diagnosed at the center until this time (academic year 2009/2010). Technical support (for example, a possibility to use a PC, screenreader, and software for persons with dyslexia) was used by 7 students and 1 applicant. 5 students also had individual lessons of foreign languages at the Teiresias center.



Now, let me remind to you a short definition of dyslexia. Dyslexia is one of specific learning disorders and it's also called reading disability.

Reading disability afflicts reading skills and comprehension of a written text, but this disability isn't caused by a deficit in intelligence. Reading disability is in the category F81.0 of the International Classification of Diseases (ICD-10), and in the category 315.00 of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV).

Basic areas, in which persons with dyslexia have problems, are for example visual and auditory perception, attention, working memory and also social and emotional area. Students with dyslexia have problems for example with reading and text processing, time-management, orientation in space, self-efficacy and so on.

In the diagnostics of dyslexia, there are three basic approaches to testing of dyslexia. The first of them is IQ Achievement discrepancy, when we confront results of an IQ test with results of other tests. When you have significant differences, you identify the person as a person with dyslexia.

The second approach is RTI – response to intervention – when every person who has problems in the main areas connected to dyslexia, is taken as a person with specific needs and an adaptation of studies takes place directly in the study environment. The third aproach is mapping of disabilities in main areas through particular tests.

In the Czech Republic we diagnose students with learning disabilities through the test battery Diagnostic of SLD (specific learning disorders) of adults by Cimlerova, Pokorna, and Chalupova, published in 2008 by the Institute of pedagogical-psychological counselling. The battery is used for global diagnostic of adults and it checks level of reading skills, writing skills, visual and auditory perception, left-right and spatial orientation, spelling skills and motor skills. A screening test and an anamnestic questionnaire are also included in the battery.

Now, let me begin the second part of my paper, which deals with work with materials.

Students with learning disabilities use three basic possibilities how to work with materials and their adaptation. The first of them is an adaptation of a current form of material, for example highlighting of text, underlining, printing text on coloured paper, use of nontransparent ruler to control the actual line and so on – when you have printed text; changing size and type of font, arrangement of background and so on – when you have a digital document.

The second possibility is that a student can co-operate with a psychologist or another specialist in learning styles with text in its current form. Students learn how to learn from lectures notes and books. They prefer some learning style based on a specialist's recommendation and their own experiences, their findings are the best feedback. The most common recommendation which can be useful, is to work with short passages of text. If a student has problems with working memory, he should take short notes of each paragraph to refresh the content of the text. These notes also help a student to learn better the text processing and grasp the main idea.

The third possibility is a change of the form of material, eventually enabling reception of information through more channels at once. This process is possible with digital documents with screen-reader software for persons with visual impairment, a voice-reader with visual adaptation of the text in software for persons with dyslexia, hybrid book and so on.

Preferences of work style with materials is partially dependent on range of diseases. We can distribute students with dyslexia into three basic categories.

Students in the first category are quick readers, but they have big problems with comprehension. Many students from this category were trained by their parents to read quickly, but they weren't trained in the ability of better comprehension. Students from this category often have feeling that their problems aren't so marked, they often see an adaptation using the screenreader as useless and retardatory. They often search for possibilities to work with a text through the visual channel.

Students in the second category are very slow readers, but their comprehension to written text is on a good level. Students from this group prefer to have a lot of time to read materials, sometimes they prefer screenreaders or some software for persons with dyslexia to check their comprehension ability.

Students in the third group have big problems in both areas, speed and comprehension. It is very useful to use as many channels as possible for these students. If they can perceive visual and auditory information at the same time, they may use software that can also highlight the text, so that they are able to follow all these channels together at the same time. Due to this, they can improve their comprehension of a specific text and also improve their perception in general. They can too combine this method with reading a text by short paragraphs with taking notes.

There are some difficulties of a work with students with dyslexia, because this issue is quite recent, and we are not so used to pay attention to adults with dyslexia. We don't have a unified framework for taking care of persons with dyslexia from the primary school to university. Many students with dyslexia aren't prepared to use a complex psychological, pedagogical and technical support. A complex support for students with dyslexia is currently developing at universities. All these and many other difficulties can become the basis and driving force for future work.

List of Workshops

Adapting Mathematical Tests for Visually Impaired - Daily Practice

Lukáš Másilko, Ondřej Nečas
Teiresias Centre, Masaryk University, Brno, Czech Republic

EasyTutor - Companion Software for Persons with Dyslexia

Břetislav Werner
Spektra, Prague, Czech Republic

ICCHP Summer University on Math, Sciences and Statistics for Print Impaired Persons

Joachim Klaus, Karin Müller
KIT - Karlsruhe Institute of Technology, Germany

Dorine in't Veld
Bartiméus Accessibility Foundation, Neederland

Dominique Archambault
University Pierre et Marie Curie-Paris 6, France

Svatoslav Ondra, Petr Peňáz
Teiresias Centre, Masaryk University, Brno, Czech Republic

Staff Training and Continuing Professional Development: Some Suggested Activities

Alan Hurst
Skill: National Bureau for Students with Disabilities, London, United Kingdom

Integrating and Extending Vyhledávač, an On-line Digital Library Aggregator and Search Engine

Matěj Laitl
Faculty of Nuclear Sciences and Physical Engineering, Czech Technical University in Prague, Prague, Czech Repulic

EU4ALL

Lydia Montandon
Atos Origin, Madrid, Spain

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