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Preface

You are holding in your hands *Procceedings* for the Universal Learning Design Track, which was a part of the 13th International Conference on Computers Helping People in Linz. It was a second international gathering with this particular focus; the first was held as a conference at Masaryk University in Brno, 8–11 February 2011 (http://www.uld-conference.org/conference/brno-2011-en).

Masaryk University has been providing services to hundreds of students with various disabilities for years. During the whole existence of the Support Centre for Students with Special Needs that was established as the University's central servicing institution more than ten years ago, providing study conditions of administrative, IT, and technical nature, besides the pedagogical and psychological ones, has not been understood by the University as a service related to a particular student or even as service for the student, but as educational standard that the school is obliged to offer to the public due to its own interests and academic traditions. Thus, it is not primarily a question of individual students' needs, it is rather in the interest of the school and the teacher. It is a question of the design of the academic environment. It is not my intention to consider at this point which is a more relevant term under which conditions in the academic environment, whether it is Design for All, Universal Design for Learning (or Learning Design), or even Universal Design for Instruction (Instructional Design). Our long-standing experience as well as the mere fact that more than a half of university students with sensory disabilities in the country opt for a study programme offered at Masaryk University have convinced us that the differences among the concepts behind the various terms should, or even must, give way should we overcome much more serious obstacles related to specific human needs: the dramatic differences between the approach of human-oriented teachers or psychologists and the technically oriented IT services providers; between research and practice; between theoretical possibilities and everyday experience; and between the seeming variability of commercial offers and the prevailing provisional or ad hoc solutions in educational practice.

The success of the first international conference on Universal Learning Design has inspired us to offer the topic to the organizers of ICCHP, which has been a long-standing meeting place for both researchers in social informatics and providers of various technological services in a field that is more or less identical with our own. People responsible for designing an environment that does not a priori exclude anyone from the academic community and enables them to gain education and participate on research disregarding their specific perception and working methods, do not always share their interests with the two groups of the typical ICCHP participants. It still holds that there are methodological and technological possibilities that are not applicable in the conditions of common practice, or they are not compatible with some other, equally necessary working or teaching methods. The ULD Track aimed to be the place to evaluate research results and market offers by the measures of education practice, do so without bias, free of the somewhat superficial optimism in this field which is often politically or commercially motivated, and be optimistic in a more pragmatic way, which is based on constructive scepticism, inevitable for any specialist when evaluating his or her own results as well as of others.

We would like to express our gratitude to all who contributed to this idea.

We believe that we will have the opportunity to meet you again at the third ULD conference, which will take place at Masaryk University in Brno, 11–15 February 2013.

On behalf of the track organizers,

Petr Peňáz

Head of the Support Centre for Students
with Special Needs, Masaryk University

Plenary keynote

Taking Responsibility for Accessibility: The Authorial Role in Document Creation

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Kevin Carey is the Chair of the Royal National Institute of Blind People (RNIB) UK (www.rnib.org.uk), founder and Director of humanITy, the UK's leading eInclusion charity (www.humanity.org.uk), Chair of the Ofcom Community Radio Fund Panel (www.ofcom.org.uk/about/how-ofcom-is-run/committees/community-radio-fund-panel/), a Board Member of the Social Investment Business (www.thesocialinvestmentbusiness.org/) and a regular contributor the Managing Information (www.managinginformation.com) and Ability Magazine. He is currently Project Co-Ordinator for Go On Gold, raising public awareness of the eInclusion of people with disabilities through the London Olympic and Paralympic Games 2012.

Carey was one of the first global experts in eInclusion and has worked for the EU (including acting as Rapporteur for the Inclusive Communications (INCOM) group as part of COCOM), UK Government Departments (including pioneer work on myguide (http://learn.go-on.co.uk/) for the BBC iPlayer team and for British Telecom on the implications of broadband for people with disabilities. He was a Member of the Ofcom Content Board 2003–06, was awarded a NESTA (www.nesta.org.uk) Fellowship in accessible broadcasting 2004–05 and won a Royal Television Society Award for innovation in engineering (electronic programme guides) 2003. He has presented and/or published more than 100 major papers on eInclusion, disability, blindness and socio/economic trends and recently presented a series of five major lectures on blindness at Masaryk University, Brno, Czech Republic.

As Chair of RNIB, the UK's leading blindness charity, he has a major responsibility for the strategic direction of an organisation with an annual turnover of 150 m Euros per year, more than 3000 staff and 4500 volunteers. From 1994–2000 he was the Editor of the British Journal of Visual Impairment and his first career was with Sight Savers International (1978–92) during which he established the first major computer-based braille production system (The African braille Centre) outside the 'Western' world.

Cambridge and Harvard educated, Carey is a novelist, a published poet, a social commentator and a chorister; he is a former amateur dramatics actor/Director and classical music critic. He is a lay minister in the Church of England and a theologian.

In order to improve the accessibility of educational material for disabled people, it is necessary to create author-engineered public domain documents (PDD) where the accessibility is built into the initial production to optimise the consumption by the end user of the authorial intention.

1 Introduction

One of the strangest ironies in the special needs sector is that academic papers advocating "universal design" or "design for all" do not follow the principles they advocate but are designed – one might better say un-designed – as if for the printing press.

Indeed, one of the most salient features of the nascent digital era has been its tenacious adherence to redundant analogue practices necessary for making plates from lead type, including the use of boxes, the maintenance of right hand justification, the binding of text into read-only formats and, in a related field, the use of bifurcating menus and an adherence to the Dewey principle that any artefact can only be in one class. So much for word processing tools and hypertext.

What I will be proposing in this paper is that authors should take responsibility for the accessibility of their work by using the tools already at their disposal and developing new tools to improve the flexibility and accessibility of digital learning materials.

I will propose that we need to develop the concept of a public domain document (PDD) where the author may keep initial work on a read-only format for the purposes of archiving but that any material specifically intended of public access on a non-discriminatory basis should be so constructed and supported by such tools as will make it as flexible and as accessible as the current state of technology will allow. This central rule should apply in the first instance to all materials produced by the public sector – and therefore funded by the tax payer – all material produced by agencies supported by public money and all agencies whose publicly stated purpose is to provide goods and services to citizens on a non-discriminatory basis. It is my contention that there is a fundamental contradiction between authorial hegemony and the publication of material in the public domain either for the purpose of informing citizens and/or for making a profit. An author who produces a document should not have the right, under these conditions, to render it in such a way that it is not accessible on a non-discriminatory basis by a person acting either as a citizen or a consumer.

In this presentation I will briefly describe:

- The history of the document
- The Technologies of Adjustability
- Text Characterisation & Transparent Rules and
- eLearning Design
- Intertextuality

2 The History of the Document

The genius of Guttenberg was to see that the document is not the document. Up until his time in the Mediterranean world and Western Europe inscription on stone or ink on skins or parchment produced a finished document in one process which could only be reproduced by repeating the whole process from scratch. Guttenberg saw that a meta-document could be produced from which many copies could be obtained and to which amendments could be made and a new version number attributed. Correcting the errors in led type that had been bound into plates was expensive but it was much cheaper than re-tooling stone or amending writing on skins or papyrus.

In spite of this technological breakthrough, the tendency to produce one-off documents persisted in the typewriter which could impress multiple copies on carbon paper but which did not normally produce a meta-document although this was a relatively simple operation, as demonstrated by the mimeographduplicater (e.g. Gestetner). The photocopier was a welcome arrival but the real breakthrough came with the word processor.

But in parallel with this technological history there was also a political history of the document which began, not altogether surprisingly, with the perceived ecclesiastical necessity of controlling the publication of bibles, followed and closely related to the political urge both to control printing and to turn a nice profit by licensing it. The recent attempts by the Chinese to muzzle search engines and by Apple and Facebook to build extremely lucrative walled gardens are only the latest manifestation of a long history of attempts to exercise political or monopolistic control over the means of self-expression.

But licensing and censorship led to the concept of copyright which closely paralleled legislation on land and property holding; and the whole scenario was completed by the quite preposterous assertion of copyright by the public sector on intellectual property paid for with taxation.

The public sector is a good starting point for a discussion on the nature of the private and the public because on the surface public documents should be public. There was a brief period when the document processor choice was Word when public documents were not only theoretically but actually adjustable but the emergence of PDF brought the whole issue of adjustability into focus because there is a direct conflict between document integrity and accessibility.

Before drawing this historical section to a conclusion, just a word about the relationship between document technology and the authoring process. I remarked earlier that digital document authors have been very conservative in document design and processing; and this is mirrored in a conservative understanding of what documents are. The prevalent understanding, even in the public sector, is that documents are authorially owned, uniquely authored artefacts; but this is to confuse how documents are made with what they are. Documents in the public domain are created to convey an authorial intention to a consumer; and so when an author creates a barrier to consumption then she is frustrating her own supposed purpose.

3 The Technologies of Adjustability

It ought to be obvious by now, a quarter of a century after the first word processing packages for small business and cosmetic use, how authors can take simple measures to achieve a substantial degree of adjustability but it is surprising how little good practice there is.

Let me start with a definition of adjustability as: ***The ability of consumers to realise an authorial intention through the use of technologies to alter the style of an authorial production.***

It is important to note at this point that any such adjustability has to be optimal rather than total, a point to which I will return later.

In terms of standard text output on screen and in documents, the following adjustments should be available as standard:

a) Data Characteristics:

- Granular
- Defaulted to simple for incremental enhancement
- Accessibility features on
- Multi modal
- User interface neutral

b) Print:

- Size
- Font
- Leading (distance between lines)
- Kerning (distance between characters)
- Relative n height
- Right hand justification on/off

c) Colour:

- Background/foreground
- Brightness

It might be thought that these characteristics are obvious requirements of adjustability but the root problem is that there is not an authorial requirement to ensure that these features are available or even, with the appropriate tools, realisable. Thus, we have a four-step sequence of possible barriers to realising the authorial intention:

- The author partly or wholly lacks a knowledge of adjustability features
- The Author has knowledge of some or all features but does not possess them or the ability to facilitate them
- The author makes digital information potentially totally adjustable by a consumer with appropriate tools
- The consumer lacks the appropriate tools

In short, there is no authorial responsibility for adjustability built into the authoring process.

Before returning to this subject to discuss solutions, it is important to look at another aspect of accessibility which is the ability of the consumer to apprehend the authorial intention lexicographically and syntactically.

4 Text Characterisation & Transparent Rules

A text which wishes to convey an authorial intention must necessarily take its reception, its consumer facility, into account. This issue was clarified for me many years ago during a language engineering project struggling with user response when we began to analyse consumer segments. We took as our example a United Kingdom government pronouncement on state income and expenditure, the annual budget.

Here are some propositions about a budget:

- It deeply affects all citizens
- It is announced to citizens by the Chancellor of the Exchequer (Minister of Finance)
- It is reported to citizens largely by journalist intermediaries
- It is enacted in legislation

The four parties respectively require the following:

- Citizens – A clear statement of measures and their consequences
- Politicians – A statement which puts the best possible interpretation on the measures
- Media – Reports which engage the reader/viewer/listener to fulfil the mission and maintain/improve audience
- Legislators – Require a clear legal text which enacts their intentions with as little ambiguity as possible.

Not all these requirements can be met from one text and so the elegant approach would be to start either with a very simple text which met publicly stated requirements or a legalistic text which could be easily and transparently simplified. In reality such a document is assembled from all kinds of sources and texts but the elegant approach should clarify the basic necessity for rules-based systems.

Let us start with a primary requirement which I will call "consumability": ***A text should maximise the extent to which the author's intention is realised by the primary audience***.

If we think again about our budget text we will see that it is not easy as a matter of principle to decide on the primary audience; is it the legislator, the journalist or the citizen? I suggest that this should not be considered as a matter of principle but rather as a matter of practice as the necessary precondition to a reversibility principle; that: ***It is much easier to simplify a complex document with a set of transparent rules than to enrich a simple document with the same reversed rules***.

Underlying this pragmatic approach is the principle of reversibility, namely: ***The authenticity of any simplified form of a document should be verifiable through the publication of associated rules***.

In other words, no simplification of a public document should be published without the intermediary showing how the author's initial text was amended. As a guarantee, of course, there is a final principle that: ***Access to an amended document with its modification rules must be accompanied by access to the original document***.

Political problems arise with budgets because the legal and the simplified versions appear in parallel without any such rule making.

The reason that this discussion is so important in the field of accessibility is that there are many citizens, notably those with impairments, who find it difficult to apprehend an authorial intention which means that documents fail on the ground of consumability. We qualified this concept earlier by talking about a primary audience but it is difficult, as we also noted, to rank lawyers over citizens, or vice versa, as the primary audience for a substantial citizenship document.

My key proposal, therefore, in the context of what I will come on to describe as a public domain document (PDD) is that responsibility not only for its adjustability but also for its consumability should be the responsibility of the author who can, for example:

- Tag the ranking of portions of text to produce a ranking of priority in verbosity
- Certify a set of lexicographic equivalences or 'translations' from the technical to the non-technical

It should be noted in this context that the use of technical terminology often decreases verbosity and so simplification does not always mean shorter documents.

Nonetheless, it is now possible to imagine a Public Domain Document which offers various degrees of verbosity and lexicography.

In summary, then, a Public Domain Document (PDD) is: ***A document which is optimally accessible through the facilitation by the author to the consumer of adjustability and consumabilitytools in association with document delivery***.

This definition somewhat unconventionally extends the concept of accessibility from its near equivalence with adjustability and gives it a postmodern dimension of consumer reception. It also uses the term "optimal" as opposed to "total" or "universal" which imposes an impossible level of cost. In this instance "optimal" is defined as: ***The affordable balance between the cost of provision***
and the degree of consumption.

Finally, the definition speaks of "facilitation" because it is the responsibilityof the author to ensure tools not necessarily to duplicate their provision.

5 eLearning Design

I have so far used the political arena for a discussion of PDD because that is where the most obvious case lies for its implementation, in the case where public-sector information is financed from taxation.

eLearning falls into a slightly more contested category.

There are five grounds for implementing PDD in eLearning document design:

- Good practice
- Law or regulation
- Public sector provision
- Private purchase
- Customer flexibility

The first three of these grounds are simple and need no explanation but I would like to spend some time on the last two.

Historically, ever since Plato regretted the development of writing as a dangerous abridgment of teaching through dialogue (and even in that case there is more than a suspicion that the questioner was simply a 'fall guy') the content of instruction has been teacher and not student defined. This initial Greco-Roman model was reinforced in turn by:

- Religion – Theological and doctrinal, moral, philosophical and scientific content

- Etiquette – Class obligation, manners, warfare
- Vocational – Ecclesiastical, law, public administration, teaching, medicine
- Craft & occupational – Reading, writing, calculation
- Services – human relations, psychology, social science

This modernist, public sector provision reached its hegemonic and client peak at the end of the 20th Century but with increasing and parallel shifts:

- Of economic power from state provision to private purchase
- Of cultural emphasis from modernist rigidity to postmodern fluidity
- From vocational and occupational to generic skills
- From location-based to distance learning
- From passive to participative involvement and
- From stratified to multi-level learning environments

The 'top/down' didactic model is beginning to break down.

The earliest and greatest changes will naturally occur where the above factors are most salient and that is bound in almost all cases to be in our universities and places of higher education. It will be a much longer time before the conservative bastions of state secondary and even more so primary education will be affected but all these six trends are inevitable.

The connection between provider flexibility and purchaser power is obvious: if purchasers exercise their power over providers then providers will be unable to impose their agendas on purchasers. This is a daunting prospect for a fundamentally conservative educational environment (remembering that radical content has been dispensed in conservative teaching and learning environments for more than 500 years in Europe, since the foundation of universities) and it will seriously damage monopolies and cartels. The counter movement of standards competition generated by a global skills market will somewhat retard this postmodernist development but it is too strong to be resisted.

From the perspective of people with impairments which affect their ability to consume educational material, my point on flexibility goes well beyond the economic.

Here are examples involving:

- Language
- Lexicography
- Syntax and
- Verbosity
- Complexity

Let me take as an example, related to my earlier discussion of budgeting, a piece of historical text about the financial conduct of the administration of King Henry VIII of England or King Louis IV of France.

4a) Language. The first question is whether the learner needs to learn the language in which the monarch's documents were written or whether, in the view of the teacher, the source material does not possess those nuances of language which must be understood but which cannot be translated in order to grasp the essence of the case. As the source

material refers to financial rather than, say, emotional, matters, access to the source material in its initial language seems marginal rather than central.

4b) Lexicography. Let us say that at some period a monarch was short of money because he was spending more than he raised in taxation. A financial technician would say that he was running a current account deficit which required fiscal tightening but a generalist would say that he either needed to spend less and raise more, or both. The question for the information provider is whether the task of the learner is to understand the monarch's situation or to understand technical terminology, what some people would call jargon. Again, the ability of the learner to grasp the essence of the case is not dependent on the grasp of technical lexicography which, some would argue, has been developed to 'protect' professional oligarchies from intrusion.

4c) Syntax. At this point we reach an area of pedagogy which is much more complex, relating to the relationship between "what" and why". complex syntax is usually associated with "why" rather than "what"; and we need to be careful to distinguish between the two. Does our learner need to know about the fiscal policies of monarchs or about why they got into situations and why they chose one solution or another for putting matters right, if that is what they did. Or, to put it another way, are all those complex subordinate clauses entirely necessary to the task in hand?

4d) Verbosity. As we saw earlier, reducing verbosity does not necessarily produce simplicity.

4e) Complexity. Underlying all of these issues is the matter of complexity and how far the learner – over and abovea contemporary postmodern suspicion of grand narrative – is required to account for an action of a monarch by recounting a complex set of speculative factors including:

- Notionally measurable factors such as income and expenditure
- Optional factors such as the need or otherwise to wage war (expenditure) or to avoid civil unrest (lowering taxation)
- Apparentlycontingent factors such as the monarch's sexual and emotional state of well-being or otherwise
- Contemporaneously unknown factors such as the monarch's possible underlying state of health

From this discussion it can be seen why an eLearning document should conform to a Public Domain Document standard.

6 Intertextuality

Finally, a short note on intertextuality. The best example I can think of where intertextuality would have been of immenseservice to European Citizens in the case of the Infamous Maastricht Treaty of 1992 which is a series of what look like instructions to a printer to add certain clauses and delete others. This pattern of statement, response and emendation is a hangover from analogue printing and hand writing whereas current technology offers an opportunity for both authorial and consumer intertextuality so that a piece of work can be considered as a working progress rather than as a final word. This method also allows the learner to stay close to the text and comment on it instead of having to generate a parallel or responsive text that must, in essence, stand alone.

7 Conclusion

In summary, the use of a Public Domain Document strategy will give users greater flexibility but it will also facilitate a much more refined approach to learner requirements. It is quite difficult enough to be a disabled person in a learning environment without being forced to learn what you do not need nor want.

It is time to transfer the responsibility for accessibility from the consumer as a post-production operation to the author as part of a standard document preparation process.

Section 1

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

SignLEF: Sign Language European Frame

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Keywords: sign language, deaf people, Common European Framework of Reference (CEFR) for Languages

Abstract

The aim of the SignLEF project is to develop a common basis for presenting three sign languages (Austrian Sign Language, Catalan Sign Language and Italian Sign Language) in accordance with the guidelines of the Common European Framework of Reference (CEFR) for Languages. The whole project is based on information and communication technology: Sign language texts are recorded and administrated electronically; via the internet and respective software, users will have complete access to the signed texts, all documentation and instruction.

SignLEF is a project of the Lifelong Learning Programme funded by the European Commission. Project coordinator is the University of Barcelona (ESP), partners are ISSR – Istituto Statale Sordi di Roma (ITA) and the Centre for Sign language and Deaf communication, Klagenfurt University (AUT). SignLEF started in January 2011 and is a three-year-project.

1 Introduction: State of the Art and Application Idea

The Committee of Minister of the Council of Europe recommends the use of the Common European Framework of Reference for Languages in setting up systems of validation of language competences [1].

The CEFR is a document which describes the competences necessary for communication, the related knowledge and skills as well as the situations and fields of communication. It is of particular interest to all who are directly involved in language teaching and testing. It facilitates a clear definition of teaching and learning objectives and methods and provides the necessary tools for an assessment of proficiency.

The CEFR has become a key reference document and is available in over 35 language versions.

Thanks to CEFR the official instructions for learning and teaching languages in the European Union have been unified. A set of language levels has been developed, making it easier to standardise all the various qualifications.
The six levels are:

- A Basic speaker
  - A1 Breakthrough or beginner
  - A2 Waystage or elementary
- B Independent Speaker
  - B1 Threshold or intermediate
  - B2 Vantage or upper intermediate

- C Proficient Speaker
  - C1 Effective Operational Proficiency or advanced
  - C2 Mastery or proficiency

2 CEFR and Sign Languages

In September 2011 an Exploratory Workshop of the European Science Foundation (ESF) took place in Zurich in order to setup a Europe-wide collaborative network. Its aim was to share existing knowledge related to sign language instruction, learning and assessment and to prepare a collaborative research project [2] .

In the last few years second language learning and teaching methods have been changed as well as the examination of attained language skills. This development has led to the introduction of the CEFR and its implementation in the educational system; however, so far only spoken languages benefit from it. Although different innovative sign language projects in this field are taking place in the United Kingdom [3], Switzerland, Ireland [4] and France, there is no description of any sign language that completely follows the principles of the CEFR yet.

2.1 Status of Sign Languages

SignLEF supports linguistic diversity in the European Union and helps to improve the quality of the structures and systems involved in sign language teaching. One of SignLEF's aims is to promote the awareness, as well as teaching and learning methods for sign languages in each participating country. The outcome should be the strengthening of users' rights as citizens and improved access to equal opportunities. Furthermore, it should lead to greater respect and similar treatment for sign languages in Europe, so that sign languages may attain the same status as spoken minority languages.

The main aim of the project is the adaptation of the CEFR for sign languages and the organisation of a respective course. There are two main perspectives to include sign languages into the CEFR framework. The first is a political one: sign languages do get the chance to reach equal status as spoken languages. The second is a pedagogic and linguistic one: an established concept for language learning and competence evaluation is applied.

Related to both perspectives, any inclusion of sign languages into the CEFR framework has to guarantee the full comparability and functional equivalence of sign languages with spoken ones. This can only be done if the intended sign-language-related CEFR is as close to already existing spoken-language-related CEFR as possible. As a consequence, the structure of CEFR has to be adopted as it is, whereas no CEFR feature may be disregarded for sign languages and only necessary changes/complements have to be performed. From that, special tasks or problems arise, such as

- the factual non-existence of a writing system for sign languages,
- the appropriate representation of the typological characteristics of sign languages ,
- the appropriate representation of deaf culture.

Linguistic Aspects

From the linguistic perspective, the only acceptable basis for comparisons between languages are communicative functions and speech(/signing) acts. Authentic sign language texts have to be produced based on these functions and acts. Here the task of adequate instruction of Deaf signers is not trivial because these functions and acts are only described in written language; the same is valid for examples. This may bias the sign production.

In order to include Deaf cultural-specific information and values there has to be a constructive principle for all parts of a CEFR adaptation to sign languages.

Concerning sign languages the only level descriptions available are for French Sign Language (LSF) and Spanish Sign Language (LSE). There is no existing course or material which explicitly keeps to the CEFR structure and contents.

Taking the full comparability of a sign-language-related CEFR to the spoken-language-related CEFR into consideration, full documents should be available in every sign language included into the CEFR. This means a translation of the general content (e.g. on learners and learning) into the respective sign languages, as well as having all the language competence oriented parts (speech acts, lexicon and grammar descriptions) in sign language. Projects such as SignLEF will only be able to produce parts of the intended sign-language-related CEFR as the application of the general principle results in a huge amount of work.

3 CEFR and Austrian Sign Language

Based on Breakthrough, our team of deaf and hearing colleagues developed a course concept in terms of (scripted) lessons that might serve as the basis for SignLEF. Lexicon, dialogues and exercises were filmed. For the adaptation of CEFR to Austrian Sign Language, we compared the competence levels in the English version with *Gemeinsamer Europäischer Referenzrahmen für Sprachen* (GERS), the German version of CEFR adapted by Goethe Institut [5, 6] as well as with LSF and a version of British Sign Language (BSL QED) [3]. In a first step a common description of the six levels was translated and afterwards filmed by one of the deaf colleagues.

3.1 Speech Acts

Unfortunately we soon realised that it took us rather long to capture the course concept – also due to the fact that CEFR does not offer any course itself but only competence descriptions – and therefore we tried to find a way to make working more efficient. We also decided to work without any written texts to be used as a model for the sign language production by our deaf colleagues.

The basis for the comparison of languages is the speech act list. Therefore we decided that its realisation in sign language should be the primary goal of our work. We determined to concentrate on single speech acts and to shift their connection into dialogues to a later stage of work. The advantage of this strategy is that – in accordance with the spoken-language-related CEFR – every single speech act is documented and can be looked up individually. We excerpted the speech act list from *Profile Deutsch* [5], which concerns levels A1 to B2 and distributed these speech acts – with minimal changes in

order to fit deaf communication culture – to the respective levels, using the examples of the English and German versions of CEFR.

A selection of speech acts related to A and B level was handed over to our deaf colleagues and they were asked to realise them without any further discussion on possible content or structure; the deaf colleagues were asked to produce realistic variants of speech acts (shown in Fig. 1.). Afterwards the deaf colleagues should assign them to the general levels A or B, using their didactic experience from sign language courses held at the university. The realisations will be translated and later also analysed grammatically. This is how we try to find the ideal method to be applied.

[Fig. 1] Realisation of a speech act

If we find that the simplest variants of speech acts have not been produced yet, we will discuss the criteria for simplicity and then produce the "easiest" variants for the first level where the respective speech act is expected to occur for the first time. This should guarantee a hierarchy of complexity within different variants of speech acts.

To give an example: The speech act of *turn-taking* can be fulfilled in a very simple way e.g. by using *please* and the accompanying non-verbal behaviour (using a respective gesture) – which would relate to level A1. In order to explicitly realise this speech act, one should be able to sign a sentence like *Please, take your turn now!* or *You are next!* – which would relate to either level A2 or B1. That means that we have the possibility of producing very simple utterances which can be related to a certain speech act within a given context but can also serve to represent very different speech acts within other contexts. And we have the possibility to produce utterances which explicitly represent only the speech act intended. Along this dimension we have to introduce a competence hierarchy between different realisations of speech acts related to levels A1 to B2, using the different criteria for complexity in grammar, lexicon or pragmatics. In other words: When assigning speech acts realisations to levels, the grammatical-lexical complexity of the respective realisation has to be evaluated.

3.2 The Adaption of CEFR to and for Austrian Sign Language

Additionally, we started cooperation with the Department of Translation Studies at the University of Graz[1] in order to be able to do all the translation work needed for the adaption of CEFR to and into Austrian Sign Language. Students of the Department of Translation Studies were asked to do translation work within the course of *Austrian Sign Language: Discourse Analysis and Translation Techniques*.

The course introduces students to a range of text genres as well as specific problems of translation (metaphor, culture-specific references etc.) to allow them to further develop their research, terminology and translation skills, text and discourse analytical skills and self-assessment skills.

The main aim of our research work was to get an overall view of the topic. GERS texts were adapted to Austrian Sign Language and deaf culture. Some texts had to be discussed in class several times. The students tried to filter the most important parts of GERS as we wanted to make the CEFR more user-friendly. Chapter 1 and 3 were adapted. Chapter 2 was not taken into consideration as there are so many repetitions. These texts were filmed and edited.

4 Results and Impacts

Until now we have completed an analysis of best practice sign language courses for hearing people in Austria. It turned out that there are a lot of different courses for hearing people interested in Austrian Sign language all over the country. These courses are carried out by many different organisations and with different objectives. A lot of them are organised by local deaf organisations and most of the teachers are native signers. Furthermore, there is an ongoing discussion about who is allowed to teach sign language and for what reason. This reason makes it even more urgent to have a CEFR in Austrian Sign Language.

The first vocabulary, the topics as well as the grammar topics hardly differ in the basic courses (level A1/A2). Unfortunately there is still a lack of material and exchange amongst the native signers and it is a fact that (because of the poor educational system for deaf people in Austria) most native signers do not have a very good knowledge about the grammar of their own language.

Moreover, most of the courses offered do not exceed A2 or B1 level. There are only a few institutions offering best practice sign languages courses for all levels of CEFR (A1–C2).

4.1 The Results of Sign LEF so far

A Demo DVD containing the first parts of level A1 including dialogues, exercises and a general project description (shown in Fig. 2.) available in written form and as signed videos will soon be finished.

1 http://www.uni-graz.at/itat/

[Fig. 2] Realisation of the general project description

An adaption of the general level description of CEFR for the three sign languages has also been finalised. At the moment we are working to get our webpage online[2] and on the realisation of the speech acts. Additionally, two chapters of GERS in an Austrian Sign Language have been finished so far. All sign language videos produced will be available on the internet.

5 Conclusion and Planned Activities

Until the end of the project we will realise as many speech acts as possible. We will also give a version of the most relevant parts of the general content of GERS (related to learning, teaching, etc.) in Austrian Sign Language. We will furthermore inform the public and especially the target groups about our project and offer them the project results and we will keep up the cooperation with researchers and institutions in Europe.

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2 http://signlef.aau.at/

Specifics of Specialized Science and Medical Programs Terminology Development in Czech Sign Language

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The integration of students with hearing impairments in tertiary education and especially in science and medical programs includes two important areas – possibilities of integrating the hearing impaired into the common system of university education and possibilities of integrating them into vocational training so that they are able to work independently when they graduate.

The group of students at the Faculties of Medicine and Science of Masaryk University is small, and from the perspective of hearing impairment heterogeneous. However among deaf students studying these fields visual-motor forms of communication are almost always preferred. The language of communication of the majority of hearing impaired students at the Faculty of Science and the Faculty of Medicine at Masaryk University is Czech Sign Language, which is their native language. Upon deeper analysis of the reasons for this preference and in light of the findings of research on the linguistics of sign languages we have come to the conclusion that the processes of acquiring spoken and sign languages are comparable, and their stratification is identical. This communication systems do not define educational aims, but creating a functional means of communication is one of the main priorities of the education of students with hearing impairments for making these fields accessible to students with hearing impairments. Consistent with general educational possibilities for hearing impaired students and with the conditions of studying at Masaryk University, students prefer the bilingual approach, which also helps integrate students.

Czech Sign Language is not equipped with scientific sign language terminology for historical reasons. Most specialized signs were initially developed as loans from spoken languages (fingerspelling). The need to expand Czech Sign Language vocabulary is growing together with students' need to understand specialized topics. For these reasons, the systematization of the creation of specialized terminology began. General issues of this systematization, number and composition of teams and the procedures of their work are presented in a lexicographic paper by Tomáš Sklenák and Jan Fikejs, which is why in our paper we focus on the specifics of the work of the science and medical programs group.

The long-term and exceptionally close co-operation of deaf students as sovereign sign language carriers and users with interpreters and expert teaching staff including teachers with knowledge of Czech Sign Language making it possible to use sign language as the language of instruction in specialized subjects are among the specifics of the MU terminological group for science and medical programs. Thus, students are able to communi-

cate with their teachers without an interpreter in their own native language eliminating possible mistakes resulting from coding between different language systems, and knowledge of the structure of specialized terminology in Czech together with knowledge of the structure of Czech Sign Language allows for insight into and a more accurate evaluation of the meaning of specialized signs, while being able to discover possible risks of interference and confusion with other similar signs with different content. Terminological groups include interpreters with experience in medical and science fields responsible for supervising the creation of glossaries and linguists responsible for checking created signs and definitions.

Background materials for these terminological groups were systematically prepared by using terminology frequency analysis. First recommended textbooks from selected courses at five faculties in the Czech Republic were collected (totaling 16 books). The subjects analyzed were: biology and molecular biology, chemistry and biochemistry, histology, microbiology and pharmacology. Suitable chapters from each book were selected for subsequent content analysis (totaling 63 chapters).The results of the terminology frequency analysis were broken down into thematic sub-groups. A statistical comparison of the terminology composition of each textbook was also conducted. Specialized terminology with statistically significant frequency in the recommended literature from fields of study that deaf students study was identified.

The fact that the analysis focused only on written texts was problematic, as they do not necessarily correlate with the spoken form of language in these specialized fields. It would be possible to analyze spoken specialized language by analyzing recordings of lectures and seminars, but Masaryk University of course has no such recordings available. Thus, a group of selected experts working in cooperation with the institutes responsible for teaching these subjects analyzed the results. Deaf students also took didactic tests where they assessed their understanding of terms used in their lessons, and interviews were held with them afterwards in order to further verify their understanding of terms. As a result of the frequency analysis, terms that appeared in the literature, but were less frequent in spoken language were removed and other terms were systematically added to the thematic sub-groups. For example the names of most enzymes appearing in chemistry and biochemistry textbooks were removed, while on the other hand other taxonomical terms (*division, order, class, phylum* and *kingdom*) were added to the terms species, genus and family determined by the terminology frequency analysis. Multi-word lexical units commonly appearing in the studied texts were also identified. Using modified terminology analysis 1283 terms were determined, which were broken down into thematic groups that were presented at terminology meetings.

In order to define these selected terms Czech lexemes were defined using invariant and variant sememes with emphasis on the fact that they will be used in a glossary. When creating definitions in the natural sciences the basic rules for creating dictionary definitions must be respected. Each term was described by determining its genus and was further specified by describing its differentia. For example here is the definition of plasma, one of the basic components of human blood: "Plasma is a yellowish liquid making up the liquid base of human blood". Plasma is defined as a yellowish liquid component of human blood, and it is further specified that it is different from other yellowish liquids in the human body in that it makes up the liquid base of human blood. In the presentations

an overview of the sememes of each lexeme was given, and selected defined specialized Czech terms were supplemented with illustrations. Each term was used in context during the presentation as well.

As part of the preparation for creating new signs, foreign specialized signs were collected for example from ASL (Medical Sign Language: Easily Understood Definitions of Commonly Used Medical, Dental, and First Aid Terms, Random House Webster's American Sign Language Medical Dictionary, UC San Diego Moores Cancer Center, ASL-STEM Forum University of Washington, Needs Outreach, DeafMD.org, etc.), BSL (BSL Glossary, Scottish Sensory Centre, Moray House School of Education, University of Edinburgh) and others (Auslan Signbank, Dictionary of the Flemish Sign Language – Woordenboek Vlaamse Gebarentaal). In addition to just the foreign signs, the context of their use was also studied.

The process of Czech Sign Language terminology creation pays respect to the visuality of sign language and adequacy of content. Signs for specialized terms are either created by the terminologization of an existing sign, by its transfer to an analogous field based on visual shape, function and properties, or they are completely new signs. Systematically borrowing existing signs from other sign language systems or the systematic usage of abbreviations used in other sign language systems was deemed to be inappropriate for Czech Sign Language. This was due to the fact this would introduce unnatural elements into Czech Sign Language (not only in the form of created signs, but also in the way that signs are created). With the help of linguists recommendations for specialized signs were examined and produced, as well as the relationships between the Czech definition and the proposed definition in Czech Sign Language.

An example of a created sign based on a similar shape is the sign for the genus of bacteria *Staphylococcus*, which looks like a bunch of grapes under a microscope (the sign for a bunch). Sign language users thus proceed in the same way as creators of Greco-Latin terminology (σταφυλή), albeit independently. Another example of a sign created based on shape and structure is the sign for the DNA molecule, which has been portrayed as a double helix ever since the discovery of its structure (a hand movement indicating a double helix, the movement also presents spiralization). Examples of signs derived from function are the stages of gene expression – *replication, transcription* and *translation*, or signs for the stages of mitosis, whose signs include information about the situation inside a cell during mitotic segregation. An example of a proposal for a new sign is the sign for the term bacteriophage. Despite the fact that a *bacteriophage* (a virus-infecting bacteria) may have various shapes, it has a standard shape in illustrations in the literature. Unlike with other terms, it is, however not possible to derive the sign from the structure of the organism as such due to the risk of confusion. Nor is it possible to proceed from the definition or function of the organism as the signs for virus and bacteria are very similar in Czech Sign Language. An expert with knowledge of Czech Sign Language can operatively show to the terminological group the limitations of the proposed solutions or possible confusions with other signs, and he/she can also add explication in sign language. A specialized term proposed by the terminological group is then maximally visual and respects sign language grammar, but it is at the same time adequate in content and in harmony with other proposed specialized signs.

Interpreters with previous knowledge in these fields form an integral part of the terminological group. Interpreters are required to give an accurate translation which preserves the level of expertise (adequacy of content) as well as considering non-standard conditions in laboratories or hospitals, which students of science and medical programs are expected to visit. Some of the theoretical rules that stand as recommendations for interpreters had to be modified according to emerging situations. Examples are the color of clothes (a white cloak in the labs), a higher level of co-operation with students incapable of carrying out experiments, taking notes and looking at the interpreter all at once, and a higher level of co-operation with teachers due to temporal and spatial conditions in the labs. The result is the full and natural integration of hearing impaired students in specialized departments of the University.

An emphasis on specialized terminology development not only helps to save time, which is important in the specific conditions in the labs, but above all, students have greater possibilities to actually using specialized terminology in communication. Spontaneous specialized communication in CSL using the created terminology naturally prevents forgetting and usage reduces the risk of confusion. Students with hearing impairments must be motivated to integrate and be involved in international projects in their native language. The bilingual approach motivates and helps students to naturally enter into the world of tertiary education, and facilitates natural communication about specialized issues, although with emphasis on work with primary sources in Czech and English.

The close co-operation of expert teachers, interpreters and deaf students has proved to be an indispensable part of adapted tuition in science and medical programs, which aims at respecting the specific requirements expected of students and at the same time integrating sign language users into departments with a hearing majority.

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A Virtual Character based Italian Sign Language Dictionary

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Keywords: Sign Language, Accessibility, Dictionary

Abstract

This paper presents a novel Italian to Italian Sign Language Dictionary that displays word translation by means of a virtual character. The Dictionary is linked to MultiWordNet, a lexical and semantic database which includes several languages. The objective is to use it as a learning tool for Deaf people to enhance the learning of written languages.

1 Introduction

Sign Language is a gestural visual language with signs as lexical units instead of words. Sign languages have their own grammar, which are quite different from oral languages [1]. Sign Language is not a universal language. Each country has its own Sign Language such as American Sign Language (ASL), British Sign Language (BSL) and Italian Sign Language (LIS). In some countries more than one Sign Language is used e.g. in Switzerland, Swiss-German, Swiss-French and Swiss-Italian Sign Language(s) are used [1]. In this paper a Platform Independent LIS Dictionary (henceforth referred to as Dictionary) is proposed to support Deaf learning of both Sign Language and written language. It provides full set of lexemes and videos data set and an online interface with MultiWordNet. This paper is organized as follows: in section 2, related work is described. In section 3, the ATLAS lexicon dataset is explained. In section 4 abstract architecture of the Dictionary is presented. Section 5 concludes the paper.

2 Related Work

There is a considerable work in progress on Sign Language dictionaries but many of them have limitations by providing limited functionality i.e. only for a word-to-sign search and only limited lexicon data set is available usually prerecorded with the help of a signer [10], [3]. Mobile ASL (American Sign Language) is a project of Washington University on Sign Language communication over cell phones in which they are checking limitations especially low bandwidth constraints of the current cell phone networks which created many video compression challenges because even today's best video encoders cannot yield intelligible ASL at such low bit rates [11]. A large lexicon project was started for American Sign Language, which facilitated large lexicon data set, but the purpose was to find similar signs in database by taking new video sign [4]. Vcom3D [12] developed and evaluated a proof-ofconcept American Sign Language and Signed English dictionary for handheld computer and media player devices. The dictionary included signed animations of English terms that could be difficult for Deaf learners to understand, including idioms, scientific terms, and words with multiple senses. The Corpus NGT is

another effort to record and archive video data from Sign Language of the Netherlands [5]. The users of the dictionary face the problem in extracting information on meanings and grammatical characteristics about the signs from the glosses. They also have the difficulty in finding information from (Dutch) example sentences, the grammar overview and from the word list. Instead, this information should have been provided in a clear way in the entries and according to grammatical categories.

3 ATLAS Lexicon Dataset

The MultiWordNet database is a multilingual lexical database that links words with respect to their synonymy. It is aligned with Princeton Wordnet [13]. The MultiwordNet database was created on the idea of concept mapping. The concept mapping is the procedure to form meaningful relationship between lexical words. It is argued that the concept mapping process promotes and assists meaningful learning by encouraging learners to identify key words, establish relationships with other words and relate new concepts with the prior concepts [14]. In MultiWordNet concept mapping is achieved by interlinking nouns, verbs, adjectives, and adverbs through semantic relations of synonymy, which are called synsets. By linking the dictionary with MultiWordNet database enriches the possibility to find the meanings of the lemma in LIS. The users can also explore the sign of synonym or words similar to lemma in order to better understand the concept.

3.1 ATLAS features

The Platform Independent LIS Dictionary is part of the Automatic Translation into Sign Languages (ATLAS), which aims at automatic translation, from Italian text into the corresponding Italian sign language. Currently, the main target of our work is to provide the signing avatar for the weather forecast bulletins broad casted by national broadcasting network Radio televisione Italiana (RAI). We have adopted mixed approach for the generation of signs, using an animation language to compose and parameterize pre-captured and hand animated signs.

The animation system consists of Planner, the Executer and the Animation engine. The knowledge-base consists of sequence of signs (encoded in ATLAS extended written LIS representation) which is input for the planner. The executer retrieves definition of the animation rules from signary where all the animated signs are stored. For each sign, it applies the matching animation mapping rule to obtain language expression for sign realization. These animations are provided as input to the animation engine, which performs the visual sign using avatar. The parameters (i.e. objects and locations) specified for each actions are bound to values and animation engine is invoked by the executor for final animation generation [6]. To create parallel corpus, a set of weather forecast bulletins broad casted by RAI were collected. Only portions related to the forecast of weather were extracted, then the contents of refined text are interpreted by LIS expert, and a sign movie is generated from it.

3.2 ATLAS corpus and lexicon

Our Sign Language dictionary provides more than three thousand videos of LIS signs. These sign videos are set of Avatar animations, which are rendered through a graphic en-

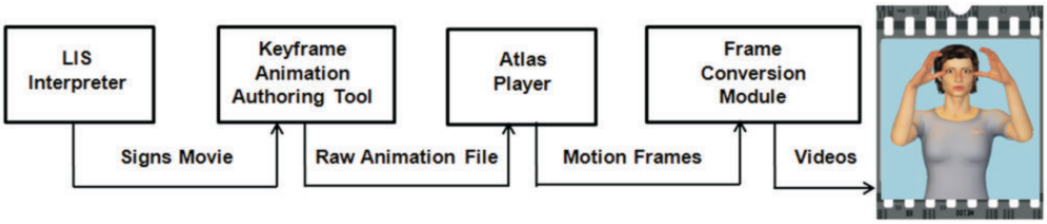
gine. Each sign is linked to a corresponding Italian lemma existing in the MultiwordNet database [7].

About Three thousand LIS video animations were created using standard Lingua dei Segni Italiana dictionary. Where, about four hundred signs were custom created by a team of expert signers and deaf. The existing corpus contains the translation of 55 Italian weather forecasts and corresponding LIS animations. These sign movies were created using the data collected from weather forecast bulletins of RAI.

4 The LIS Dictionary Architecture

The Sign Language Dictionary takes Italian lemmas as input and provides their visual representation in LIS as output to the end user. The process for the generation of avatar based signs in the LIS Dictionary is shown in Fig 1 . The control flow works as follows:

1. A LIS interpreter perform the sign of each lemma which is recorded through motion capture .
2. A raw animation file is produced through the key frame animation technique.
3. The raw animation file is played within the ATLAS player in order to produce virtual character based motion frames.
4. The frames are converted in movies by means of an automatic procedure.



[Fig. 1] The process for the generation of avatar based signs

Italian words, which the system takes as input, are linked to the correspondent movie in the database. The signs are rendered through the ATLAS Player developed at Virtual Reality and Multi Media Park which is able to perform several functionalities such as the blending of signs in one sentence and the application of procedural transformations on the sign to manage relocation [6]. Below a short description of the visualization module and of the procedures applied in order to produce LIS Dictionary lemmata.

4.1 The ATLAS Visualization system

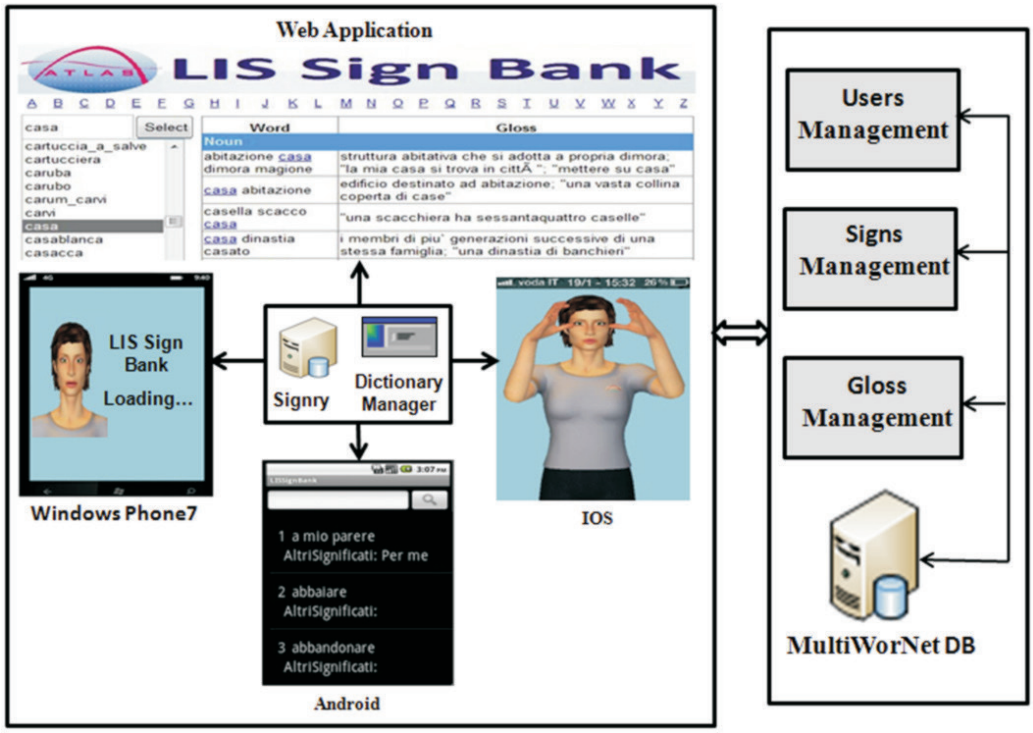
The module used for the signs generation is system that generates real-time animations, display them in a player and export them as picture frames. It takes as input the symbolic form of LIS called ATLAS Written Extended LIS (AEWLIS) [8], a sequence of lemmata and a description of the meaning, syntactic number and other semantic, pragmatic and articulatory information.

The signing space in front of the interpreter is structured with locations where the items mentioned in the sentence are positioned and kept for further references in the sentence. Signs are described by a default animation (stored in a repository, the "sig-

nary"), which has to be parameterized with respect to the context given by the specific sentence. When the player receives a sentence in AEWLIS form, it plays the signs in sequence adding manual and non-manual components with well defined priority strategies [9]. To some extent the LIS Dictionary involves the aforementioned signary and links it with additional information provided by MultiWordNet.

The LIS Dictionary is implemented in such way that its functionality can be enhanced according to the availability of resources. For offline users lexicon data set along video signs is stored locally while for online users dictionary is mapped with MultiWordNet synsets in client server fashion. Figure 2 shows an abstract architecture of the Platform Independent Italian Sign Language dictionary providing the comprehensive meanings of requested lemma. The dictionary provides same interface for mobile and web users in which user enters or selects the required word from preloaded list of lemmas. LIS video animation is displayed against selected lemma. If the video of desired lemma doesn't exist in the dictionary, user can explore the LIS meanings of the related word/words existing in synset, which exist in LIS dictionary to get an idea of the meaning. Availability of signary database locally maximizes the performance, as no streaming is required. Browsing through synonyms helps to enhance the usage of same sign for different lemmas.

To continuously enhance the system with new signs or optimize existing one and animated Signs Management is performed by System Administrator from the server side.



[Fig. 2] Abstract Architecture of Platform Independent Italian Sign Language dictionary

End users are capable to suggest new signs by submitting lexeme and corresponding video. System Administrator will check the new lexeme and will verify whether it exists

already in database. After verification of existence and originality, if the sign is not found, the System Administrator will add gloss and animation against suggested lexeme and will make them part of the system.

5 Conclusion and Future Work

In this paper we discussed a novel platform independent Italian Sign Language dictionary, which is capable to run on several devices and is linked with MultiWordNet. It is available as a Web application and Mobile application for Windows Phone7, iPhone and Android. Our dictionary contains a large video data set, which covers significant part of the MultiwordNet database by providing the corresponding LIS sign or LIS meaning of the synonymy or related word. Its structure is flexible enough to include further signs or perform modifications in the exsitinge ones in future. The Italian Sign Language dictionary is part of the ATLAS project, which aims at automatically translating Italian sentences into Sign Language. We plan to develop web applications that take effort of the LIS dictionary. The objective is to propose such an interface as a tool to enhance deaf learning of written Italian language in schools. Different scenarios will be created to check the usability, coherence and understanding of the LIS sign and hence get feedback on lexical resources from the deaf users with help of some expert signers. Since MultiWordNet has multiple links with other languages such as Spanish, German and Portuguese, it could be helpful for written multi-language learning.

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Towards a Visual Speech Learning System for the Deaf by Matching Dynamic Lip Shapes

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Keywords: lip reading, speech learning, dynamic Shape difference features, deaf people

Abstract

In this paper we propose a visual-based speech learning framework to assist deaf persons by comparing the lip movements between a student and an E-tutor in an intelligent tutoring system. The framework utilizes lip reading technologies to determine if a student learns the correct pronunciation. Different from conventional speech recognition systems, which usually recognize a speaker's utterance, our speech learning framework focuses on recognizing whether a student pronounces correctly according to an instructor's utterance by using visual information. We propose a method by extracting dynamic shape difference features (DSDF) from lip shapes to recognize the pronunciation difference. We have collected a database, which contains multiple persons speaking the selected words, to evaluate the performance of the proposed speech learning method. The preliminary experimental results demonstrate the robustness and effectiveness of our approach.

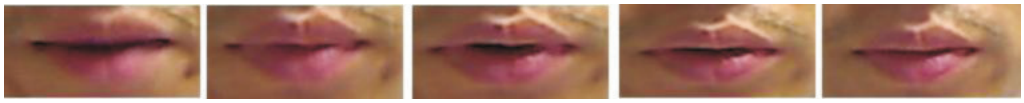
1 Introduction

About 35 million Americans today are deaf or hard of hearing. Approximately 12 out of every 1,000 individuals with hearing impairment are under 18 years of age, based on the most recently available data from the National Center for Health Statistics (NCHS). Recent research has demonstrated that even mild hearing losses can create significant challenges for children as they develop skills to interact with the world [5, 7].

The loss of auditory feedback poses significant difficulties on the speech learning for the deaf people, since they cannot know immediately if they speak correctly [1, 10, 12]. Some researchers propose to use animation as feedback according to audio signals [6, 11]. The animation can be helpful for the deaf people to know if they speak correctly. However, such animation does not provide feedback on how to correct their speech and how the incorrect speech different from that of the instructor.

On the other hand, visual cue often provides complementary information for speech recognition [8, 9, 15]. Figure 1 shows a lip movement in a video sequence when speaking word "apple". It is easier for a deaf person to visualize the difference between the incorrect and the correct utterances by simply looking at the lip movements.

(1) (2) (3) (4) (5)



(6) (7) (8) (9) (10)

[Fig. 1] Sample lip movements of a video sequence when speaking word "apple".

Potamianos et al. [9] have shown a significant improvement of speech recognition through both audio and visual modalities as compared to the approach of audio modality only. Matthews et al. combined lip contour and lip appearance information to recognize isolated letters A–Z [8]. Then the authors employ Hidden Markov models (HMM) as the classifier to model the temporal dynamics of a speech. The authors demonstrated the effectiveness of the speech recognition based on only visual modality. The visual based speech recognition becomes particularly useful in the noisy environment, in which audio signal is significantly degraded.

Zhou [15] recently captures temporal dynamics of a speech by extending Local Binary Pattern (LBP) to a temporal domain [14], which is also visual based speech recognition. Ten phrases are used for their speech recognition experiments. The experimental results also show a promising performance of visual based speech recognition.

[Fig. 2] The basic hardware configuration of the proposed interactive intelligent tutoring system, which includes a computer (desktop or laptop), a web camera with auto focus (face to the user), and a microphone.

Inspired by these advances on speech recognition, we propose a visual-based speech learning framework to aid deaf people. As shown in Figure 2, the system configuration is set up as an E-Tutoring system. A deaf student in front of a computer learns speech by following an E-tutor. A web camera is used to capture the student's face and lip movement. The video of the student is then processed in real-time by comparing the student's lip movements with those from the pre-recorded tutor. Interactive feedback is provided to students through easily understandable visual displays.

Different from the visual based speech recognition, which usually recognizes a few words, a practical speech learning system usually needs to handle much larger vocabulary. It would be extremely difficult to design a speech learning system if we have to recognize every single utterance between a student and an instructor. Hence, we propose

a new framework by extracting dynamic shape difference features (DSDF) to directly measure the visual difference of lip shapes between two speakers, i.e. the student and the instructor. Therefore, we can reduce a multi-class recognition problem in a speech learning system to a binary class recognition problem, i.e. recognizing whether the student pronounce correctly according to the instructor's utterance.

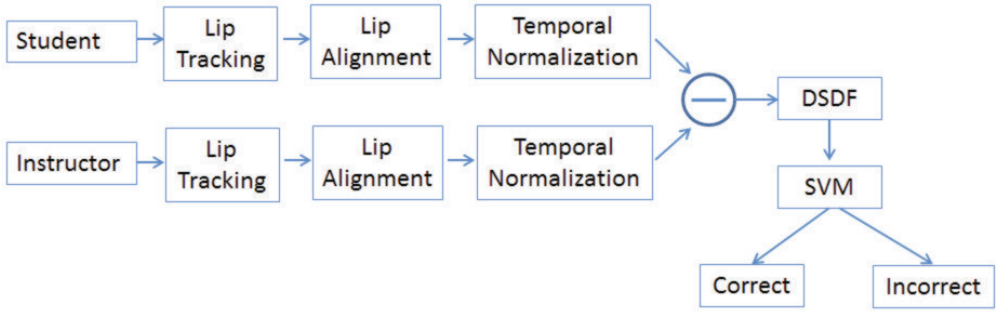
We have collected a database which consists of 9 words spoken by four people respectively. By pairing up two subjects speaking same or different words, we generate "correct" or "incorrect" samples to evaluate performance of the proposed speech learning framework. The "correct" sample corresponds to the case when both subjects speak the same word, while the "incorrect" sample corresponds to the case when the two subjects speak different words. Our preliminary experiments have shown encouraging results of this approach.

2 Visual Based Speech Learning Method

2.1 Overview

Figure 3 shows an overview of our speech learning framework. First, the lip movements of both student and E-tutor are tracked by an Active Shape Model (ASM) [4, 13]. Then we align the lip shapes to remove the head movements while speaking, i.e. translation, and rotation. In this step we also remove the lip shape variance caused by different subjects. Due to the time resolution difference when speaking a word, we perform temporal normalization over the extracted lip shapes in a video sequence, so that both student and instructor can have same speaking speed. The resulted features are defined as dynamic shape features.

Finally we calculate the difference of the dynamic shape features between the student and the instructor, i.e. dynamic shape difference features (DSDF), as the input to a Support Vector Machine (SVM) based classifier. The SVM classifier then automatically determines if the lip movements of the student correctly follow the lip movements of the instructor based on the visual difference of lip shapes between the student and the instructor.



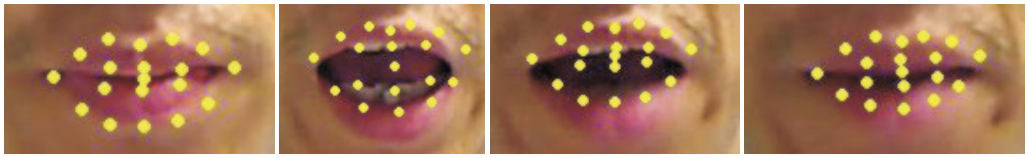
[Fig. 3] Overview of our proposed visual speech learning framework.

2.2 Lip Tracking

We employ Active Shape Model (ASM) [4, 13] to track lip movements. ASM is a shape-constrained iteratively fitting method, which utilizes prior knowledge of lip shapes in training images. The shape is simply the *x* and *y* coordinates of all landmark points on a lip after appropriate alignments, which is shown in Eq. (1).

$$X_i = [x_1, y_1, x_2, y_2, \ldots x_j, y_j, \ldots x_n, y_n], \quad (1)$$

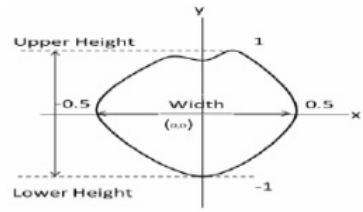
where *n* is the number of landmark points labeled for a lip. In our experiments, we choose 19 landmark points, including both outer contour and inner contour of a lip. For the simplicity, we use the built-in ASM model, which is trained using the 68 landmark points of the whole face including the 19 lip points [13]. Figure 4 shows a lip tracking example in a video sequence using the ASM model.



[Fig. 4] An example of lip tracking in a video sequence by employing Active Shape. Model (ASM).

2.3 Lip Alignment

In order to remove the effects of head movements and rotations during the speech, we perform an alignment procedure. The alignment procedure calculates the angle formed by the line connecting both lip corners and *x* axis. Then we rotate the shape by the calculated angle so that the left lip corner and the right lip corner have the same *y* coordinate value. The mean *x* and *y* values are removed. The entire shape is then adjusted vertically to align the two lip corners on the *x* axis.



[Fig. 5] Typical neutral lip shape after the alignment and the normalization with the upper height, lower height, and width of the lip shape on the neutral frame.

Different subjects have different neutral lip shapes. To eliminate these subject dependent shape variations, we perform a normalization using the upper lip height, the lower lip height, and the width of the neutral lip shape for each subject. The neutral frame in our database is simply the first frame in the video sequence. Figure 5 shows a typically aligned and normalized lip shape on the neutral frame without the landmark points. The normalized lip shapes in a video sequence represent how the lip shape deforms from the neutral shape during the speech.

From the experiments, we find that the performance is usually improved by adding the upper height, the lower height, and the width of each frame's lip shape to the normalized shape vector as described in last paragraph. Finally, we perform the L2 normalization on the resulted feature vector in each frame.

2.4 Temporal Normalization

The time usually varies for different subjects even when they speak same words. In order to handle this time resolution difference, we temporally normalize the video sequence to a fixed number of frames by linearly interpolating each frame's feature vector along the temporal direction [2, 3]. We choose 30 as the number of temporally normalized frames in a video sequence.

Each frame's shape feature vector has the feature dimension of 41, i.e. 2*19+3. Therefore, a video sequence is represented by the concatenated frame feature vector with the total dimension of 1230, i.e. 41*30. The concatenated feature vector of a video sequence is defined as dynamic shapes.

2.5 Dynamic Shape Difference Features (DSDF)

By taking the difference of the dynamic shapes between the instructor and the student, we form the dynamic shape difference features (DSDF). The DSDF features directly measure the pronunciation difference of the two speakers, regardless the words spoken.

Here, we do not recognize the words spoken by the instructor and the student individually to determine if the student speaks same word as the instructor, since this approach can quickly become too complicated to recognize every word accurately as the number of words increase in the speech learning system. By employing the DSDF feature to recognize the similarity between the utterances directly, our system is not limited to the number of words or utterances spoken, which is desirable for any practical speech learning system.

2.6 Support Vector Machine Classifier

Finally, we employ a support vector machine (SVM) as the classifier with the DSDF feature from the instructor and the student as the input feature vector. The output of the classifier is to determine if the student correctly follows the instructor's utterance regardless words they speak.

SVM is to find an optimal hyper-plane which can separates the opposite classes with the maximum margin. We employ the RBF kernel, which has demonstrated the state of the art performance in many applications, such as object recognition and detection etc.

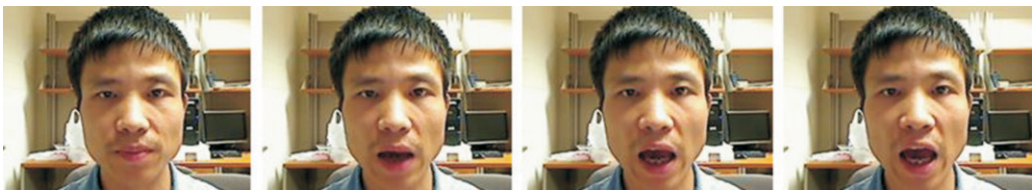
3 Experimental Results

3.1 Database

We have recorded a database to study the effectiveness and robustness of the proposed speech learning framework. Nine words were chosen such that some words are unique, and some words are similar to each other. The selected words are "apple", "cruise", "find", "hello", "music", "open", "search", "vision", and "window".

In our database, each word is spoken ten times by each subject. There are four subjects in the dataset. The video is captured at frontal face by a web-camera with the entire head of the subject within the image frame, in order to ensure the face has enough resolution. The speaker begins a word with a neutral expression, says the word, and then returns to the neutral expression. Each of the chosen words takes an average of 1 second to complete. Depending on the speaker, some words take up to 2 seconds to complete.

All the videos have a spatial resolution of 640 × 480 pixels, with a frame rate of 30 frames per second. The videos are edited such that the first and last few frames (about 3–5) contain a neutral expression. The average video sequence is between 20 to 40 frames long. Figure 6 shows a sample video sequence of a subject speaking the word "apple".



[Fig. 6] A sample video sequence of speaking the word "apple".

3.2 Subject Dependent Results

We evaluate the speech learning framework by pairing up two persons from the database. If the selected two persons speak same word, then we know that one speaker has correctly followed the other speaker. Otherwise, one speaker has incorrectly followed the other speaker. Hence we have the ground truth, whether one speaker correctly follows the other speaker, by simply checking the words they speak. That is, if they speak same word, the ground truth is "correct". Otherwise, the sample consisting of the pair of speech has the label of "incorrect".

Each word is spoken 10 times by each subject, and there are 9 words in our database. Therefore, we have 900 possible pairs of utterances which speak the same word for each selected pair of subjects, i.e. we have 900 "correct" samples. Similarly, for each pair of subjects, there are 7200 possible pairs of utterance which speak different words, i.e. there are 7200 "incorrect" samples. We choose 900 out of the 7200 "incorrect" samples, so that the number of "incorrect" samples from every combination of different words is approximately equal. Then we divide the 900 "correct" samples and the 900 "incorrect" samples to the training and testing sets by the ratio of 9 to 1.

Our speakers include 1 American male (M), 1 Chinese male (S), 1 Chinese female (X), and 1 American female (K). The capital letter is an identifier for the person. We adopt precision and recall as our evaluation metrics, which are defined in Eq. (2) and Eq. (3).

$$Recall = \frac{TP}{TP+FN} \qquad (2)$$

$$Precision = \frac{TP}{TP+FP} \qquad (3)$$

where *TP* is the number of "correct" samples which are also predicted correctly. *FP* is the

number of "incorrect" samples which are misclassified as "correct" samples. *FN* is the number of "correct" samples which are misclassified as "incorrect" samples.

Table 1a shows the average precision and the average recall over all words for each selected pair of speakers. That is to train and test the proposed speech learning framework by the same pair of subjects. Table 1b shows the detailed recall over the individual words for the corresponding pair of subjects. These results indicate the robustness of the proposed speech learning system.

There are some variations among different pair of speakers on the precision and recall. One explanation for this variation is the fact that different people say the same word differently. When collecting the database, we have observed some speakers open their mouse slightly prior to saying a word.

[Table 1a] Average precision and average recall over all words for each selected pair of speakers.

	Precision	Recall
M-S	95.2 %	87. 8 %
M-K	100.0 %	97.8 %
M-X	98.9 %	96.7 %
S-K	96.5 %	91.1 %
S-X	100.0 %	92.2 %
K-X	100.0 %	92.2 %

[Table 1b] Recall over the individual words for each selected pair of speakers.

	Apple	Cruise	Find	Hello	Music	Open	Search	Vision	Window
M-S	70 %	100 %	90 %	70 %	100 %	70 %	90 %	100 %	100 %
M-K	80 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %	100 %
M-X	80 %	100 %	90 %	100 %	100 %	100 %	100 %	100 %	100 %
S-K	30 %	100 %	100 %	100 %	100 %	100 %	100 %	90 %	100 %
S-X	70 %	100 %	80 %	100 %	100 %	80 %	100 %	100 %	100 %
K-X	80 %	100 %	100 %	90 %	60 %	100 %	100 %	100 %	100 %

3.3 Subject Independent Results

In order to evaluate the proposed speech learning framework for the subject independent case, we group all "correct" and "incorrect" samples from every pair of speakers as shown in Table 1. Then we just train a single model to recognize if one speaker correctly follows another speaker. The precision and the recall shown in Table 2 demonstrate that the proposed framework is also effective for subject independent case.

[Table 2a] Average precision and average recall over all words when grouping every pair of speakers in Table 1.

Precision	Recall
98.7 %	95.9 %

[Table 2b] Detailed recall of (a) over the individual words.

Apple	Cruise	Find	Hello	Music	Open	Search	Vision	Window
81.7 %	96.7 %	100.0 %	95.0 %	95.0 %	96.7 %	100.0 %	98.3 %	100.0 %

4 Conclusion

We have proposed a framework to help deaf people learn speech by visually comparing the lip movements of a student and an instructor. The framework utilizes lip reading technologies to determine if the student correctly follows the instructor in pronunciation of a word. Furthermore, our proposed framework is very practical by employing the dynamic shape difference feature (DSDF), which can avoid the large vocabulary problem in traditional speech recognition systems. The preliminary experimental results indicate that our proposed speech learning framework is robust in both subject dependent and subject independent cases. More extensive experiments and user interface study will be conducted in future.

5 Acknowledgement

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Teaching Support Software for Hearing Impaired Students who Study Computer Operation – Synchronized Key points Indication Tool : SZKIT

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1 Introduction

Our university is a special one which admits only visually impaired or hearing impaired students. The division for the hearing impaired students has a department of synthetic design and the department has many lectures concerned with operating graphic design software, such as Adobe Photoshop or Illustrator. In these lectures, our teaching staffs are struggling every day to teach how to operate the software using sign language, power point materials, video resources et cetera. In general, the graphic design software requires a variety of combination keys and tricky mouse actions to operate it. Teaching such complicate operation to hearing impaired difficult. The main problem is that the students cannot read the instruction text (or the sign language) and the mouse cursor movement at the same time when they watch the screen which reflects the teaching staff's operation. Imagine watching someones operation of graphic design software without any voice information. It might be hard to understand what the operator does even if there is an instruction text on the corner of the screen.

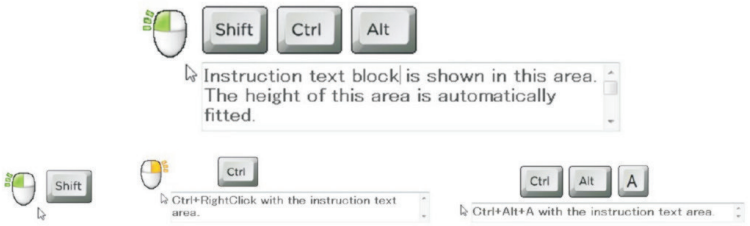
Of course using video materials or giving precise preliminarily instruction is available when hearing impaired students learn something [1, 2] and our teaching staffs utilized such kind of education materials in usual case. Also speech recognition system [3] or summary scribing service is valuable to support hearing impaired students in these days, however, it seems they can not solve the problems of teaching computer operation because the instructing text information of these systems is not in the same place and not in the same time to the computer operation. Summary scribing service in usual case and its display area is separated. The delay and separation between the text information and the real time computer operation makes the students confuse especially in the complex operation mentioned above. Besides such background, one of the authors was just against this problem in his lecture class, and then, he thought up an idea to solve it.

2 Basic Idea

The idea is really simple. It is to show icons of mouse clicks and pressed combination keys and to show instruction text in real time aside of the mouse cursor. We started to discuss new supporting software based on this idea. The most important point is that the positions of each indicating components placed around the mouse cursor not far from it. Because the hearing impaired students cannot pay attention to the separated area at the same time. At first, we surveyed software which displays mouse clicking and pressing modified keys [4, 5]. However, they are not appropriate for our purpose. Then, we decided to develop an original software tool and named it as "Synchronized Key points Indication Tool: SZKIT."

Figure 1 shows an overview of SZKIT. It is composed of several icons and an instruction text area. To explain its function, the first figure shows most of components. Preparing icons are mouse click indicator and modified key indicators (Shift, Control, and Alt Key) and normal key indicator which appears in case of pressing it after modified key (it is not shown in this figure). Each icon is hiding under normal condition and the clicks mouse button or presses the modified key. On the other hand, the instruction text area is displayed all the time basically and the content of the text can be changed on appropriate timing by the operator. When the instruction text area is not needed, it can be hided arbitrarily by pressing Windows key + Ctrl key. To re-display this text area, the only thing the operator has to do is pressing Windows key + Shift key.

Other figures are example of display instruction texts. The first example shows "Shift Key + Left Click" without the text area. The next figure is an example of "Ctrl Key + Right Click" with the text area. The difference of right click and left click is not only the shape of the icon but also its color. The last example is "Ctrl Key + Alt Key + A." As shown in this example, every combination key with modified keys is displayed.



[Fig. 1] An overview of SZKIT and examples when it works.

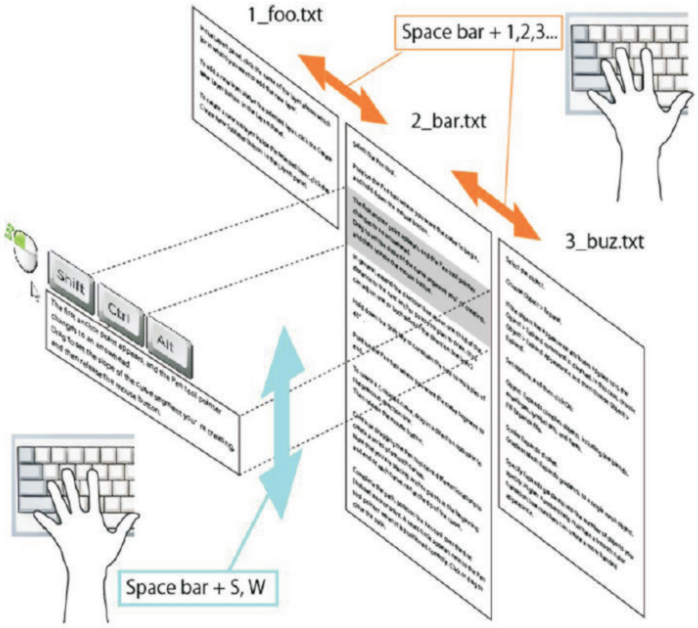
3 Functions of showing in struction text

Addition to the basic function of showing icons related to the actions which operator makes, SZKIT has a function to display a series of instruction text blocks sequentially. The text contains explanations how to operate target ed graphic design software and is prepared by the teaching staff in advance. Each text block should be separated by a blank line in the text file and SZKIT displays from the first text block after loading all contents of the file.

Here, this text blocks should be changed in appropriate timing during the lecture like subtitles in the movie film. To implement this changing function, SZKIT should accept triggered key action which causes forwarding or rewinding the text blocks. We were annoying this point because SZKIT runs simultaneously to the target graphic design software and the focus of the operating system is not on SZKIT, but on the targeted one. It means that the key action to control SZKIT must not be the same as anz operation of the software. In usual, graphic design software has so many combination keys and it is difficult to find a combination which no software use. After several discussions and try and errors we finally decide to implement hooking of space bar. As shown in Figure 2, "Space bar + S" causes forwarding and "Space bar + W" causes rewinding the in struction text blocks. Besides the assignment, "Space bar + number" is implemented for changing the

series of text files which file name starts with numbers. Space bar works normally when the operator doesn't press any key after pressing space bar, therefore this key hooking doesn't disturb normal operation of space bar using this key assignment, the operator can change the instruction text block in appropriate timing without being out of focus on the targeted software. He/she can also show to hearing impaired students mouse click and modified key operations without any special actions as a matter of course.

In addition, it is possible to modify or fix the instruction text after pressing "Windows + Shift Key". The fixed instruction text is automatically saved when the file changes or SZKIT ends. With help of this function, the teaching staff can make improvements in the instruction text during the lecture.

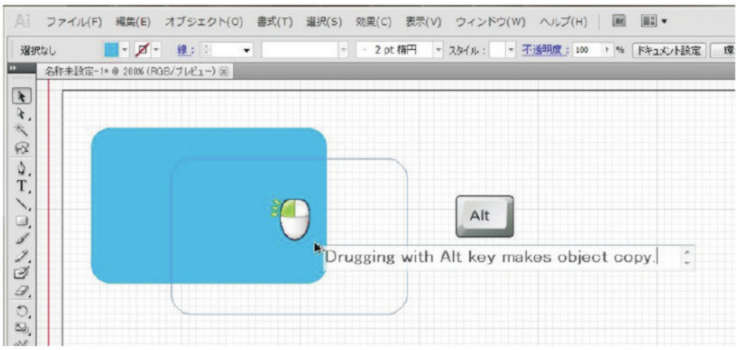


[Fig. 2] Key assignment of changing instruction text blocks.

Estimation

In the autumn semester of 2011, one of the authors uses SZKIT in his class and it is now continuing. All students of the class have hearing impairment, including severe one. We have a plan to take an interview and some questionnaire to the students at the end of the semester. Therefore it is not clear the results of estimation still now but he reported he feels surely that the students understand the graphic design software well compare with last lecture without SZKIT. The tangible effect is that there is less question about operations from students and less miss operations. More precise estimation results will be reported in camera ready paper.

Figure 3 is an example of screen shot which shows operation of Adobe Illustrator with SZKIT. It is a case of dragging an object with pressing Alt key. It is clear what operation is done by the teaching staff and it is easy to get information for the hearing impaired students.



[Fig. 3] A screen shot which shows operation of Adobe Illustrator with SZKIT.Every operation of mouse clicking and pressing modified key is displayed in real time.

Conclusion

To solve the problems of teaching computer operation to hearing impaired students, we developed a support software tool which displays mouse clicking and modified keys and instruction texts. With this software, instruction texts and its operation is clearly displayed on the screen in the same time.

Moreover, this software is also available for e-learning as a by-production. Only recording the operation using this software makes e-learning contents because all required information is into the screen. In this manner, we think software is not only for the for elderly person or novice person when they learn the computer operation.

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Deaf university students as foreign language learners in inclusive settings

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Introduction

Teaching foreign languages to the D/deaf still can be treated as a relatively new educational phenomenon that still needs to be thoroughly searched. Today the teaching process is mainly organized in mainstream institutions, both at primary, secondary and tertiary level. Together with the ideas of normalization and inclusion majority of the deaf students is educated in mainstream institutions and this has to be taken into account by the researchers in the field.

Foreign language is an obligatory subject in Polish schools for pupils in every form, beginning from the 1st grade. English is the favorite language for majority of students. Since 2001 foreign language classes are obligatory also for pupils with hearing impairment. Simultaneously with the educational practice, the theoretical reflection on teaching foreign languages to the deaf started and has been continuously developing (Domagała-Zyśk 2001, 2003, 2005, 2006, 2009, 2010; Harań 2005), creating the body of a new science discipline, *teaching and learning foreign language by the deaf and hard of hearing individuals (surdoglottodidactics)*.

The main approach used in Poland in education of the D/deaf it is an oral approach and this idea is also visible in teaching English to the D/deaf: They are taught all four language skills, reading, writing, listening and speaking – the last on only if they want and manage to do it. The main methodological idea is to use in teaching languages to the D/deaf the same approach, the same methods and differentiate only the techniques: way of communication with the students and different prompts used in the classroom. CIT serves a lot as a way of modifying the language environment and creating an accessible classroom.

So far the research has concentrated on the students themselves, their cognitive skills (Domagała-Zyśk 2008, 2010c), learning styles (Domagała-Zyśk 2011a), vocabulary acquisition (Domagała-Zyśk 2009) or reading comprehension skills (Domagała-Zyśk 2010b). However, there is not a single study known that would touch the problem of the teachers' and the deaf and hard of hearing students' peers preparation to undertake this job. The issue is the more difficult because language teachers in mainstream schools have more often than in the past to work with the disabled students, but the education the teachers possess has not prepared them to perform this job and does not enable them to work effectively with the disabled students.

1 Teacher's awareness

While teaching a D/deaf (or hard of hearing) student in a mainstream class certain conditions have to be met. First of all it is necessary to take a team approach to this work and

try to build coalition of people who aim at supporting the deaf student. Both other staff members and the student's peers should participate in this work.

The D/deaf (or hard of hearing) student's participation in an inclusive lesson is specific. This results also from the major teaching approach that is used nowadays – the communicative approach. It implies that all the students are actively participating in the process of teaching and learning, by asking questions, making dialogues, negotiating the exact meaning of new words and grammar rules. Such an approach is thought to be effective: thanks to it students are to become more autonomous and independent language users, they are more active in using language in communication with foreigners and native speakers. On the other hand, for those not possessing the ability of a good hearing, a lesson conducted in a communicative approach might pose serious problems. First of all they are connected with multiple language users actively participating in the conversations. For a deaf or hard of hearing student it is difficult to identify the source of sound – and only after he/she does it, it is possible to lip-read. Unfortunately, it is usually too late to catch the full meaning of the utterance then. Hearing-impaired students having foreign language individual tutorials get used to the style of speaking presented by the teacher – his/her intonation, rhythm of speech, tempo, pitch etc. While accustoming to it, it is much easier for them to lip-read the teacher's words. The situation is less safer when different people are speaking and a deaf student has to recognize different voice and language qualities which makes lesson participation much more difficult. In order to minimalize the obstacles arising from using this communicative approach, it is advisable to stick to some rules. It is essential that both the teacher and the hearing students understand the significance and keep to the rules of effective communication: they should be seated in such a way as to make it easy to see one another's lips (their desks should be placed in a circle), each person should indicate his/her will to speak by using a common signal – e.g. raising a hand or a thumb – so as to help the deaf student via this visual signal to identify quickly the speaker. Next important thing is for everybody to speak clearly and not too quickly, so as to enable the deaf student to keep with the pace of conversation. Such layout of the language classroom on the one hand restricts spontaneity and slows the pace of the lesson process but on the other hand, improved sound and vision conditions will be profitable for all the class participants.

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. Deafness 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 Polish 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 text messages 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 lessons 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.

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 pedagogicial 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 surdoglottodidactics 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 with the 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 approach or Total Physical Response, just to name a few most common ones. The methods of teaching (understood as a way of selection and portioning the material to be thought 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).

It is also valuable if an English teacher might have a support staff employed. This second teacher may play the role of a note-taker, lip-speaker, sign language interpreter, Cued Speech transliterator, communication support worker, learning needs assistant, classroom assistant for the deaf student or a speech therapist. The roles mentioned above are different, but the task of these staff members are similar: to make it possible for the deaf student to participate effectively in a foreign language class. The first thing that should be done to achieve that, is to make it possible for the student to understand the teacher's and the peers' words. It may be achieved by correct lip-speaking which is repeating the teacher's words clearly and silently, at a closer space, supporting it with some gestures or fingerspelling. The second effective way is that of note taking – writing down important passages of the lesson. If it is done electronically, the advantages are doubled: not only has the student immediate access to the words of the lesson, but after the class the text might be copied and given to him/her as a material for revision and individual studies. Such way of support might be done with the use of a simple notebook, but there is also a special software available, *speech-to-text reporters*. Thanks to the equipment and effort of qualified stenotypists there is a possibility of a high speed writing and it enables majority of the words to be put down for the deaf students.

In the classroom practice with D/deaf students the teacher must take into consideration the following issues:

- The basic thing should be to present the exact meaning of the new word precisely, which means that it should be checked whether the student know the native equivalent of it, is able to use the new word in a proper context and can operate it: construct its family, find synonyms and antonyms, explain their usage in different grammar context. A teacher should remember that a deaf student lack the possibility of spontaneous EFL learning outside the classroom, so the EFL lesson provides the basic opportunity to get accustomed with new words.
- A deaf student should be also assisted in creating his/her own EFL learning strategies, like *mind mapping*, using pictures, drawings, tables, graphs, searching the Internet for new ways of using the words or texting in English.
- Psychological research teaches us that the D/deaf people find it easier to learn single items than collocations. It is helpful for the students if they are taught not how to recite language, but how to *operate* it. Here the question of the students' work assessment arises: language correctness cannot be the aim of its own, because in the case of the deaf students it sometimes means that the students rather use ready-made structures than produce meaningful sentences of their own, as they are afraid to make a mistake. Reading comprehension or writing exercises should

be treated as an occasion to use language creatively, even if it means making mistakes.

- EFL deaf students should be provided with more classes of EFL than the hearing persons, as both explaining new material and revising it systematically takes much more time than in case of the hearing students.
- Another important issue is the motivation to learn a foreign language. Generally deaf Polish students (as majority of Polish students nowadays) have high motivation to learn a foreign language. This primary motivation might be strengthen by creating a positive emotional atmosphere during the classes. At our university, as the classes are small, very personal relationship may be established among the teacher and the students. The student feel safe and emotionally engaged and that is why EFL may be personalized and the students can ask questions like: *How old is your daughter, What is your husband's name?*, etc. and comment on their own experiences: My brother is quite lazy, my sister works half-time. Thanks to that the main aim of language teaching, communication, can be easily achieved.
- Our experience taught us that pronunciation should also, to some extent, be taught, on the condition that the student wants it and he/she mastered to a certain extent speech in his/her national language. It is advisable to suggest the student which words are the most important to be learnt and base the work on the students experiences from his/her speech therapy classes: in many cases they are able to work consciously on pronouncing certain phonemes and reach good results in speaking English, especially in a well-known context.

2 Peers's awareness

The hearing disability is in fact a language and communication disability, as the main problem of the D/deaf and hard of hearing students lies in understanding other people's communicates (both oral and written, in fact) and to react to them in a language manner that will be understood by the interlocutor. It is of an utmost importance that the classmates of the D/deaf and hard of hearing students understand this issue and consciously do their best to manage the situation. Not only the teacher but also the students themselves have to be aware of the rules of proper communication with their hearing-impaired mates. In case of the D/deaf and hard of hearing students who use speech as the main means of communication, the hearing peers should be attentive not to speak if their deaf colleague does not see their face, they should feel obliged to attract his/her attention before starting their utterance. Their speech does not have to be too loud – it is enough if it is of a normal loudness and pace, but it has to be delivered clearly and attentively – the hearing students should learn to repeat their utterances or exchange the words for these who might be more easily lip-read, and thus understood by their hearing impaired mate. In fact, such way of speaking might appear very effective for both the hearing and hearing-impaired while using a foreign language in an unknown context, e.g. abroad – to be understood one has to speak clearly and patiently choose words, so doing a group work with a deaf colleague might teach the hearing students some cultural and communicative competence necessary in using language in natural context.

It is advisable that during a group work activities a deaf or hard of hearing student should work with different groups of students and this is the teacher's role to secure this. A useful way to achieve that is to assign different rules of group building – it should not always be a spontaneous students' decision. The groups might be formed according to the students' position on the list, according to first letters of their names or surnames, months of their birthday, their favorite season etc. In such a case a deaf and hard of hearing student will feel integrated with the classroom (not only with his best friend who always "has to" work with him/her) and at the same time every student will have the chance to know better their deaf colleague and learn how to work together. However, group work might create for the D/deaf students certain problems. Firstly, during such exercises the level of noise is usually much higher and it may be more difficult for the deaf learner to cope – the background noises of other peoples' talks might disturb and be a lot tiresome. Secondly, the D/deaf and hard of hearing student may feel uncomfortable to speak to the colleagues that are not too much known to him and this may even lead to stopping the participation in group work. These difficulties can be maintained by constant work on the student's peers' disability awareness and care for securing best possible acoustic conditions (e.g. a D/deaf or hard of hearing student might be seated in a corner of the classroom).

3 Communication and Information Technology

Using information technology is one of the most effective techniques, and there are a lot of possibilities to use this tool in our work with deaf students. One cannot even presume that using Communication and Information Technology (CIT) makes it always simpler to conduct the foreign language lesson. An audio component is very often an indispensable part of the teaching material and if it is not possible to get the subtitles, the presentations might be useless for D/deaf or hard of hearing students. For a D/deaf or hard of hearing student it is much more difficult to understand what is being said on the screen, than by a real person. Standard CIT materials do not recognize the special needs of deaf and hard of hearing students and e.g. when two people are speaking, their faces are not always visible and it makes it difficult or even impossible for a deaf or hard of hearing person to understand such a speech then.

Here are some of useful tips for using CIT in inclusive settings with the D/deaf and hard of hearing students:

- In order to use it they must know something about it. We must remember that deaf students usually do not pick up information spontaneously, listening to the radio programmes, watching TV, using computer games, freely sharing information with their peers – they usually *have to be taught* each piece of knowledge we want them to possess. Because of this fact it is advisable to help them e.g. in deciphering manuals and other usage instructions. My students were e.g. very surprised after reading one of specially prepared for them text that Internet was invented in the late eighties and they definitely could not understand how was it possible for people like me to study and graduate without using it!
- Internet is a rich source of information for deaf students, it enables them to be more independent in looking for what they are interested in. During our classes we check these web sites that give interesting information about the students' fa-

vourite film stars or sportsmen and sportswomen, life stories of deaf people, facts about deaf communities around the world.

- Internet provides an excellent opportunity for improving reading and writing skills, e.g. it makes it possible to read magazines on-line. Some students systematically do it and one of them, Łukasz was lucky enough to publish his life story (in English) in an on-line magazine *On Cue*.
- Students also spend some of their free time using English web sites, as during our classes they proudly inform me that they managed to chat or exchange e-mails in English with their peers, sometimes even with native speakers, thus developing better cultural understanding and cross-cultural communication skills.
- Our favourite media, however, is still a mobile phone. It makes it possible for me and my students to be in contact practically all the time. As the groups are small (2–3 people) I ask them to inform me (in English, of course) about each smallest change in our timetable. If they feel like they are going to be some minutes late I expect them to send me an SMS. Using this way of communication they can also cancel or postpone a class (*so see you on Tuesday at 5 pm*), inform me about their sudden illness or unexpected success during exams, check whether I am all right after my flu (*Will I meet with you on English today at 4 o' clock in afternoon?*) Not mentioning Christmas or Easter greetings!
- Occasionally typical English learning computer programmes (like e.g. *Polish Your English*) are also used, but generally they are used by students at home as their extra circular work.
- Television still appears to be the most common media used by majority of D/deaf students. All of them admit they spend a lot of time watching TV and it is definitely their favourite pastime. Fortunately, sometimes they choose films in foreign channels so they are "forced" to watch films with subtitles in English. Some of my students told me that they spend 3–4 hours a week watching films with English subtitles – it is pretty much and perhaps bad for their general development but definitely good for their English skills.

4 Conclusion

The aim of the paper was to show the special educational needs of the D/deaf and hard of hearing students in the context of foreign language acquisition in mainstream settings. Analysis of the learning and teaching reality and research results calls for significant actions to be taken so as to prepare the foreign language school teachers to work with different students, also with students with hearing impairment.

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Early Language Development of the Deaf and Its Relation to Foreign Language Learning

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Keywords: deaf, language learning/teaching, early language development, mother tongue, sign language, language modality, cognitive development

Introduction

The paper deals with the complicated nature of the early linguistic access, specificities concerning the mother tongue of the deaf[1] and their cognitive development, and the impact this has on their foreign language learning. It is a part of a theoretical discussion which constitutes foundations of a research concerning deaf learners of English as a Foreign Language on the tertiary level of education and particularly their reading skills in English. Students on the tertiary level of education are also expected to have a very high level of linguistic skills (including reading, writing and working with a language in general at least in their mother tongue). They are expected to be able to use various strategies in keeping with different aims and to learn new approaches quickly and independently. However, linguistic skills of the deaf students on the tertiary level of education generally do not comply with these expectations. Foreign language classes present a space quite unique to the tertiary education, where these skills could be practised and improved. However, that poses a requirement for teachers with high level of expertise and sufficient support from the basic and applied research in the field, which is also one of the objectives of the present paper.

The paper summarizes the impact of early comprehensible language access on further language learning abilities of an individual from the points of view of linguistic and cognitive development. First of all different approaches to mother tongue acquisition will be summarized, and the influence of age, language input as well as the language modality on the process will be explained in the context of the linguistic situation of the deaf who often grow up with two languages. The significance of a difference in language modality for the bilingual-bicultural model of education will be discussed. Afterwards, cognitive development which is on the one hand influenced by early language access and on the other hand influences further language development will be examined. In conclusion these issues will be related to the situation of the deaf in the English language classroom and possible effects and implications for language learning.

The significance of early language development

The target group in question is far from homogeneous not only because it can be viewed from two perspectives: biological and cultural. In terms of linguistic research, however,

1 For the purpose of this paper the term deaf (rather than Deaf or d/Deaf) has been used as the medical aspect and/or type of impairment is of concern here rather than the social, cultural and political view.

prelingual deafness seems to be the most remarkable and suitable. The linguistic situation of the deaf is specific in that they often acquire two languages – the national sign language and the spoken language of the majority society. Mostly one of them can be viewed as the mother tongue, and the other one as the second language. This means that the first challenge in the debate about teaching languages to the deaf is terminology, since the common terms used in the field of teaching are first language (mother tongue) and second (i.e. foreign)[2] language (and possibly third, fourth, etc. language). However, in the case of the deaf, another issue comes into play: the complicated question of which language can be regarded as the mother tongue of the deaf and which language the particular deaf individual considers as his/her mother tongue (these two points of view can differ). Scholars disagree as to what is the main criterion for determining one's mother tongue (e.g. the parents' language or the first language acquired). For example, the mother tongue of most of the deaf in the Czech Republic can be either Czech or Czech Sign Language (CSL). At present the language of the majority society is regarded as the second language (see e.g. Vysuček 2004). Therefore, a foreign language only comes third, which should be reflected in the terminology used (ESL, EFL, ESOL). Moreover, the teacher should be aware of the interaction of the two languages acquired and its impact on learning a foreign language. Also important are difficulties in the individual languages, such as the struggle of the deaf to fully acquire the majority language of their country, the limited vocabulary of CSL (especially with regard to technical terminology) and the fact that speakers of CSL often lack metalinguistic knowledge (unlike their hearing peers, they are not taught about their language at school).

Whichever understanding of the mother tongue of the deaf is accepted, several points will always remain fundamentally important from the point of view of further linguistic development as well as education in general. These are especially early access to comprehensible input to a (any) language and successful acquisition of a language. The discussion about the mother tongue of the deaf cannot be seen as purely theoretical if one bears in mind the significance of a fully acquired language for the thought and perception of every individual, as emphasized, for example, by Hans-Georg Gadamer: "In all our knowledge of ourselves and in all knowledge of the world, we are always already encompassed by the language that is our own. We grow up, and we become acquainted with men and in the last analysis with ourselves when we learn to speak. Learning to speak does not mean learning to use a preexistent tool for designating a world already somehow familiar to us; it means acquiring a familiarity and acquaintance with the world itself and how it confronts us" (1976: 62–63). Language acquisition is a necessary prerequisite to learning.

Furthermore, the problem of the mother tongue of the deaf is connected to several topics that are crucial for teaching languages to the deaf, most of all the problem of early linguistic development, which is deeply influenced by two factors – age and intake of language input (Vaněk, 2011, 26). Besides the impact of an acquired (first) language on learning other languages, which is discussed below, the **critical period hypothesis** should also be mentioned. According to this hypothesis, the ability to acquire a language is biologically linked to age: there is a certain phase during which learning languages is easier,

2 For the sake of simplicity, bilingual hearing children are not considered here.

while later it becomes much more difficult or even impossible. In this context, it is important to bear in mind that most deaf children are born to hearing parents who have no command of sign language or are at the beginner level, which means that many deaf children do not have access to sufficient amount of comprehensible language input in the early stages of their development. As Alena Macurova argues, "Although deaf individuals born into hearing families are endowed with […] innate mental dispositions for language, at the critical stages of their development they are often left without any language at all. […] This state of an early absence of language […] inevitably projects into the ability of the deaf to learn other languages" (2005, 32). The critical period hypothesis thus seems to be especially relevant when discussing language teaching to the deaf.[3]

The question of the early stage of linguistic development of the deaf entails one of the three main differences between deaf and hearing learners of English (as well as other foreign languages), as listed by Vaněk (2011, 41–42). Another difference is the insufficient metalinguistic knowledge of the deaf: unlike the deaf, hearing pupils become familiar with the structures of their mother tongue, they learn to describe and analyse it and can utilize this knowledge when learning other languages. The third dissimilarity involves the different modality of sign language and the target language. Whereas sign language is visual and movement oriented, the target language is audio-oral.

This difference in modality also casts doubt on the use of the widely accepted notion that the level achieved in the mother tongue influences learning other languages in deaf education. Cummins (qtd. in Spencer & Marschark, 2010, 102–103) postulated the **linguistic interdependence hypothesis** according to which fluency and high level achieved in one language aid the development of skills in other languages. In the field of deaf education this theory formed one of the bases of the argumentation supporting the bilingual-bicultural model of education. Yet here the question of the choice of mother tongue (or the first language or the language acquired on the highest level) becomes practically important. As Mayer and Wells (1996) contend, while the linguistic interdependence theory remains valid for spoken languages, it cannot be applied to the relation between a sign and a spoken language due to these two languages' different modality (i.e. visual-spatial and audio-oral). Mayer and Wells, drawing on Vygotsky's and Halliday's research, explain that the non-existence of a written form of ASL (and this can be extended to other sign languages) prevents ASL from facilitating the learning of written English by ASL users. Hearing children go through the following phases of becoming literate in their mother tongue: first they learn the oral mode of the language in interaction with adults (what Vygotsky calls "social speech"); then they develop a kind of egocentric spoken language which is later transformed into "inner speech" – an idiosyncratic language just for the self, an instrument of verbal thinking (Mayer and Wells, 1996, 95). This inner speech is a transitional point between the spoken and written form of the language: later, the child proceeds from this inner speech to the written form with the help of the already

3 Other researchers (e.g. Castro-Caldas, 1998) argue that some neurological changes occur in the brain during the critical period in one's development. They claim that learning a certain skill as a child partly determines the structure of the individual's adult brain. While not all scholars concur with the views of an irrevocable impact of early linguistic development on deaf individuals, there is a consensus that "even if the critical period theories are incorrect, early intervention is an effective way to increase the auditory experience of the deaf" (Blamey, 2003, 241).

mastered spoken language. Similarly to the egocentric spoken language, which serves as a bridge between the social and inner speech, spoken language helps learners bridge the difference between the inner speech and the written mode of their native language. By contrast, deaf children whose first language is a sign language lack a bridge between the language they have mastered and the written form of an oral language: although they, too, develop inner speech (or rather inner sign), this does not provide much support for them in learning the written form of an oral language due to the profound gap between a sign language and an oral language (e.g. ASL and English) in terms of syntax, morphology, and semantics (Mayer and Wells, 1996, 97–99). In other words, "the incompatibility between the code used in inner speech and the code used in writing" presents sign language users with a great obstacle in the process of mastering the written mode of a language (Mayer and Wells, 1996, 102). In addition, successful acquisition of all three modes of the mother tongue (i.e. spoken, inner and written language) facilitate a hearing individual's learning of a second or further language (Mayer and Wells, 1996, 102–103), which further augments the seriousness of the problems encountered by the deaf in their early linguistic development.

Influence of cognitive processes of the deaf on language learning

Above the early access to language and its acquisition have been linked exclusively to the linguistic development. However, if one looks at the broader picture, it becomes obvious that although research has not yet fully explicated the link between language delays and cognitive abilities, the existence of interrelatedness between an "early access to effective language and normal cognitive development" and consequently academic success is clear (Marschark, 2002, p. 114).[4] The cognitive processes undoubtedly influenced by the situation of deafness which have a clear connection to the learning and teaching process are for example visual attention, memory, learning and problem-solving processes.

Hence educators should move from the oversimplified view of deaf individuals as literal thinkers oriented at visual stimuli to a much less superficial understanding of the cognitive development of deaf children and its practical implication for teaching and learning. For example in case of visual attention the superficial view is that the insufficiency in audio-oral/verbal channel can be to some extent easily compensated by supplying visual information. However, research has shown that the quality of performance in this field depends on the specific kind of task as well as the modality of the language prefered by a deaf individual (Marschark, 1998, 2–3). Moreover not all of the performance in the visual attention sphere is different in a positive way. For example the use of visual input may be complicated by the fact that deaf individuals are prone to distraction by activity happening in the peripheral visual field (Dye, Hauser & Bavelier, 2008), which should be taken into consideration when creating appropriate learning environment for deaf students.

Another difference in cognitive processes between hearing and deaf students as regards teaching lies in assessment and testing. The test questions and types of tasks have proven to play an important role in the results achieved by deaf students. For example

4 For more information on the difference in cognitive processes of the deaf and hard-of-hearing, see Marschark, Convertino, & LaRock, 2006; Moores & Martin, 2006; Power & Leigh, 2005.

deaf students are more prone to selecting an answer just by identifying matching words when choosing from several answers in response to a reading comprehension task and are more inclined to guessing rather than employing problem-solving activities (Marschark, 2002, 115). These and similar findings in the area of problem-solving processes of the deaf pose a demand for more specialized testing and assessment approaches and techniques, which would help to avoid or lessen the effects of these issues on the deaf students' results. Simply excluding the listening part of the test, using shorter reading extracts with clearer layout and/or simplifying and shortening the instructions (as is usually the case at the moment) is not sufficient.

Yet another issue in this field is the question of memory. Again educators often seem to be simply accepting as a fact that the deaf remember less than hearing individuals. However, is this knowledge or belief sufficient for a teacher to use appropriate techniques and materials? The educators should try and get a deeper understanding of the topic, strive to find the reasons of the differences on the level of short-term and long-term memories and ways of compensating for them.

Conclusion: Practical implications

The findings presented above influence language learning and thus constitute useful tools for instructors of foreign languages for the deaf as they enable them to adjust their methods and techniques of language teaching to the deaf to the aim of compensating for the extra difficulties the deaf face in language learning. It is therefore important not only to continue the debate about the linguistic situation of the deaf, but also to evaluate the experience of teaching practice in order to be able to come up with specific solutions to the problems.

From the point of view of teaching foreign languages to the deaf, the aforementioned lack of bridges facilitating language learning is clearly a significant complication. We should therefore try to look for ways of alleviating and compensating for this disadvantage. Further research is needed to find out whether we are able to supply deaf learners with the missing bridges. One of the possible solutions for deaf learners of English might be using cued English. The results of this method need to be surveyed and evaluated, which, however, should not stop us from searching for other potential bridges that would be more accessible and universal than cued speech, as it only exists for some oral languages and as in non-English speaking countries it might be difficult to find teachers who have mastered both English and cued English.

A deeper understanding of the cognitive processes of the deaf and their influence on language learning and academic success in general is also needed. This is not only a question of more research in the field but in particular of applied research and bringing the results of research to the attention of teachers who could consequently apply the finding into practice. The research should also be brought into practice by means of specialized teaching materials and standardization of teaching and testing materials.

To sum up, a positive development could be supported in several ways. First, more research in some areas and its connecting to practice would improve the current prevailing situation in the field of didactics, which is marked by lack of research transferred into practice and by using methods and approaches based on superficial beliefs and assump-

tions. The second way is subsequent education of teachers: more specialized instructors are needed. Last but not least, the specific features of the linguistic situation of the deaf should not be perceived as insurmountable obstacles but as special challenges that should encourage educators to enhance their teaching methods. Teachers should be on the lookout for means of identifying and strengthening the advantages and minimizing the disadvantages of these specific circumstances.

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Preliminary Survey on the Present Issues Regarding Cinema Subtitle for Hearing-Impaired People in Japan and Future Possibilities

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1 Introduction

The presences of cinema and television are indispensable in enriching our daily lives and in supplementing cultural activities. However, with the super aging society in Japan accelerating and the number of people with various physical characteristics (such as hearing or visual impairment) on the increase, there still lacks a substantial system that allows these people to enjoy these contents that serves as one of the ways of enriching their daily lives. Until now, film directors and producers, subtitle creators, audio descriptors, people with disabilities, welfare participants, and the authours have come together to discuss research and issues regarding concerning how cinemas should be presented so anyone can enjoy them with or without disabilities. In the process of that, it became clear that subtitling for hearing-impaired people is insufficient in that, domestic films usually do not come with subtitle data as in the case of foreign films in Japan and when it comes to animations even lip-reading becomes useless, resulting thus in the still high barrier that prevents hearing-impaired people from enjoying cinemas.

With an aim to reexamine cinema subtitling for hearing-impaired people in Japan used until now, a questionnaire survey was conducted under this study at a film festival showcasing subtitles created by film producers, with people both with and without hearing disabilities as survey subjects.

2 Methodology

Prior to the survey, hearing-impaired people, film directors and producers, and subtitle creators were interviewed about their views on the creation of subtitles for Japanese films. From the interviews we were able to confirm the following 5 elements pertaining to the overall picture of cinema subtitling for hearing-impaired people:

1. the amount of subtitles in one scene or throughout the entire film;
2. the method of indicating who is speaking the subtitled script;
3. subtitles that explain the voice tone and accent of the spoken script;
4. subtitles that explain environmental sounds or sound effects;
5. subtitles that explain the music being played.

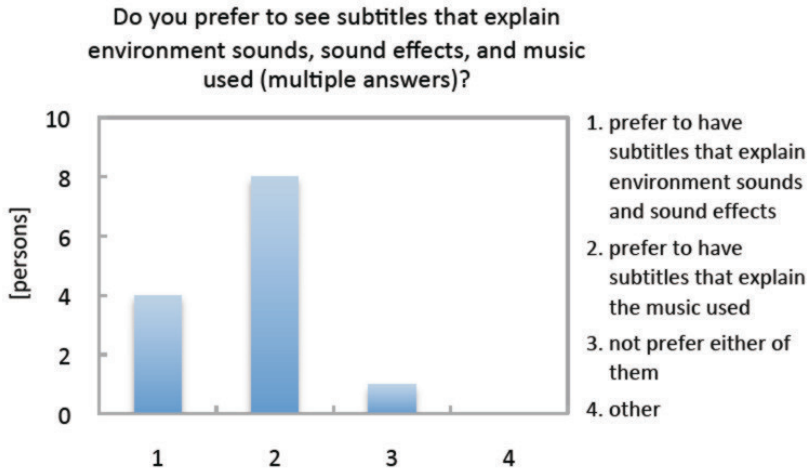
Based on the above 5 elements the questionnaire was then created. There were 11 Japanese and South Korean films shown at the festival (5 film drams, 1 anime, and 5 documentaries), and the questionnaire was answered by 17 hearing-impaired people and 170 hearing people.

3 Results and Examination

As an example of the survey results, Figure 1 shows the answers given by hearing-impaired people in response to the question "Do you prefer to see subtitles that explain environment sounds, sound effects, and music used (multiple answers)?" While comments like "There is no need to explain the music as I can't hear it" were often given during past surveys, results of the survey conducted this time showed that a certain number of hearing-impaired people prefer to have subtitles that explain the music used. From this and from the results obtained for the question "What kind of information concerning music would you like to have subtitled?" it was revealed that most respondents requested for the subtitling of song lyrics. On the other hand, the results obtained from the responses by hearing people show that almost half of people (64 out of 137 (48 %)) respondents answering "Sometimes" or "Often" to the question "Do you ever find voices in films in daily life hard to catch?" Furthermore, responses given by the highest number of people concerning such specific aspects were "It's hard to hear what is being said because the background music is too loud", or answers to the "Other" section like "The actors' voices are not loud enough" and "The people speaking don't speak clearly". Furthermore, as shown in Figure 2, in response to the question "Are there any scenes where you find subtitles useful in the films watched this time?" 75 out of 95 (79 %) people who provided valid answers said either "Several times" or "More than 10 times".

4 Summary

Under this current study an in-depth questionnaire survey was conducted on the content of subtitling with direct involvement by film directors and producers in subtitle creation. The results of the survey allowed us to grasp some of the specific elements required in subtitling or the needs of hearing-impaired people when it comes to the text representation of environment sounds, sound effects, or music that have hitherto been insufficiently described in Japanese films. Meanwhile, the survey results also suggest the possible advantages of subtitling, such as in helping not only deaf or hearing-impaired people and people suffering from medium or severe haring disabilities who hold a disability certificate, but also young to senior people who are beginning to experience deterioration in their hearing understand information that is hard to catch by ear (such as the spoken script). From these, the following possibilities and issues of subtitling as a universal method in Japan's progressing super-aging society were obtained.



[Fig. 1] Results obtained from the responses by hearing-impaired people.

[Fig. 2] Results obtained from the responses by hearing people.

Integrated and innovative solutions to support deaf students during class attendance

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Keywords: hearing impairment, lip reading, class attendance

1 Motivation

The main idea of PoliLips, the assistive device we present in this paper, arose during conversations with deaf students, at the MultiChancePoliTeam (the service for students with disability at Politecnico di Milano). Students reported a strong difficulty during class attendance (and their scores, got at the end of courses, confirmed the problem).

We tried to solve the problem by means of traditional devices used to support deaf students (see [Lang, 2002]). Voice recorders –coupled with Automatic Speech Recognition (ASR) applications, for off-line voice transcription– are often used, but the accuracy of the ASR is often sub-optimal as accuracy is deeply affected by the terminology adopted by the teacher. Magnetic induction loops can be used with students that wear a compatible implant, but are expensive to deploy (small, portable magnetic induction loops exist, but work well for very small audiences). Human-based subtitling services are often too expensive. Sign-language interpreters are also expensive and rarely requested by deaf students (in our university, we didn't receive any request for sign-language interpreters in more than 10 years). Thus, none of these solutions proved to be effective enough.

Several deaf students provided us an interesting clue, reporting that lipreading was their preferred compensation mechanism, sometimes mixed with aural information (see [Erber, 1975]), but several factors affected lipreading effectiveness: some words are inherently hard to lip-read, some people can be particularly hard to understand (for example, who talks very fast), or, finally, the position of the speaker can prevent good observation of her/his facial movements. Thus, we started thinking whether a specific device could have increased the effectiveness of lipreading during classrooms.

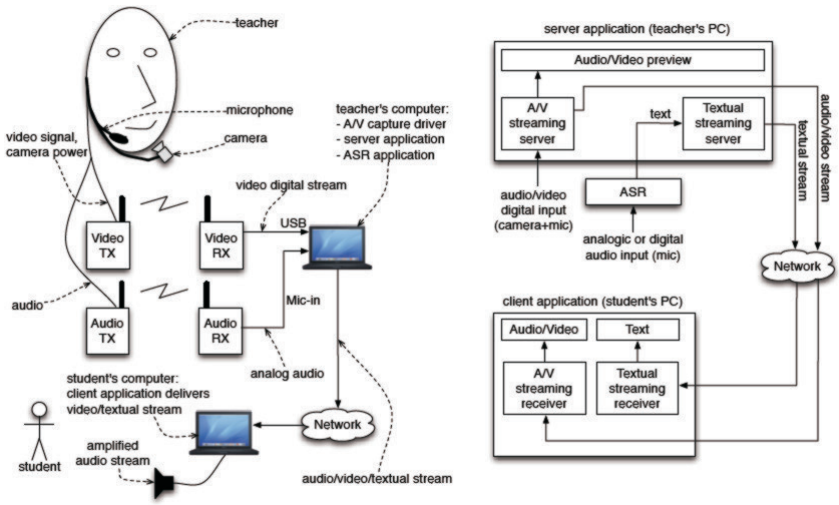
2 PoliLips

PoliLips mixes the three information modalities we can collect from the teacher—visual (lipreading), aural, and (ASR generated) textual. In doing so our goal was twofold: first, we argued that each modality could have compensated for errors present in or induced by the others (for example, if the ASR had failed to transcribe a word, the student could have used lipreading to correct the error and understand the correct word); second, the resulting system could have been able to handle different degrees of hearing loss (especially profound deafness), and students' preferences in compensation mechanisms.

2.1 How PoliLips works

PoliLips captures and sends to students' laptops, via wired or wireless network, an audio/video/textual stream composed of a video of the teacher's face, her/his voice, and a

textual transcription performed by an ASR (see Figure 1, on the left). PoliLips facilitates class attendance when the student cannot see the teacher's face (for example, whenever the teacher writes on the blackboard) or the teacher is too far, or she/he not in front of the student. The device could be useful not only in university classrooms, but in whatever context where a speaker talks to a large audience, and network connections are available. PoliLips is a hardware/software solution – the teacher wears a hardware device, while specific software applications are installed on teacher's and students' laptops. We designed and built the hardware, relying on off-the-shelf components, and developed the applications. ASR functionalities were provided by a commercial application.



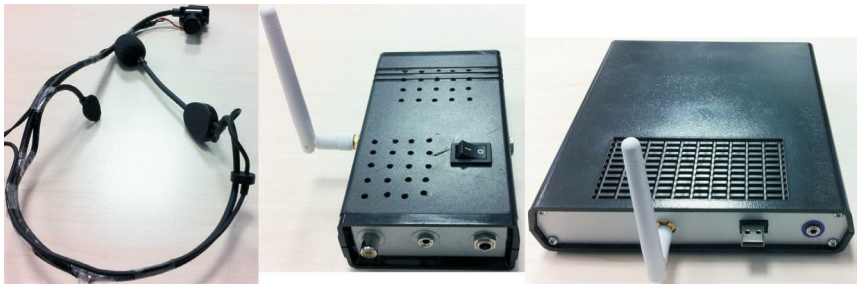
[Fig. 1] PoliLips setting (left) and software architecture (right)

2.2 Hardware

The PoliLips hardware consists of a wearable device and a base station (in Figure 2 the pars of PoliLips built by us; audio transmitter and receiver are commercial devices). The wearable device is composed of a tiny video camera – with f = 3.6mm/F2.0 lens, which permits to frame the face of the teacher, even using a short shooting distance– coupled with a high-quality, noise-canceling microphone, and a transmitter unit. The weight of the camera/microphone mounting was 127 grams, and proved to be light and stable enough for the teacher to wear the device without any particular problem. Audio and video signals enter the transmitter unit, composed of two elements: a 2.4 GHz video transmitter (which also provides power to the camera) and a high-quality 600 MHz audio transmitter, both powered by battery packs.

The critical components of the wearable device turned out to be the microphone and the audio transmitter. In fact, the cheap camera and video transmitter we used proved to be good enough for our goals; the lesson we learned is that, once a decent resolution, frame rate, and signal/noise ratio are provided, increasing these specifications does not affect the lipreading ability of the person. Conversely, the audio signal must be as clear as possible, in order for the ASR to properly generate the text.

The base station is composed of three elements: a video acquisition box and a 600 MHz high-quality audio receiver. The video acquisition box, which contains a 2.5 GHz video receiver and a video capture device, digitizes the video signal and provides a stream through a USB connector. The video acquisition box and the audio receiver are connected to the teacher's laptop, where the ASR and the PoliLips server software are installed.



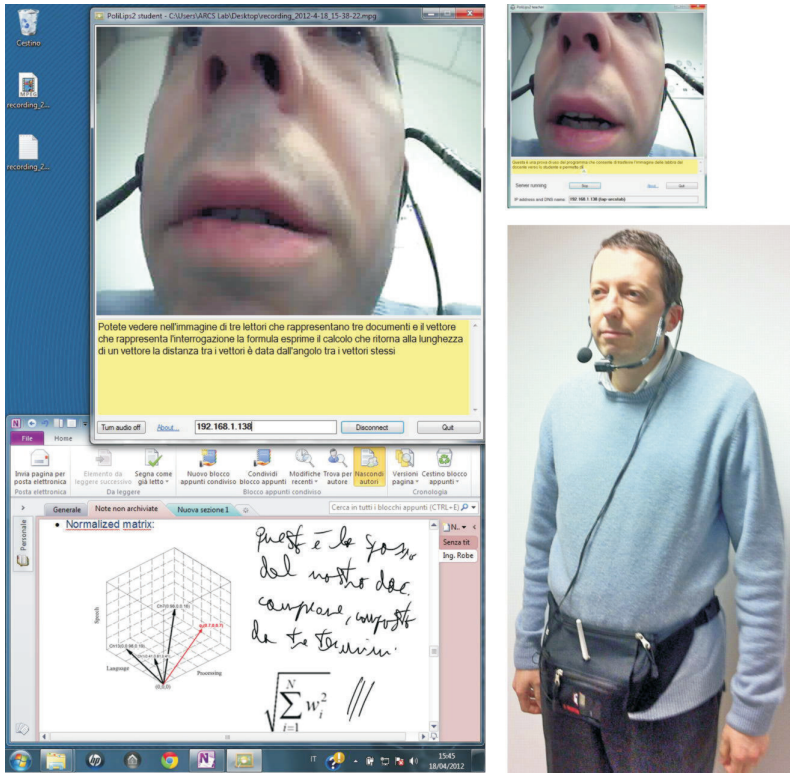
[Fig. 2] From left to right: camera and mic, video transmitter, video receiver

2.3 Software

The PoliLips software is composed of two parts: server and client (see the architecture shown in Figure 1, on the right). The server is installed on the teacher's laptop (along with the ASR), while the client is installed on students' laptops.

The PoliLips server is based on DirectShowNet (a library that wraps the Microsoft DirectShow framework, used to manage the audio/video devices) and nVLC (a library that wraps the libVLC framework, used to capture, preview, and send the audio/video stream). The PoliLips server acquires the digital video stream and the audio, combining them in an audio/video digital stream at 30 fps; audio also comes to the ASR, which generates the textual transcription of the teacher's speech. Finally, the PoliLips server waits for connections from clients and, once a connection has been established, sends the audio/video/textual stream. The PoliLips server application also provides a preview of the stream (so that the teacher can check whether the camera is well positioned and the ASR is working fine).

The ASR was not integrated into the PoliLips server (as the ASR Software Development Kit is quite expensive); instead, we used the desktop-class ASR application, connecting it to the PoliLips server in a naive but effective way – the user interface of the PoliLips server application contains a text field where the teacher must click (giving it the "focus" of the user interface) before starting the ASR; then, simply relying on the dictation feature of the ASR, the generated text is captured by our application, which adds the newly inserted words to the textual stream. Figure 3 (right) shows the PoliLips server preview window. The PoliLips client, based on nVLC for receiving and displaying the audio/video stream, connects to the server and displays the audio/video/textual stream, saving them as an MPEG and a TXT files. Figure 3 (left) shows the PoliLips client application running side by side with PoliNotes [Marrandino et al., 2011], our note-taking application that extends OneNote, permitting to mix, on the fly, PowerPoint presentation objects and annotations.



[Fig. 3] PoliLips client and PoliNotes (left); PoliLips server and Polilips devices (right)

3 Conclusions and future work

The PoliLips prototype is ready to be tested with our deaf students. Preliminary, encouraging, tests have been carried out; a controlled experiment, gathering measures about the effectiveness of the system, is planned. The PoliLips server will be enhanced with a video filter able to address the slight "barrel distortion", caused by the camera lens, reported by students. Finally, we plan to generate accessible screencasts of lessons, adding our audio/video/textual stream to the video generated by interactive whiteboards.

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Section 2

Universal Design of the Documents Including Accessible Graphics in Tertiary Education

A Bilingual Bimodal Reading And Writing Tool For Sign Language Users

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Abstract

Sign language is used by many people who were born deaf or who became deaf early in life as their first and/or preferred language. There is no writing system for sign languages; texts are signed on video. As a consequence, texts in sign language are hard to navigate, search and annotate. The BiBiKit project is an easy to use authoring kit which is being developed and enables students, teachers, and virtually everyone to write and read bilingual bimodal texts and thereby creating electronic productions, which link text to sign language video. The main purpose of the project is to develop software that enables the user to link text to video, at the word, phrase and/or sentence level. The software will be developed for sign language and vice versa, but can be used to easily link text to any video: e.g. to add annotations, captions, or navigation points. The three guiding principles are: Software that is 1) stable, 2) easy to use, and 3) foolproof. A web based platform will be developed so the software is available whenever and wherever.

1 Introduction

Many people who were born deaf or who became deaf early in life use sign language as their first and/or preferred language. The number of deaf sign language users is relatively small and in most EU countries, deaf learners are integrated in mainstream education. Each school, each teacher who has a deaf student in his/her class struggles to find solutions to circumvent the reading/writing problems of the deaf learner: This applies equally to primary school, secondary school, vocational training, university, formal and informal adult education.

There is no writing system for sign languages; texts are signed on video. As a consequence, texts in sign language are hard to navigate, search and annotate. Often, they are difficult to 'read', because all you see is a frontal signer, comparable to traditional frontal teaching. Although researchers have promised text-to-sign conversion for over a decade, results are very limited. Conversion at word-sign level is not sufficient; each sign language has its own grammar, so text has to be translated, not just converted. There is some existing 'Text-Video linking' software; 3 'types' of linking or linked products were found:

- Programs developed for sign language research: many functions, but often difficult to use: *ELAN, ILEX, SignStream* and *Berslab*;

- Programs developed for education: Easy to use, but most are outdated, and many no longer work: *Link-it, SignSmith, TegnBehandler* and *TegnSpiller*;
- Programs for website developers: *JoomLink, SignLinkStudion 2.0* and *Videotext web*; There are also linked productions that are made 'by hand', there is no editor, and often each 'link' starts a new video.

As said above, there is no software which is so user friendly, that young children can use it to write their own bilingual stories. There is no software which is so easy to use, that even the children's grandparents can use it to look at the stories of their grandchildren, or to write their own stories. There is no software which is so flexible, that not only children and grandparents, but also students, teachers, authors, and publishers will want to use it.

2 The BiBiKit Software

BiBiKit is an acronym for Bimodal Bilingual Kit for reading and writing tool for sign language users. The name sign refers as follow to:

1. The right handshape refers to: two languages, or two modalities. Also to: using your eyes to read, and to watch video.
2. The movement refers to 'translation'.
3. The left-handshape is for ' page', or 'tablet'.

The BiBiKit is an easy to use authoring kit which is being developed and enables students, teachers, and virtually everyone to write and read bilingual bimodal texts and thereby creating electronic productions, which link text to sign language video. The main purpose of the project is to develop software that enables the user to link text to video, at the word, phrase and/or sentence level. Each word, each sentence in the text can then be linked to a sequence in the video. Video can be a translation of the text signed by the author, signed by a sign language interpreter or teacher, or even imported video of a signing 'avatar'. Documents can be saved in various formats. Readers can read text and click on a word or sentence to see the linked video. The software will be developed for sign language and vice versa, but can be used to easily link text to any video: e.g. to add annotations, captions, or navigation points. The actual work will be done in an Editor and the ready product viewed in a Player. The three guiding principles are: Software that is 1) stable, 2) easy to use, and 3) foolproof.

2.1 How to make it happen?

The BiBiKit is a 2 year project; the starting date was January 2011. In the first year, the software is developed. In the second year, the software will be tested by using it in different contexts. In the BiBiKit consortium, 6 organizations from 6 EU countries work together. To involve more future BiBiKit users, colleagues and members of other EU consortia are asked for input. They are called 'associated partners'. Each organization has 4 associated partners from different EU countries or 30 in the whole, from 12 EU countries. Associated partners are very important because they help to describe the functionality of the software. The associated partners have given feedback on what they want to use BiBiKit for, and what their requirements and/or wishes are. The different prototypes are shown to them and they asked for feedback: Is this what they want? The BiBiKit will be validated

in over 30 educational settings in 12 countries, by deaf and hearing writers and readers.

2.2 The BiBiKit: target group

The target group is very large, and very diverse. Users can be 8 years old, or 88 years old. Users can be children, parents, teachers, students, researchers and publishers. The wishes of these users are very diverse, too. They go from 'very easy, basic functionalities only' to 'very flexible, as many functionalities as possible. For instance: Basic users want one text window, one video window, and an easy way to link text to video. Researchers want more text windows, more video windows, and the option to link video to video, to link to sign libraries, maybe even to use *SignWriting* or *HamNoSys*. As for BiBiKit, was decided to start at the 'easy' end of the spectrum.

User requirements and software specifications are written in cooperation with the associated partners. Each partner focuses on the user needs of a specific target group/educational context: Deaf children, deaf students in higher education, sign language interpreter students, sign language teachers, formal and informal adult learning and e-learning.

2.3 The BiBiKit: technichal details

After closer look at the available programming options, was concluded that the best solution would be either to make a local application (Adobe Air), or a web application. Some pros and cons for the two options for the Editor and the Player are listed in Table 1 and Table 2 bellow:

[Table 1] Platform for the Editor

	Web application Run on a webserver and accessed with web browser	**Local application** AIR application run on a local PC/Mac
Pros	Can be used on PC/Mac/iPad and other units with a web browser; No installation; Central maintenance and updates;	Local video (user responsibility); Fast response and no upload of video files; Can be used without Internet connection;
Cons	Maintenance of server; Storage for large video files; Slow response and upload of video files;	Limited to use on PC/Mac (no iPad); Program must be installed; Limited choice of video formats;
Conclusion	Test video response and upload times; Possible to edit on webserver and download the result (no storage on server)?	Test AIR-application; Check possibilities for video conversion;

[Table 2] Platform for the Player

	HTML5
Pros	Can be used on PC/Mac/iPad and other units with a web browser; Can be run from local disk, CD/DVD and web server;
Cons	Might be differences in layout and functionality for different web browsers; No common video format for all web browsers;
Conclusion	Test different web browsers (IE, Safari, Chrome, Mozilla, Opera);

It was decided to develop a local platform for the Editor and the Player as to test different web browsers.

The application platform

As said above, for BiBiKit the first priorities are: *Stable*: The software should not crash and should work 2 or even 5 years from now. *Easy to use*: Children should be able to use the software, but also their grandparents. Users can use BiBiKit right away, they do not have to go to a training course first, or read a thick manual. *Foolproof*: Even when the user makes a mistake (he/she clicks on the wrong button, or he/she forget to click on a button), the programme should not crash; he/she should not lose his/her work. When the user makes a mistake, he/she should always be able to correct it.

BiBiKit will in some ways resemble PowerPoint: It is an editor or an authoring system, that authors can use to create their own content, that others can read and look at. The unique feature of BiBiKit is that authors can 'link' text and pictures to specific sections of video on the same page and vice versa. Because users want to be able to 'read' productions on desktop computers, but also on tablet PCs and even smart phones, it was decided that the output, the linked productions, can be read (but not edited) with standard browsers like the Internet Explorer and Safari. In the working process was dedicated that no other software, i.e. player, will be needed to read the BiBiKit productions (see 3.2). When exported, the project can be run in a HTML5 compatible browser.

The BiBiKit editor

The main feature of the BiBiKit Editor is that it can be used to create multimedia productions: electronic productions with links between text, pictures, and video. This is a very useful feature, not just for sign language users but for many other target groups, and for a diversity of productions. There are a number of programs which can be uses to integrate text, pictures and video, but the important feature for BiBiKit is that the user can make links to **parts or sections of video clips** and not only to the whole clip.

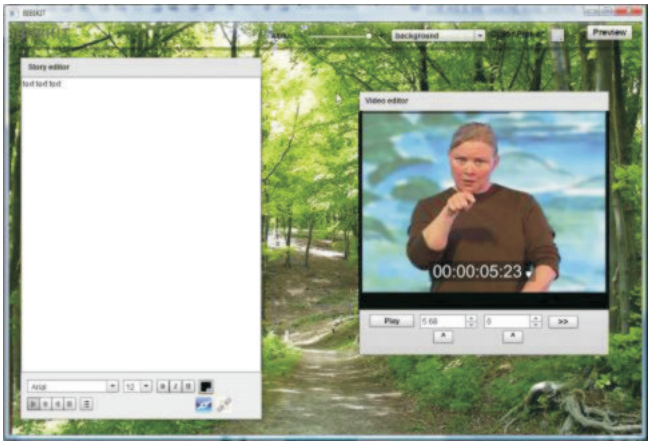
3 BiBiKit: Work In Progress

The program team made two prototypes which users got to try and the users gave feedback on them.

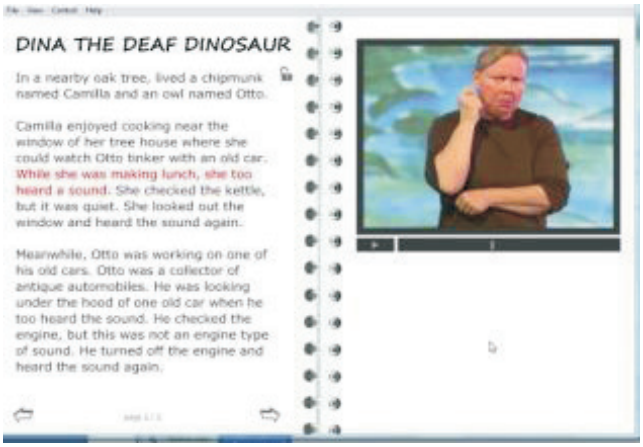
3.1 Prototype 1

Prototype 1 was developed to test the 'basic functionalities', and to help deciding some of the difficult questions. *Prototype 1* is now finished. It cannot be used yet to save documents. The lay-out was not decided and it may still changes: Different buttons, or buttons in different locations. *Prototype 1* really is only the first prototype.

Prototype 1 is the result of a selection of wishes from all wish-lists-using the three priorities as guideline. *Prototype 1* was developed to test these 'basic functionalities', and to help deciding some of the difficult questions. The 'basic functionalities' are writing a text in a text box, linking it to a video sequence, import bakground for the project (see Figure 1) and the linked text changes colour while the video is played (see Figure 2):



[Fig. 1] Backround



[Fig. 2] Linked text in colour

Changes that the users can make are as follow: add text, correct links, add new video and new picture, both as background and as a clarifying part of the document. So teachers can correct stories made by children. Students can open assignments made by teachers. Authors can work on stories, together.

3.1.1 Feedback of users

Having linked sign language and written language it is easy to preview the narrative in a playing mode. In the programme it is easy to make bilingual learning materials for deaf students. The tool is especially valuable in teaching languages to deaf learners. The programme can also be used for making teaching materials in sign language for hearing persons.

The users found the interface simple and user-friendly. They liked that sign language is the source language and the important aspect of a continued availability of the learning material and the possibility for repetition, e.g. the student may look at and examine the written text and the sign language text repeatedly, back and forth and at such speed as he/she wishes or needs and can compare the languages involved as often as he/she wishes all in the now. The parents of deaf children have very different sign language skills, that is why teachers found it useful to be able to create learning materials and tasks for different skill levels. The possibility to respond to parents' work, i.e. teachers can "communicate about the tasks" with the parents was evaluated as very important and original. The basic framework offers great potential for sign language teaching and learning; linking text and signing as a teaching tool makes sense. Students can even write their own version of the signed feedback as a learning opportunity and compare their version with the tutor's.

The recommendations regard mostly the technical part, see below. The most important of them is that the student can easily make his own materials and that the interface will not get complex. The development team should keep it simple!

3.1.2 Technical results

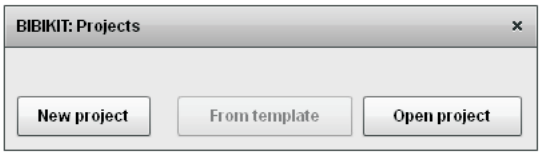
Prototype 1 was made primarily to test the functionality and the user interface. It turned out that users found it difficult 1) to understand how to link text, picture to different video files in the same video frame and 2) the questions about the video format. Screen buttons / controls need to be clearer and more human/computer interaction is needed. Video loading time is too long and the video file types are limited. BiBiKit should work on computers with standard configuration. The users found it also difficult to upload video clips.

The users commented on what they needed but it was missing in *Prototype 1*. They want to be able to have multiple (at least 2) video-frames on each page, side by side, at the same time and to use the Editor online so that students and teachers can work on the same project(s), without having to send large files back and forth; e.g. the video file should always be attached when viewing the ready product. A possibility to write directly into the text window with a pen (touch screen) should be an option if the application is locally. The users found it also necessary to be able to insert only audio files so it is possible to follow the story in sign language without inserting a textual description and to save the audio files as to be able to insert subtitles.

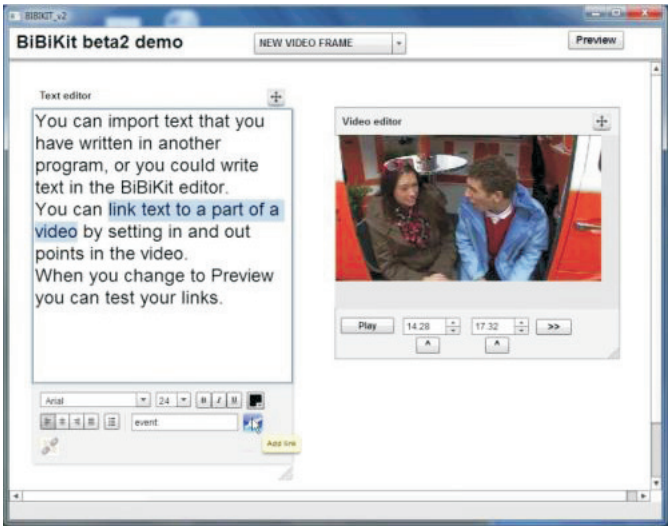
The commercial publishers requested the option to 'lock' their productions to protect them from unauthorized re-use of text, pictures and videos. They stressed the importance of producing BiBiKit projects for multiple platforms: desktop (Windows and Mac), tablets (iPad and Android), and smartphones (all platforms). The main challenge is still the video navigation and the different video formats. It is not so easy for users to understand that their video files will not work because the video is in a wrong format. This problem must be solved.

3.2 Prototype 2

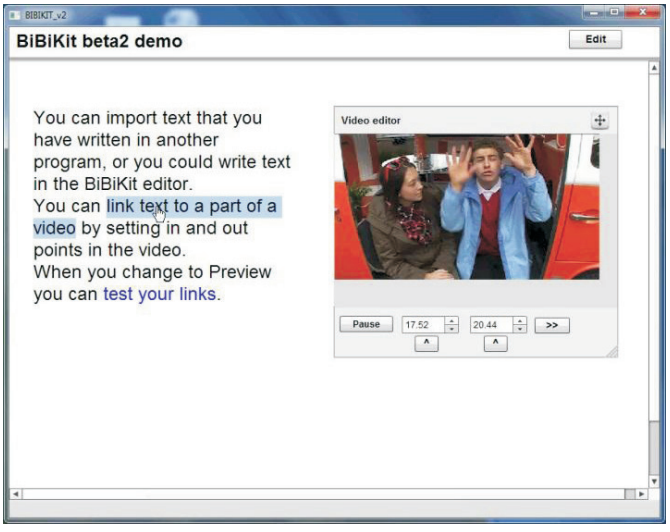
Prototype 2 is a better working version of *Prototype 1* where the user can produce, save and open his own documents. *Prototype 2* has an Editor (Figure 3 and 4) and a Player (Figure 5):



[Fig. 3] BiBiKit Editor



[Fig. 4] BiBiKit Editor



[Fig. 5] BiBiKit Player

The functions of *Prototype 2* is very similar to the first prototype apart from the possibility to save (and open) projects. All files the user needs for a project are stored in a separate project folder with a respective name. If the user decides to start a new project and to use a video file which has been used in the previous project, this video file is saved again in the folder of the new project.

3.2.1 Feedback of users

Partners and associated partners produced their own materials in *Prototype 2*. They found *Prototype 2* nice looking and easy to use in general. It is not longer an imagined software and it is possible to try it. Many recommandations given for *Prototype 1* have been taken into account.

The users underlined again that they want BiBiKit on the Internet, not local. BiBiKit should be accesible wherever and whenever.

3.2.2 Technical results

We had some of the same challenges in *Prototype 2* as in *Prototype 1*: The main challenge still remains the video navigation and the different video formats. The software is to slow even for using it local. The SAVE function in the Editor does not work as it should: If the user works for a short time and closes the program, the written text is gone. If he/she works for a longer time, e.g. 20 min., the written text is there when he/she opens the saved project. It is not possible to forward fast. The software crashes but when working slowly, e.g. forward video, it does not crash. It is not so easy to correct a mistake after the user has opened a wrong video file for a project. New folders are created automatically with too many files inside each time the user makes mistake starting a new project. Every video file which is been opened is saved each time in a new folder, even though the wrong video file has been opened. The user has to delete each folder manually. This is not easy for children and people with limited computer skills. Two videos in one frame are not still an option.

4 Conclusion And New Strategy

The software team developed two prototypes as local Air applications (made in Flex) that will run on Widows and Mac PCs. The AIR applications accepted only a limited number of video file formats. Apparently there were more problems on Mac than on Windows, but the main problem is the limited choice of video formats. The prototypes worked fine for us (the developers) as we knew which video file formats to use. In "real life" testing the users had problems understanding and accepting the limitations regarding video file formats, and lacked the knowledge of how to convert the video into acceptable formats.

During the last year Apple has managed to „kill Flash", and there has been a shift towards web applications and HTML5. Unfortunately HTML5 is not mature yet, and it had probably been better if the BiBiKit project had been started later. From the perspective of the software developers, it should have been waited 2-3 years, to see how the battle between Flash and Apple is decided, to wait for the maturation of HTML5, and to see if and how web-and cloud-based services will become the standard.

Our target groups, however, cannot wait. They say that they've been waiting for something like BiBiKit, for much too long already! We will develop a web application, an Editor, with basic functionality. The advanage will be that the user can use any video format, i.e. the video files are converted to the "standard" HTML5 video formats. To solve this problem we will now make a web application that will do the video format conversion. We will also try to make it possible to run the web application locally on the user's own PC because the problem of setting up and maintaining a server is still there.

5 Acknowledgements

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The Hybrid Book – One Document for All in the Latest Development

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Abstract

The term "Hybrid Book" stands for a digital document with a synchronized multimedia content. In the narrower sense, the Hybrid Book is a name of a technology used at Masaryk University for creation of study materials for users with a variety of information channel impairments: the blind, the deaf, dyslectics, and others. A document in this format can include a digital text, an audio recording of a text read by a human voice, and a video recording of a translation of a text into a sign language. These records are shown simultaneously by the given software application when browsing documents. A user can navigate in documents using a variety of specific navigation functions. The Hybrid Book does not only compensate for an information channel; for example, it can also be used as a unique system for creation of foreign language textbooks.

1 Introduction

We have been continuously developing the Hybrid Book at Masaryk University for more than ten years [1]. We understand the term "Hybrid Book" as a digital document, which includes at least two parallel records of an identical content – typically, text and audio – with a possibility to browse both records at the same time or alternately. The aim of such document is primarily to provide access to the given content for readers with a limited perception of some of the information channels (for example, the blind, the deaf, dyslectics, and others) and to present information to them with the help of complementing records in the least possibly distorted form.

Viewed thus, the Hybrid Book is primarily a digital publication type. As such it may consist of a variety of recording formats, which are ordered according to given rules. It this broadest sense, it is not a specific digital format. At Masaryk alone, three version of the Hybrid Book are currently in use. This overview focuses on the latest version, the third generation of the Hybrid Book, which we will refer to as the Hybrid Book 3.0.

2 Hybrid Book 3.0

2.1 What is the Hybrid Book 3.0

Unlike the previous version and some of its competing systems, the Hybrid Book 3.0 excels mainly in its full multimedia equipment. A document in this format may include a digital text, an audio recording, and a video recording. It enables a synchronized "playback" of these records and a hierarchical navigation in their contents.

We have laid emphasis on several requirements during the development of the format: firstly, on the requirement of a low-cost preparation, which term does not primarily refer to financial costs, but rather aims at minimal allocation of labor force and also a possible use of already existing texts and multimedia documents when compiling a hybrid book. This lead to the idea of "external storage of synchronization data", which means that besides the document content as such, there will be created data structures that describe what the document consists of and how its components are interconnected.

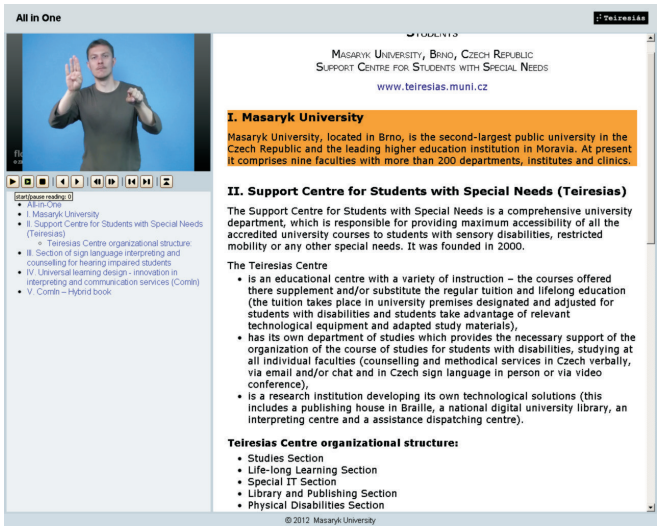
After several attempts to use an existing technology for this purpose (such as the format SMIL, for example) which did not lead to promising results, we decided to develop the record of synchronization data on our own. Based on XML, we created a simple, manually editable record for publication and synchronization data.

2.2 Reading a Hybrid Book

As we decided to develop our own presentation format for the Hybrid Book, we are naturally also forced to offer tools for its decoding – tools for reading and browsing documents created in this format. Development of these software programs is carried out together with the development of the format itself. Each version of the Hybrid Book has its document reader.

Hybrid Book Reader [2]. The Web application "Hybrid Book Reader" is a practical means of hybrid document browsing. As of now, all possibilities that the Hybrid Book Format offers are not yet integrated, but its functionality is continuously expanded. Its current version supports the essential Hybrid Book functions:

- simultaneous playback of all table of contents records,
- synchronized navigation,
- navigation in the document hierarchical structure,
- switching between individual records,
- currently read passage display.



[Fig. 1] Hybrid Book Reader

There are various ways of reading a Hybrid Book:

- following a continuously moving synchronized content,
- playback of individual passages,
- following a selected recording only,
- navigation in reading by phrases, headlines (including their level in the document outline).

Supported media:

- text in HTML format,
- video in MPEG-4 and FLV formats,
- audio in MP3, WAV, and FLV formats.

Document browsing functions:

- begin continuous simultaneous playback,
- play the selected passage only,
- skip to the next phrase,
- skip to the previous phrase,
- skip to the next headline,
- skip to the previous headline,
- skip to the next headline of the same level,
- skip to the previous headline of the same level,
- skip to one level above.

The Hybrid Book Reader enables the user interface adjustment according to the document content and according to the user's needs. For example, if a document only includes a text and audio, the video player automatically hides when the document is open.

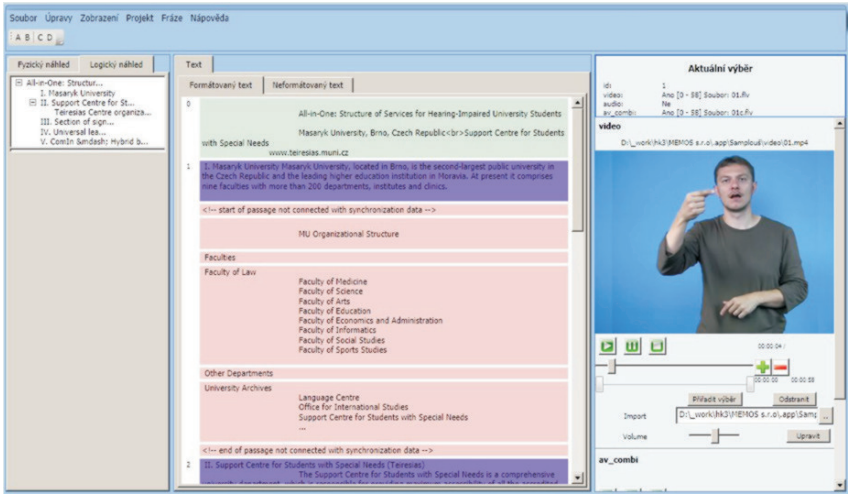
A user can use simple controls to change positions of objects on the screen, hide or show objects according to their temporary needs, and it is also possible to change the color scheme and text size.

2.3 Creating a Hybrid Book

Just as the person reading a Hybrid Book needs the reader application, a creator needs a tool for a convenient creation of the Hybrid Book content. It has been mentioned above that the content itself (text and multimedia) basically remains in the form which is commonly used for other applications – thus it seems reasonable to leave creators with the liberty to use editing tools of their preference.

For these reasons, we do not pay much attention to developing tools for Hybrid Book content editing, but we focus primarily on tools enabling synchronization (and compiling) of already existing contents.

Hybrid Book Creator. The tool Hybrid Book Creator can be used for synchronization of various types of digital documents when creating a Hybrid Book. This tool was designed specifically for designing the document structure and subesquent synchronization of selected types of digital data.



[Fig. 2] Hybrid Book Creator

The application works primarily with a text in the HTML format, which it uses for marking the Hybrid Book structure and preparing a script for an audio/video studio creating the multimedia content. Naturally, it is also possible to attach already existing multimedia files and use an integrated editor to mark synchronization units in them.

The program creates a valid code of the Hybrid Book 3.0 and distributes it together with the document content to a selected storage. It includes a lot of automatic functions such as document content arrangement and existing multimedia data attachment.

The Hybrid Book Creator is also a universal application that also offers to import data from older Hybrid Book versions and the Daisy DTB format. It also allows publication of existing documents in these formats.

Alternative Uses. The code of the Hybrid Book has been designed so that it is transparent, comprehensible and "human-friendly". Although the use of automatic tools for document creation is the simplest way, the form of the record does not hinder a manual creation and editing of documents. The main aim is not as much to make manual editing possible; it is to make integration of the Hybrid Book format into other applications as simple as possible. For example, it is very simple to use this format to add sound to specific parts of web pages, or supplement them with a translation into or a commentary in a sign language.

This is a way to produce "miniature" Hybrid Books as alternative elements granting access to information on web pages to users with impairment. It is possible to manually create documents which include few synchronization units in a relatively short time.

2.4 Who Is the Hybrid Book for?

Interest in the Hybrid Book was primarily connected to searching for an alternative way of granting access to study materials for blind students at Masaryk University. Further practice however showed that the Hybrid Book can provide for the needs of not only the blind – we registered positive feedback from readers with specific learning disorders such as dyslexia from the start.

Currently, the main target group of Hybrid Book users are primarily students with an impaired perception of some of the information channels, i.e. the blind and vision impaired, the deaf and hearing impaired, dyslectics, and others.

2.5 What Is the Hybrid Book Good for?

The Hybrid Book offers a lot of possible uses. The basic ones are clear – it enables to supplement a text with an alternative record for users who encounter a barrier when accessing the text. The Hybrid Book does not only assist to get over these barriers: it can also be a unique tool for foreign language teaching (both spoken and sign languages) as proves the popularity of an English textbook published in this format at Masaryk years ago. A possibility to engage native speakers' services for creation of a content of such textbook is an obvious benefit for the user.

Besides teaching languages, the Hybrid Book aspires to reach completely different areas, too. As mentioned above, it is quite simple to use it to add an alternative content to a web page, and to supplement some of the parts of a web page with a spoken interpretation or a translation into a sign language. The use of the Hybrid Book 3.0 for these purposes is currently in the testing stage, which currently consists of specialized attempts to show whether the Hybrid Book 3.0 is really suitable for this. If our assumptions are confirmed, we could develop a framework for web page creators facilitating the integration of hybrid documents or Hybrid Book functions into web pages and applications.

2.6 Competing Applications

Creators of the Hybrid Book 3.0 began to work with a similar resolution as the one that preceded the birth of the first generation of the Hybrid Book: to create a system which will primarily supplement what is missing elsewhere. The Hybrid Book has been compared to its immediate competitor Daisy DTB [3] at Masaryk University since the beginning of its development. The first two generations of the Hybrid Book are comparable to Daisy DTB, although the second generation of the Hybrid Book was already primarily intended for distribution in the World Wide Web environment; however, such a comparison is only hardly possible with the third generation. For one thing, the system now includes an element that Daisy does not take into account – video recordings; for another, the philosophy of the system itself has changed: it has been said that the Hybrid Book pushes the way of document creation from simple interpretation of a given text in the same language more towards a translation of the text into another language, or towards supplementing the pristine content with alternatives allowing to specify the presented information.

In the area of providing access to documents for the blind and vision impaired, the Hybrid Book compares well to Daisy DTB as concerns the user. As concerns creation, the Hybrid Book does not yet have such support. Technically, however, the Hybrid Book has an advantage in its code, which is transparent, logical and simply manually editable. Moreover, the code is designed so that it allows simple addition of new functionalities, such as new multimedia document and text formats. The code is not yet standardized, which can be viewed as its shortcoming, of course – on the other hand, SMIL – the language used by Daisy DTB – is the W3C standard but it lacks general support and is not widespread[d]. This language was also considered as the language of the Hybrid Book,

but its complicated code and practically zero web support diverted the developers' interest towards a simple XML encoding[e].

The Hybrid Book 3.0 has been seen as a suitable format for the Internet environment from the beginning. Shortcomings in the possibilities to distribute Hybrid Books on hard media – still heavily requested mainly by the blind – will be gradually recompensed. Presently, the only Hybrid Book reader is a web application, which needs a web server to run; and, this does not help distribution on hard media much. The development team at Masaryk has already designed client applications able to run without the web environment. Their implementation is planned for the near future.

3 Future Prospects and the Conclusion

The Hybrid Book 3.0 is a young document format built on years of experience and verified basis. Its program code enables simple integration into other systems and introduction of new functionalities. Presently, software tools for document creation and reading in this format are available. These tools as well as the format itself are under constant development and testing. A lot of theoretical and practical attempts to integrate the technology into various systems, mainly web applications, are done.

We believe that the Hybrid Book is a sufficiently specific format not to remain unnoticed by professionals and users in the area of the creation of documents with synchronized contents as well as web and local software applications developers. By all means, the primary aim of the Hybrid Book development team is to provide its users with the easiest possible access to undistorted information presented by the author of the studied work.

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Providing Digital Resources to Enhance Employability Skills for Disabled Students

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1 Introduction

In 2011, the employment rate of disabled people in the United Kingdom was 48.8 per cent, compared with 77.5 per cent of non-disabled people [1]. The rate for disabled adult employees has been rising consistently in the last 10 years and there is still a significant discrepancy compared to those without a disability. In addition youth unemployment at around 20 % [2], and one of the main indicators generated by the financial crisis in Western Economies, is of increasing concern.

The CBI's (Confederation of British Industry) Education and Skills survey in 2011 highlights the concerns of Employers in relation to the low level of numeracy, literacy and employability skills of many school and college leavers [3]. Although many of the skills as set out by the CBI are not those that can be addressed with traditional digital resources there are many technological solutions which can enhance and promote their use. For example, an individual's time and self management can be significantly improved by the use of scheduling applications.

In 2011 JISC TechDis were commissioned by the Department of Business Innovation and Skills to provide a range of resources to improve the employability skills of adults with disabilities and or difficulties. Employability Skills are recognised as "an essential precondition for the effective development and use of other, more specialist or technical skills required for particular jobs. And they are a key underpin to [your] effectiveness at work" [4]. To this end, the TechDis Toolbox was developed to hold a collection of digital resources aimed at improving the skills of adults with disabilities in order to increase their employability.

2 Existing Resources

JISC TechDis have a history of providing simple easy to use resources which focus on the need for teachers and tutors to be able to provide accessible teaching materials for their students. The most successful of these were 'Benevolent Bill – What Microsoft does for Accessibility' [5] and the 'Accessibility Essentials' Series [6]. The crucial factor in success of these resources is their highlighting of how everyday office applications such as Microsoft® Word and PowerPoint can be used to create accessible teaching material which can benefit all students.

All the JISC TechDis resources have so far been purposed with the tutor or lecturer in mind. They were written for academic staff using academic or more formal language.

3 Digital shorts

The advent of YouTube in 2005 transformed the way in which many young people access information as it allowed users to upload their own content. Much of this is of limited

value and of an individual nature, but there is also a wealth of information on any given topic. Although it is possible to upload videos longer than 15 minutes the majority of the videos are short – less than 10 minutes long [7]. The statistics for the site are unprecedented – 48 hours of video are uploaded every minute and there is more video uploaded in 30 days than the 3 major US TV channels produced in 60 years [8].

In 2007 Michael Wesch produced a short video on 'A Vision of Students today' [9] in conjunction with his 'Introduction to Cultural Anthropology' class in 2007. He was aware that although the students attended his lectures, their attention was not completely on him and the information he was imparting [10]. The video highlights the anomalies between traditional academic practice and the way in which these students behaved. The video was viewed over a million times in the first month [11]. It highlighted that although the surveyed students would read 8 books in that year and write up to 42 pages for their class, they would also write 500 emails and view over 2300 web pages and 1281 Facebook profiles.

The increasing popularity of the microblogging site Twitter also shows the astonishing ability of the internet to disseminate information. Although only sending messages of 140 characters in length the site can spread news in a way previously unthinkable. In January 2009 when an aircraft crashed into the Hudson River in New York the news and images were spread by twitter users with the world's media desperately trying to catch up [12].

With this knowledge in mind we started to plan the sort of resources that would be of use and interest to the current 'digital consumers'. Our target audience for these resources were students with disabilities who would possibly rely even more on digital content than others to meet their access and inclusion needs. We therefore had to produce resources that were focussed, simple, short and linked. A crucial aspect of the project was the involvement of disabled students themselves in both using and commenting on the resources and disseminating them with their peers.

4 Student Centred

The first part of the process involved speaking to adults and young people about how they used technology. We conducted a number of short focus groups with disabled students in a number of different settings. These ranged from special schools, independent specialist provision for young adults, mainstream colleges and students from Higher Education with diverse needs.

In general the results showed that although most of the students used technology with the college or classroom situation, the technology itself was limited and usually dated. One group of 16 year old boys with learning difficulties and/or disabilities explained how the teacher had to be helped to use the virtual learning environment. They also talked about how they used their games consoles at home and had an informal network of friends and enthusiasts who helped each other out if they got stuck in a particular game. They were adept at manipulating these consoles and had received no formal training or instruction. They also had essentially developed their own online community where they shared music, videos and things they found interesting on the internet.

5 Developing the resources

It was vital to ensure that any resources created would be relevant to students and would directly influence their Employability Skills. An analysis of our existing materials identified gaps that required further resources. These included updates to Accessibility Essentials to encompass both Word 2010 and the Windows 7 built in accessibility features; the extensive accessibility feautures in both the Mac OS X (Mac operating systems) and the iphone/iPad operating system iOS; and basic information literacy.

JISC TechDis commissioned consultants with experience of teaching, an understanding of pedagogy and knowledge of the existing TechDis materials to produce the Toolbox resources. Although the production of the resources was done by external consultants there was a clear work flow for their development. Agreement on the language to be used, and approval of scripts for audio and video files, had to be given before any resources were created and this prevented unnecessary and time consuming editing of multimedia. Resources were created in the format deemed to be of most use to the users (an audio file, video file, step-by-step guide or a combination of these). Video and audio files were required to be less than 3 minutes in length and have little or no technical jargon.

5.1 Phase one resources

- Getting to know Google – 9 videos starting from absolute basics
- Mac OSX accessibility
- iOS
- Windows 7
- Windows XP
- Word 2010
- Reading PDF documents on screen

5.2 Phase 2 resources

- Self Management
  - Email
  - Calendar
- Planning
- Team working
- Free and Open Source Software
- Freemium Services
- iLife

6 Feedback

Once the resources were being produced we recruited further young people and adults to act as reviewers. These were in three distinct groups.

6.1 Digital Outreach Trainers

A European funded project in South Yorkshire supports a number of young people in further education to become Digital Outreach Trainers (DOTs) [13]. The project enables students in further Education to share their expertise using computers with friends, relatives and colleagues who may be reluctant or unable to get online. This is to further the Race Online 2012 agenda [14]. There are currently over 400 DOTs. The students complete a portfolio to show how they have supported or helped those previously without connectivity to engage with and use the Internet in a productive and useful way. JISC TechDis are working with this group of DOTs to encourage them to use the Toolbox resources. They have been used in ways in which we hadn't anticipated, for example, to help refugees in learning English as well as ICT skills with a basic series of videos on 'Getting to Know Google'. Other DOTs have used the resources to encourage siblings with disabilities to engage with Internet resources in a way which is meaningful for them.

Feedback from the DOTs has resulted in additional material being commissioned. They explained that a lot of the people they were working with did not have the most up-to-date hardware so would not have access to Windows 7 for example. As a result of this we commissioned accessibility guidelines for users of the Windows XP operating system. Despite our showcasing the options for reading word documents and PDF files on screen these videos remain the most popular with all our testers.

6.2 Ambassadors

TechDis have recruited a number of students from many educational backgrounds. These have varied from independent provision, work based learning providers, mainstream FE colleges and Higher Education. They have trialled some of the resources that were relevant to them and provided feedback. High quality videos to capture this feedback as case studies have been commissioned to further promote the Toolbox resources.

6.3 InBook

A secure social network tool has been developed with two Independent Specialist Colleges and a mainstream FE college in the North West of England [15]. This has been developed to promote good e-safety practice and to enable students with learning difficulties and/or more complex needs to be able to share their experiences and rich digital content. The system has been piloted with students aged between 18 and 24 in the three colleges and is proving to be very popular. The students have been asked to comment on the Toolbox resources and share those that they find useful with each other. This feedback process will begin in January 2012.

7 Hosting

The toolbox project resources will be hosted on a microsite of the main JISC TechDis site. http://tbx.jisctechdis.ac.uk. The materials will be available as standalone resources, but also will be linked in an easy to access format where appropriate. For example the Word 2010 videos on creating accessible documents work in conjunction with each other and the user will be able to easily browse from one to another. The site will also have each of the resources in context allowing the user to find the right resource for the information they need.

Dissemination

All the users mentioned in the previous section use various tools on the internet for communicating and sharing information. We will encourage them to share the toolbox resources using their own preferred methods which will include, twitter, facebook, Webdoc and possibly Pinterest.

Future work

Work done so far on the Toolbox project is only a start with further resources planned. These will include further resources on problem solving, information literacy and a section on Apps for accessibility. We anticipate that the communities fostered as part of phase 1 and 2 of the project will develop and continue to act as reviewing and steering process. The feedback we have received from them has been practical and relevant. They are our main audience and focus.

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On Producing Accessible Course Material

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Abstract

In this contribution we describe briefly what accessible documents are, which ones are needed with respect to the type of reading/writing impairment of the final user and how they can be produced. The two major production paths nowadays are: (1) the use and conversion of existing electronic documents and (2) alternatively, scanning of existing paper documents. In the latter case all of the structural content as well as tables, mathematical formulae, complex layout etc. generally is lost making it very difficult to use them as course material. In practice (examples given below) scanning is only to be used as a last resort or when immediate availability is requested.

1 Introduction

In many educational situations, PDF (sometimes PowerPoint) is seen as the major distribution format for electronic course material. However not all students can access and handle such documents. This group of reading/writing impaired students consists of persons with a visual impairment, blindness, dyslexia or a motor handicap that does not permit the manipulation of printed material.

To these categories of students (and staff members) other types of documents have to be made available. This is required not only by national and European law, but also by the United Nations Convention on the Rights of persons with disabilities [article 4, paragraphs (f) & (g)][1].

2 How many types of accessible documents are in use?

A short overview of the major types (together with some positive ▲ and negative ▼ comments) follows:

- **Pure text files**
  - ▲ easy to produce, universally readable on all platforms
  - ▼ no structure for navigation, systematic reading not possible, symbols and most foreign characters wrongly displayed
- **Microsoft Word files (DOC)/OpenOffice.org (ODF) files**
  - ▲ are generally usable on most platforms, also for blind students, but care should be taken to maintain structure. Guidelines for accessible MS Word files do exist[2].

1 http://www.un.org/disabilities/default.asp?id=264adfa.

2 http://www.kuleuven.be/digitaletoegankelijkheid/documenttoegankelijkheid/inleiding-documenttoegankelijkheid.

This format is preferred by blind students in Flanders also because software for handling for mathematical formulae is available (SensoMath).

- ▼ complex tables and pictures need alt-text encoding

- **HTML**

  HTML files (i.e. web pages) are almost as usable as word processing files. A huge literature does exist on producing accessible web documents and sites[3]. Mathematics can be included if MathML is used.

- **LaTeX**

  Latex files are basically text files, not meant for human reading due to the extensive number of codes put in between the text parts; however, Latex is sometimes used to represent linearized mathematical formulae.

  - ▲ is produced mainly by academic staff; good source format for large print production (as it is a word processing format)
  - ▼ internal format is much too complex for human reading of mainly text based documents

- **PDF**

  - ▲ generally readable and usable if tagged PDF is used (this is NOT standard if a document is produced by scanning/OCR)
  - ▼ editing and adding notes is complex (and/or expensive), not directly usable for students with dyslexia

  Note: authors need to know which PDF export options are to be checked in order to export into tagged PDF from Microsoft Office or OpenOffice.org. There are no tools that export LaTeX to tagged PDF.

- **KES (Kurzweil) and enriched PDF (Sprint)**

  These formats are generally used by students with dyslexia. They are based on PDF but post-processing is necessary to get logical spoken output afterwards (cf. ADIBIB project below).

  - ▲ very easy to handle in the appropriate reading software. K.U.Leuven is equipped with sufficient licences of both programmes
  - ▼ two different reading suites are widely used in Flanders.

  Editing the documents or adding student's notes is complex.

3 See for example the K.U.Leuven guidelines at http://www.kuleuven.be/digitaletoegankelijkheid/webtoegankelijkheid/inleiding and a selection of other guidelines at http://www.kuleuven.be/digitaletoegankelijkheid/links/links/richtlijnenweb.

3 Production paths for accessible documents

3.1 Common path

Basically there are two major starting points for the production of accessible documents.

a) The use of existing electronic files. However in most cases some manual intervention or conversion will be needed (cf. above)

b) Scanning the paper documents and applying OCR to produce text containing files. Is the most rapid approach, but only admissible for simple text documents

Retyping texts (e.g. those with a very complex layout) is still necessary in some cases. This is clearly the most expensive way.

3.2 Specific paths

As stated above in most circumstances an extra conversion of source documents will be needed to come to a really accessible document. The number of approaches is huge and ranges from simple (e.g. RTF output of a .doc or .docx document) to very complex (Latex to correct mathematical braille e.g.). Describing all procedures is out of the scope of this contribution, but below a few approaches (focussing on students with a visual impairment & students with dyslexia) are detailed.

4 Approaches

4.1 K.U.Leuven

In the K.U.Leuven Digital Accessibility Support group for students, both scanning and source document conversion (requiring agreements with publishers) have been used in parallel. For Braille production, sometimes retyping is necessary. Several groups were involved in these processes.

From 2012 onwards a new organisational structure will be implemented (see table).

4.2 ADIBib (Belgium)

The ADIBib consortium was created a couple of years ago in order to provide accessible electronic documents for primary and secondary school use in Flanders. Thanks to their collaboration with the Vlaamse Wetenschappelijke Uitgeversgroep (and support by the Ministry of Education), they can get the electronic versions of the schoolbooks (PDF, possibly Adobe Indesign) from the publishers, often even within a couple of days.

ADIBib's primary focus is on students with dyslexia, but they are expanding their support to all other reading and writing impairments. ADIBib caters for two types of conversions (scanning is NOT used anymore):

- **type A**: unprocessed PDF (mainly for large print or if type B does not exist yet)
- **type B**: processed PDF (tagged PDF, Kurzweil format, Sprint format)

  ADIBib has obtained a specially developed conversion tool (PDF editing software – from Jabbla company) to produce these formats, but manual intervention remains necessary for correcting structural scanning errors (facilities for doing so are built into the conversion tool). Social watermarking is used for (moderate strength) copyright protection

ADIBib is a not-for-profit organisation funded by the Flemish Ministry of Education. Conversions are mainly done by volunteers (parents, school teachers...). More on ADIBib can be found in their recent presentation at the AEGIS 2011 conference[4].

Type of disability / Type of material	**Course material (created by lecturer)**	**Book (printed by publisher)**	**Reader of printed articles and/or book chapters provided by lecturer**
Visual impairment (esp. blind)	Accessible digital version should be provided; ideally in word processor format (e.g. Word or OpenOffice. org), which can be converted to Braille, large print or synthetic speech (daisy).	Accessible digital ver-sion should be pro-vided; ideally in word processor format (e.g. Word or OpenOf-fice.org), but usually only (poorly accessi-ble) PDF is available. PDF is not supported by all screen readers (for blind students). Convert-ing poorly accessible (untagged) PDF to Microsoft Word leads to very low-quality Word doc-uments. For this reason, PDF documents are often converted to plain text files (TXT), with one file per chapter.	If the materials are not available in a digital for-mat, making these materials accessible is a very time-con-suming and expensive proc-ess: OCR, add-ing heading structure, recre-ating logical reading struc-ture and tables, adding alt text to images, re-moving repeat-ing headers and footers, reposi-tion-ing foot-notes… This is typically done by special-ised conversion centres, on spe-cial re-quest by the student.
Dyslexia	Accessible digital version should be provided; ideally in word processor format (e.g. Word or OpenOffice. org), but accessible (i.e. tagged) PDF is also accept-able. Software such as Kurzweil can work with PDF (e.g. read it aloud).	Digital version is re-quested from pub-lisher; this is usually PDF. Nowadays also tagged PDF is possible (if Adobe InDesign is used properly when layouting a book).	Scanning and OCR are the most mini-mal requirements. These electronic versions have to be converted into KES or Sprint (e.g. using ADI-Bib software, cf. below)

4 http://www.slideshare.net/aegisproject/20-adibib-aegis-paper.

4.3 Danish central office for Educational material (DK)

They produce accessible documents for the whole Danish educational system and currently have 14000 books on file. Scanning/OCR is only used for urgent requests where students are willing to adapt the output themselves. Only two weeks can be gained from scanning as this is the time span needed to collect books from the publishers and have them turned into truly accessible books[5].

4.4 ADOD project (International)

Recently the Inclusive Design Research Centre (IDRC) in Toronto has started an information collection project on the use, usability and accessibility of Office type documents. A large web database[6] has been created. For the moment most of the info is in English but some of it is also available in Dutch. More details about this project in their AEGIS2011 slide presentation[7]. This presentation also details their "12-General Techniques" for accessible document creation and also pays attention to cloud based Office documents.

5 Acknowledgements

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5 source: discussion at Aegis conference Dec. 1, 2011.

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LaTeX based notation as computer math notation for the blind

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Keywords: LaTeX, mathematical notation, Braille display

1 Introduction

Modern Information Technology (IT) and Assistive Technology (AT) enables the blind learners to access standard computer applications. It helps them to be successfully integrated in inclusive form of education. It is almost hard to imagine a blind learner to attend classes without computer and assistive technology. Even at math lessons.

Majority of Slovenian blind learners attend mainstream schools. A few years ago each of them had to find an arrangement with the teacher about the mathematical notation. Such individual agreements were not effective on long term. It was very important to have a uniform standard for math notation used by computer and Braille display.

2 Searching for the right system

For accomplishing this goal a project group was founded in year 2006. The participants were experts from The Institute for blind and visually impaired children Ljubljana and Slovenian associations of the blind and visually impaired.

The main purpose of this group was to find a way that would allow blind and partially sighted people to access mathematical expressions of all kind by computer at all levels of education. It should be a system that would be used as widely as possible and would allow easy communication between teachers and learners. As the most appropriate linear notation LaTeX based notation was chosen.

The arguments that have spoken in favor of it were:

- This notation is internationally acknowledged.
- All mathematical symbols, formulas, regardless of the degree of difficulty can be accessed.
- Physical and chemical symbols can be accessed.
- Mathematical expressions can be printed for the sighted. The communication between blind and a sighted person is possible.
- Inclusion of blind learners into education is much better, they can present their results in the same way as other learners.
- The school textbooks can be made by LaTeX based notation.
- LaTeX is taught at natural sciences at university; therefore math teachers already know the system.
- Progressive learning of LaTeX is appropriate for blind learners.

3 Description of the LaTeX based mathematical notation

LaTeX is a document description language commonly used especially by the Internet community. The system provides a powerful set of instructions to describe mathematical expressions.

LaTeX based mathematical notation is designed for all blind learners, for all levels of education. Text editors, such as Notepad, WordPad or MS Word can be used for writing math expressions. Learners do not need to print out math expressions in a high quality layout. Teachers should be familiar with LaTeX syntax. Teachers should write math exercises and test papers in text editor that is well known to the learner. Only LaTeX commands for math expressions should be used, not the formatting ones. Teachers can always upgrade the file with formatting commands and use it for sighted learners. This is one of the advantages.

3.1 Simplifications and Deviations from LaTeX syntax

In LaTeX it is possible to create mathematical expressions in several different ways. In order to make the learning process easier it is very important to define only one variety that all learners and teachers should know.

Some commands in LaTeX are very long and therefore unsuitable for Braille display. Some are too complex for learners in primary schools. In such cases, learners and teachers should know and use simplifications, which may partly deviate from LaTeX syntax. Off course it is all right for learners to follow the correct LaTeX syntax.

Simplifications and deviations from LaTeX syntax:

- The symbol for multiplication is * instead of \dot.
- Exponents are always written in braces.
- The indexes are always written in braces.
- For the fraction it is always used command \frac.
- Base in the root command is always written in braces.
- There is no backslash sign before percent sign.
- Less or equal sign is written as a combination of characters < and =.
- More or equal sign is written as a combination of characters > and =.
- Capital letters are used for the names of the sets.
- There is no backslash sign before braces and box brackets.
- For measured angle the command \angle is used instead of \measuredangle.
- The minute of arc sign is written as an apostrophe. The second of arc sign is written as double apostrophe.
- Vector sign is written with command \vec in all cases.

3.2 Rules for writing

The rules for writing make the reading on Braille display easier. They are almost the same as the rules for the 6-dot Braille mathematical notation. They also ensure the test papers, exercises, exams are always written the same way regardless of the teacher.

A list of rules:

- The beginning and the end of mathematical expression is marked with the sign $. For example: $ (a +b)(a -b) =x $
- Before the sign for addition, subtraction, multiplication, division, cross product, equal, larger and smaller there is always a space (the exception is a combination of >= and <=).
- There is no space after the command which is followed by exponentiation, index, bracket, comma or semicolon.
- There is always a space between the numerator and the denominator at dual fraction.
- All brackets tightly enclose the expression.
- Euro currency is marked by the abbreviation EUR and not by a symbol.

3.3 Tools to make mathematical expressions easier to write

Macros in MS Word can speed up writing the mathematical expressions. Keyboard shortcuts make writing fractions, roots ... quite fast.

Suggested keyboard shortcuts:

- Alt + M: dollar signs $ $
- Alt + N: dollar signs in a new row
- Alt + U: fraction \frac {}{}
- Alt + P: exponentiation ^{}
- Alt + I: index _{}
- Alt + K: square root \sqrt{}
- Alt + Shift + K: n th root \sqrt[]{}

Some commands (Find, Change ...) can be used to upgrade the file for printing for the sighted.

Examples

Multiplication: $ 3 *4 =12 $
Exponent: $ a^{2} +b^{2} =c^{2} $
Index: $ p(x) =a_{n}x^{n} +a_{n -1}x^{n -1} +... $
Fraction: $ \frac{x -5}{2} = $
Square root: $ \sqrt{9} = $
Set: $ A ={n \in N; 2 <n <=8} $
Surface of circle: $ p =\pi r^{2} $
Integral: $ \int_{a}^{a}f(x)dx =0 $

4 Transition from 6-dot to 8-dot mathematical notation

Transition from 6-dot to 8-dot math notation is not simple. It takes systematical and individual approach. The transition process can not be the same for everyone. The learner

should get support from a specialist teacher and from their teacher of mathematics as well.

Before using LaTeX learners should be able to:

- use IT and AT properly,
- to recognize all characters used in LaTeX on Braille display accurately and quick enough.

Learners should use LaTeX based math notation at mathematical lessons at least one year before taking external exams.

5 Conclusion

There is uniform method to access (write and read) computer based mathematical notation for blind learners in Slovenia. It is the so called LaTeX based math notation. It is not something entirely new because LaTeX has been used for many years. The most important thing is the fact it is a form that has proved to be friendly to Braille users as well. And not only for Braille users, LaTeX based notation is suitable for some partially sighted screen users too. Braille typewriters and 6-dot mathematical notation is now used only in the first three grades of elementary school or for those learners who are not able to use AT.

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Tactile Images for Inclusive Teaching in Primary Education Nature and Science

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Abstract

In the project '(Get to) know your world' Dedicon and Bartiméus Education examined what would be the best way to select and produce tactile images in swell paper for biological, technical and science subjects for blind students in the second phase of primary education. Tactile image production rethought, with as central challenging thoughts:

- *Don't start with selecting the images in the book but start with the learning goals (which makes the process very different from adapting images for students and adults).*
- *A selection of images from the book leads to problems as tactile images are always different (simplified, (re)structured); can we use D4All images for the whole group or class?*
- *Talking though tactile images allows multimodal and interactive learning, invites the (blind) child to ask questions revealing (a lack of) prior knowledge of the child.*

1 Introduction

In this introduction I will first describe the conditions: who participated, what was the reason to start a project, what do we want to achieve. After this introduction I will describe how the project was set up. At the moment of writing we are on two-third of the project. The tests we do using the images in class will stop half way June. Yet we already can share some important findings, that I will summarize in paragraph 3. Next I will describe how we want to continue and what conditions for successful implementation we found. In the last chapter I will indicate how we try to give this very practical project scientific foundations.

1.1 Project partners

In the project '(Get to) know your world' Dedicon cooperates with the primary school of Bartiméus Education for the VI. Dedicon is the Dutch 'Reading for all' Library. The educational department provides accessible school- and studybooks for print impaired people of all ages.

Dedicon wants to innovate the production process for tactile images and realize a better connection of tactile images and education. Bartiméus wants to investigate if the use of tactile images can include the blind students in their lessons, where they now sit and listen passively.

Bartimeus selected a (mainstream) method they use for what we call in the Netherlands 'world exploration'. In this method the central question is '(what is it and) how does it work?', e.g. our climate, energy, our eyes and ears, in what types of houses do people live here and in other continents and why?

The project was made possible with the help of the Association Bartiméus-Sonneheerdt.

During the project a request came from Visio Education for the VI, who had just introduced a new method for geography. Here too it proved problematic to include the blind students in the lessons. Therefore they had ordered many tactile images, just marking them with a post-it memo. A shared question (by Dedicon and Visio) was if it would be possible to use so many tactile images during the lessons and if the right selection was made. They agreed to cooperate in similar tests/pilots as we did with Bartiméus.

1.2 Tactile images, a major issue

Modern schoolbooks are full of images. Some are 'eye candy' and don't need to be made accessible. Others illustrate or summarize the text. Some even replace the text.

For Dedicon a major issue is how to make the many images in these books accessible for visually impaired students in an Evidence Based (and cost effective) way, allowing:

1. the students
- To work independently
- To cooperate with sighted peers and teachers
- To fully understand a subject
2. the teachers
- To include a blind student or student in plenary lessons and to help the teacher to provide a proper explanation, taking into account that there may be gaps in the knowledge of the student

Tactile images in primary education provide a very good means to talk about subjects, how they work or function, what they look like, etc. They can help teachers and other adults to help the child to fill in gaps of knowledge and understanding, that often go unnoticed when only describing. It is well known how blind students build up their knowledge of the world around them in a fragmented and random way and how they often talk of subjects or objects that they don't really know.

1.3 Conditions for making usable tactile images

We already knew from experience at the start, that using tactile images effectively in primary education presupposes:

1. a well designed image, from the point of tactile perception, matching the skills of the student to read tactile images
2. that the content and explanation match with the prior knowledge of the reader (building a description around not well-known elements is the same as using 'difficult words' that have no meaning to the children (yet)).

Ideally a multidisciplinary team designs the images. The design of a good tactile image requires:

1. technical (drawing) skills
2. knowledge of how to draw tactile images
3. knowledge of the subject

4. knowledge of what exactly shall be explained to the reader – and how (and why)
5. knowing how and in what situation it will be used

1.4 Present situation and goal

Tactile images presently are very little used in primary education, except maybe for maps and math diagrams. Reasons:

- Many teachers are not familiar with working with them
- There is no black writing (normal latin letters) on the images to help the sighted peers, teachers and parents; the tactile images lacking any explanation are pretty inaccessible to sighted peers and teachers as they differ from the 'normal' images because of simplification and because of the rules for tactile perceptibility
- The tactile images are not attractive for the sighted peers and teachers (adding color might not only make them more attractive, but might also raise their usability by children with partial or low vision)
- Mostly no tactile image is at hand, even in Special Education in The Netherlands
- Dedicon presently allows everybody who ask to (re)produce a book, to order 50 (new) images. Teachers think making this selection is very difficult and time consuming. In practice mostly Dedicon decides which images will be produced and how.
- It takes too much time and expertise for both mainstream, specialist and itinerant teachers to produce tactile images themselves. Occasionally a specialist or itinerant teacher in this area (second phase of primary education, science subjects) will produce an image – mostly by hand.

The project '(Get to) know your world' aims at introducing more frequent and better use of tactile images in primary education. It focuses on the selection, design and production in swell-paper (the production method presently used by Dedicon) for tactile images in schoolbooks.

A central point is the connection with education. Dedicons designers do a good transcription job, but they are not familiar with the class situation or the student and rarely get any feedback from teachers or students

Of course tactile images in the first place are made for the student. But they must also consider the people around the child. They must facilitate the teacher to teach effectively. The teacher must be able to select and choose what he wants to use in the lesson. An important feature is that there must be black writing on them.

In this project we test the use of images in 'normal' lessons in Special Primary Education to see if they fit in the lesson and if they are understandable and add value to the lessons for the child, the teacher and the (partially sighted) peers.

2 Proceedings of the project

As explained above, we worked with a method for Nature and Science, 'Natuniek'. Bartiméus Education for the VI used this method and was looking for a way to better involve the blind students in the lessons. This method is designed for and used in mainstream schools.

A set of dates was planned, where images would be used in the lessons. Tactile images were produced for these lessons. The two interns of the UU would attend the lessons and film. In an evaluation session both the quality of the images and the effect on the learning process of the child were evaluated with the teacher. An important question was if the lesson proceeded according to the intention and expectation of the teacher, regarding the use of the tactile image.

In one class the blind student was taken apart by the teacher, in the other an assistant would work with the blind student. Both classes had about 6 students.

At Royal Visio Education for the VI 'Meander', a new method for geography had recently been introduced. Here we organised two tests in a very similar way and circumstances.

2.1 Phase 1

In the first phase of the project the teachers were asked to select the images. A format was used where they noted their arguments and intentions.

The teachers were asked to:

- select images from the book they thought they would need and/or to
- ask for additional or alternative images if they would think that necessary or better

They were asked to motivate their choices and to indicate the purpose of each image, e.g.:

- explaining (or testing the knowledge of) the main subject (e.g. electricity, the working of the senses and so on)
- explaining a particular object or concept that might not be known or clear to a blind student (e.g. a belly speaking doll that was given as an example for how the senses may be tricked).

In this first round the teachers never asked for alternative tactile pictures; they only selected images from the book. They motivated their choices with quotes from the text in the book; the image would serve to make that fragment clear. Sometimes they added sketches of how they wanted the image to be transcribed and/or they added Braille labels they wanted to have added in the tactile images.

We got very little response on the questions for the expectations of teachers of how using the tactile image(s) would work out during the lesson, or what their assumptions were as to questions the child might aks or time that would be needed or if it would be easy or difficult to assist the child or dividing one's attention between the (partially) sighted and blind children. In one class the blind child was taken apart to avoid this problem.

The images were designed, then evaluated on (expected) tactile perceptibility by the projectleader, the interns and the teachers. Most images were reworked once or twice before being used in the lessons.

The images were used in ordinary lessons (that otherwise would have taken place without images). A complicating factor when doing research in an ongoing situation (without disturbing it), is that the available dates and time do not always permit optimal preparation or choices. On the other hand there is an added value in it too, since one can identify all the practical obstacles for implementation right from the start. In fact what we do is starting up a repeated learning circle of 'plan-do-check-act', each time bringing

into practice what we learnt in the previous round. In fact this is a famous model for safeguarding and improving quality.

2.1.1 First observations

From observation it was immediately clear how inclusion improved since the blind students now could more actively participate. The hypothesis from the first tests is that having a tactile image – or a model – enhances the inclusion of the blind student and the pleasure in learning as we observed from the response and mimic of the students. The multimodal experience probably also enhances the quality of learning. This is subject for further study.

For the teacher it seemed that the extra effort using tactile images with the blind student paid back. However at Visio we observed that the teacher had to do quite some extra effort in the plenary lesson, since the partially students worked with different material (the images in the book). The blind child had fewer images that didn't cover all terms that were explained during the lesson.

The reactions of the students on individual tactile mages sometimes was surprising and very instructive for us. Some things would prove challenging and fun instead of difficult. For example: a map where the child had to find the cities in a random order. Often children were invited to ask questions, that helped the teacher understand what explanation the child needed.

Children started to ask more questions than without an image. Like: 'where are its ears?', when studying a caterpillar. A detail that is easily missed when only describing. (BTW: describing a caterpillar in such a way that someone who has never seen any, will understand its size, the place and proportions of its segments and his legs, is not easy...).

2.1.2 Quality of the images in the book

Images in schoolbooks are of very different quality. Very often our designer had to do extra research to look up details. E.g.: the position of the legs of a spider, the shape of the tail of a dolpin seen from the side.

If we provide an image of a spider in a web, the image in the book may not reveal exact shapes, structures or proportions, depending on the angle from which a photo was taken and other optical effects.

When sighted people look at a picture their brains mostly fill in the gaps either in a creative way or from memory. They have seen many (pictures of) spiders. Or they don't wonder about missing details.

Blind children have not seen many (images of) spiders and may not have a clue as to what it looks like. When providing a tactile image of the spider, it very much depends on what one wants to show. Is it the size of the spider in relation to the web? Is it how the spider attaches to the web or how it weaves the web? Generally just copying the image from the book will not give a meaningful result. Designing a tactile image often needs extra study and thinking.

Often we had discussions on how to draw and what to draw since it was not always unambiguous what message(s) the picture should transmit and/or what is important to include in the drawing for the student.

E.g.: the human eye from the front: with or without eyelid and eyelashes? Nomans-

land around the circle of the eye? And around the pupil? Pupil black (feels thick, not as a hole)? Do we depict the iris or not? Do we magnify it very much? Loads of questions for one image!

A frequently returning question was if is it enough to give a scheme or if the image should also explain what things look like?

E.g. an image of a power station. Should it simply and only convey the steps or should it also show the (different) form(s) of details like the power pylons? Or an image of a bat and the sound waves it sends and the echo's it receives from them; should we display the bat as a symbol (e.g. a square or a circle) or should we (also) give an image of a bat?

2.1.3 Difficulties in designing tactile images

We didn't work with our own designers because at the time the project started, for one reason because they were not available all the time. Dedicon knows some annual production peaks. Instead we worked with a designer who had some experience in designing for young blind children. She drew by hand with the computer, based on the guidelines explained and shown to her in an earlier stage [1], [2], [3].

The team discussed the outcome of the studies of Maarten Wijntjes [4], so tThe designer was aware of the effects of tactile illusion, the fact that an obtuse angle is often perceived as a slightly curved line, etc. She was familiar with the use of white (sometimes called 'nomansland', or (French) 'vide de confort'), hights of lines and the behavior of the material we used (swell paper).

Still it proved more difficult than expected to come up with well designed images from a tactile point of view. It obviously is very difficult to let go of the visual image. We found this too in the sketches the teachers or interns would provide; time and again too many details were drawn and no too little or no white space was left around elements of the drawing that should be well perceivable. Everybody who has ever tried to make a tactile image will confirm how difficult it is to let go of our visual training. We LOOK at pictures; designing for haptic perception really is something different and it really takes time and a lot of practice to get the hang of it.

Of course we ran into dilemmas and questions. E.g. designers tend to use black where we see black, e.g. in a hole as in the example of the pupil. But then the hole on swell paper becomes a bump. Does this make sense from a tactile perspective? Or is this irrelevant? What to do with a white cloud? To sighted people it looks like a round surface. When left white tactilely it feels very flat, as a hole even. Again we wondered if this is relevant from the point of tactile understandability? The learning curve was steep and we learnt a lot; but it has not ended; there still is much to learn.

2.2 Phase 2

In the second phase – at the time of writing this preliminary paper – Dedicon will have to select the images. It had been useful for involving the teachers to let them select and it was instructive to them, but it was not effective or efficient.

The existing problem of teachers not having time or expertise to do the selection will remain. It doesn't work well for Dedicon to produce 50 images in the first round and allow new customers to order new images. This means that the text has to be adapted each

round, because references to the new images must be made. It looks like the best solution is that Dedicon has (or finds) experts who do the selection.

Starting point will be the learning goals. We aim at providing a set of images, that:

- can be used for the whole class
- provides choice for the teacher to use some extra images if he feels this is necessary.

Offering choice to the (trained) teacher, basically makes it easier to teach in a more adaptive way, with material for everyone.

Fast and visually oriented students can study the (now 'extra') images in the book, while the teacher discusses the Design4All images with the students who have learning styles that require more discussion, verbalizing and interaction.

We expect this will work fine in Special Education, the present testing environment, but also in (subgroups) in mainstream education, where we hope to test in the follow up project.

3 Summary of findings & indications

3.1 Tactile images can be fun

We found many blind students enjoy working with tactile images because they allow them to fully participate in the lesson. We expect learning effects will raise because it is a much more active and a multimodal way of learning than passively listening.

We have indications that bright students enjoy the challenges tactile images may give them. For some students it may be necessary to present subjects always the same way. For talented students it may be valuable to design more challenging and varying images, e.g. maps where they have to discover what is where (instead of reading the map always from upper left to bottom right or starting from a central point).

3.2 Tactile images enhance inclusion and independence.

The use of tactile images enhances active learning, interaction and participation of the blind student. In one lesson the blind student clearly enjoyed that she at her turn could give an answer and find on the tactile map the next place the river Rhine was passing through. So far, without her own tactile map showing the same places as the map in the book, she had never been given turns during the lesson and had to listen passively.

3.3 Tactile images can offer structure

Designing tactile images of animals, parts of the body, the different types of housing, a power station and the like, forces the designer-team to make choices and to simplify.

Generally it is not possible to make a one to one translation of images in the book. Often complex images must be split. Perspective must be translated into 'from above, from the front and from the side' tactile images. This alone forces to rethink and often do additional research regarding the proportions, exact shapes of parts and their relations in space.

Tactile images as a result generally are more structured, better thought of, verbally well explained and more clearly and explicitely related to the learning goals than illus-

trations in the book. This advocates for a use in wider groups so that other children will benefit too.

It is very instructive to design tactile images ☺. A tactile image often is a very valuable addition to a description, making the information much more precise and understandable. They often invite children to ask questions.

Working with tactile images forces to make clear choices, sometimes to simplify and (re)structure. It also forces to be exact. We expect that all the children in the class will benefit from the well structured explanation.

3.4 The learning goals must lead the selection

Not the images in the book, but the learning goals should be leading in the selection and designing process. These can be general or individual learning goals. NB: it almost always will be necessary to make changes to the images in the books in order to make them usable. Our plea is in fact to make a new set of tactile images. Only images that that are needed to make an exercise must be transcribed (image + text). All other should be mentioned with a shortest possible description. They can be referred to in the text that goes with a tactile image or in a list.

3.4.1 General learning goals

The images in schoolbooks often are not well chosen. We even found illustrations that were false (e.g. a lens of a camera that, according to the book, could accommodate like the human eye). Often it is not clear what their message is. For example: we see a photo of a person representing a group of people; but what is the message of the picture; why was this person chosen; what does he represent?

3.4.2 Individual learning goals

It may be necessary to add tactile images, e.g. when something is mentioned in the book that may not be indispensable for reaching the general learning goals, but that the blind child may not already know.

These images should be optional. They are meant to fill possible gaps of knowledge the blind or partially sighted child may have, because, unlike his sighted peers, (s)he has never seen them (well). When there is no time and no need to discuss them with the whole class or in a subgroup, the teacher or class assistant may use them in a separate activity with the child or let him take the image home.

3.5 Tactile images can be used for the whole class

We have strong indications that in many cases it will be better to make the tactile images leading in the lesson, (if possible) in combination with a scale model or real object. Advantages:

- That way it is easier for the teacher to divide his/her attention between the partially sighted students and the visually impaired student(s). The teacher can refer (partially) sighted students additionally to pictures in the book (that mostly can be studied at a glance).

- Probably this will help verbalizing better what one sees. Second language children, children who need extra structure or who have concentration problems or learning difficulties, will benefit.

A "design for all", adding black writing and color, may be helpful for acceptance by everyone (NB including partially students with some remnant low vision, who often prefer using their vision).

3.6 Wanted: standard basic drawings and a learning line

Right now we make many subjects several times a year. For example the human ear. We do so because the original image in the book may add or leave out a detail. Not only is that a waste of production time.

It also is easier for the blind student to have one standard image to begin with, that can be expanded with detailed images showing the shape and/or process and that can easily be found, ordered and customized (e.g. with other labels) by the teacher. It goes without saying that it will save students time when they can work with standard images and only need to concentrate on new details in an image explaining the subject on a more advanced or complex level.

We think it is possible to design coherent and reusable tactile images, which will allow building a 'library' of tactile images, enhancing their quality and availability. We may end up with three or four basic ears; one for primary education, one for secondary, one for tertiary, one for specialists. Or with a 'grow-ear', where details are added to the basis when necessary.

Finally, both regarding reading skills and prior knowledge teachers (and designers) would benefit from a learning line which can guide them.

3.7 Creating usable tactile images takes a multidisciplinary team

It is necessary to work in an interdisciplinairy team: an expert on the subject, an educational expert and a well trained designer who knows how to draw for the blind. Communication between the expert on the subject and the educational expert on the one hand and the designer on the other, must be visual to a high degree.

3.8 Formation and research are needed

Creating usable tactile images requires well formed designers and more research on the parameters for each technique and domain.

Setting up a learning line (both for reading skills and for 'prior knowledge') as mentioned in this text, would be very helpful too.

Very important is that teachers are trained or coached in the use of tactile images.

The questions around reading tactile images are plenty. Very little is known about how the perception of tactile images is transformed to a mental image, or the influence of a visual memory, and 'perceivability'.

In a research, mentioned before (200 sighted and (partially) sighted volunteers during the national expo for visually impaired people in The Netherlands in April 2012), we found:

- Adding white around an element doesn't seem to affect the reading speed, but it does enhance the reading quality (it raised the number of right answers significantly). This 'nomansland' or 'confort de vide' is often not applied
- Using finer lines in shading within a thicker outline gives a clearer image. Answers are not given significantly quicker, but they are significantly more often right. In many tactile images legends are used with equally thick lines. The next outcome also says something about this practice.
- It is much more difficult to find two squares with the same line shading than anyone expected. Situation: 6 squares with shading lines on an A4, 5 different ones. Task: find the two equal ones. This task proved easier when the square has an outline, but it still proved much more complex than anyone had expected.
- Experienced readers of tactile images would respond quicker, but they didn't come up with the right answer more often than unexperienced (mostly sighted) readers. This gives food for thought; why would that be?

Because of the limited time it was not possible to test if a low equal filling to indicate 'inside the figure' improves readability. From our practice we certainly have the impression that this is the case.

4 Implementation and follow-up

Right now Dedicon is thinking of how to structurally implement a new production process with experts who will select the images. This happens in project EDDA: Expertisecentre of Didactical and Digital Adaptations, financed by the Dutch Ministry of Education and a cooperation between Dedicon, Bartiméus and Visio Education and Viziris, the Dutch Federation of VI people. This project runs from 2012-2014.

EDDA plans to research in an evidence based way if we can conclude that the adaptations (amongst which the tactile images) result into better and more inclusive learning and teaching and if other students than students with a visual impairment, benefit from the adaptations.

If we can find evidence that using tactile images helps inclusion and/or improves learning results positively, we want to see in a follow-up project of '(Get to) know your world' if it is useful and possible to develop a 'learning line' and/or 'levels' for reading of tactile images.

4.1 Conditions for implementation

The project will end in September 2012, resulting in:

- a method for selecting tactile images
- teaching material for designers and teachers
- improved guidelines for designing tactile images
- teaching material both for teachers and designers.

Implementation has been a concern right from the start. We know from many conversations and experience(s) that:

- Teachers, both in mainstream schools and in specialist schools, are generally not familiar with working with tactile images. Formation is needed.
- Teachers want ready-made solutions, short instructions, design/usability for all (at the least for a group of students).
- Teachers prefer easy-to-customize learning materials (that do not require a high investment of time).
- The students have a basis to read tactile images, but there is no 'learning line' for reading tactile images (subject for the follow up project).
- We may need to develop levels for beginning and more advanced readers (as with literacy).
- Teachers think that learning to read tactile images should not require an extra subject; it should be built in in other subjects, so that only a minimum of extra instruction is needed and can be given 'on the fly'
- A training for designers and for teacher is needed (one of the results of this project).
- Finally the production method of Dedicon to be rethought. Changing the transcription of images has consequences for the transcription of texts. This is subject of project EDDA.
- EDDA will also take into consideration the teacher-conditions sketched above.
- Dedicon must build an online catalogue and develop a good system for metadata. We hope to find partners and be able to cooperate internationally on this.

4.2 Limits and (lacking) tools

It is good to define what one will do in a project, it is as important to define and report what one cannot solve presently (that possibly can be subject for a next project).

4.2.1 Production technique

- We would like to make our images suitable for all low relief techniques (Braille printers printing images and all types of swell paper) yet we know we will not be able to. Each technique requires its own parameters. They still have to be defined.
- We would like to make our designs so dummy proof, that they can be reproduced everywhere (with a Zy-Fuse oven) without problems, even for someone who is not very skilled in using the machine. If there is much variation in a swell image (very tiny dots or thin lines and black areas), it is difficult to get good results. Either the thin dots may not swell or the black area may start to bubble when passed through the oven. We avoid big differences as much as possible, yet the clarity of the image often wins with contrast. This often is a dilemma.
- When using grey scale to add normal letters (very convenient for sighted peers and teachers), sometimes it will swell unintentionally. When that happens varies per type of paper, machine and sometimes even per drawing (because of varia-

tions in the heat of the lamp). We used a Zy-Fuse with the standard paper that is used by Dedicon. We would also have liked to try the Piaf. Here it is infrared that makes the black lines swell. There was no time to experiment with color and/or Tiger print either, or with TactileView. This software allows to quickly and – after learning to work with it – easily customize images. The teachers that worked in our programs, nor the interns, found time to experiment with it, however.

4.2.2 Reading technique

Another interesting option is using the image in combination with the pen that can be used to draw (digitally, on the Tactipad) with TactileView. One can add sound files to the image. So if the student wants to be sure if he is touching the nose or the tail of the dolphin, the device could tell. In that way the student can be much more independent. At the time of the project this option became available in a testing mode.

4.2.3 'Grammar' for drawing and reading tactile images

We have guidelines for drawing tactile images for swell paper. They are based on the sources mentioned and on experience of the designers, but not yet written down. We feel we lack a 'language' or 'grammar'. Not only in general, but per domain or discipline; transcribing diagrams is very different from transcribing a map, an infographic, architecture, art, biology, technical schemes etc.

The same goes for transcribing images for younger and beginning readers. For adults and academics the best solution is to transcribe all images in a book (that are not just 'eye candy'), give a short and clear description that allows the reader to decide if he wants to study the image in depth and a slightly more extended description for if he decides to do so. We (can) leave the choice to the reader.

In primary education the images are more strictly used in the context of class instruction and of making exercises. They are not only for the student, but also for his peers (to cooperate) and teacher (who often is indispensable for guidance and explanation). Time is limited to read and use them. Prior knowledge about the subject may well be lacking in the child.

4.2.4 Online catalogue, availability

Dedicon doesn't display the available images online yet. They are 'hidden' in one or more binding-cases with images that one can order with the book. What we want to establish is an online catalogue where teachers or parents can look up in a catalogue if there is an image for their student or child to explain a subject or which images they want to order with the book (default is 'all'). We want to produce two types of images:

- images that are 'general' and can be reused (e.g. without the labels for an exercise, but as is in another method) and/or rapidly be customized when necessary
- Images 'for this situation or exercise only'.

Images of the first category will be reused in other books and deliverable individually.

5 Scientific basis

5.1 UU testing protocols

By involving students from the Department of Eductional Science of the University of Utrecht as interns, a start was made with scientific foundations. Esther van Rieken and Sheva van Dam, thesis students at the University of Utrecht, Department of Educational Science, set up the testing protocols, were present at the tests which they filmed and analyzed.

5.2 Tactile perceptibility research

Additionally they set up a test they took with almost 200 sighted and (partially) sighted volunteers during the national expo for visually impaired people in The Netherlands in April 2012. This gave us an opportunity to test our conclusions, findings and assumptions about:

- tactile perceptibility of shading (with lines) for legends and/or to distinguish between different surfaces
- the influence on reading speed and reading accuracy of e.g. putting a line around shadings, using extra white between the shading and the outline, the thickness of lines and the distance and size between dots in shading
- differences in both speed and accuracy of recognition between readers with and without experience and skills reading tactile images
- differences in both speed and accuracy of recognition between people with and without visual memory

A publication of the outcome is planned, but we can reveal here a couple of findings under the heading 'Summary of findings & indications,…'

5.3 Research in real life situations versus controlled situations

In these latter tests it was possible to work with more controlled 'laboratory settings' then in class where we didn't want to interfere with the natural course of things in the lesson and had very small numbers, and (fast) learning effects of participants.

Of course it is always a little hazardous to draw conclusions from pilots; it is hard to analyze which factors are responsible for the success or failure of a test. That is why we worked with protocols and developed an instruction for teachers on how to work with tactile images.

An explicit problem in trying to make ones methods evidence based and to work scientifically is presented by the small amounts of students, their wide geographical spread and the often very different circumstances (size of the class, assistance, schooltype, remnant vision or not, additional motor problems or not, education and prior knowledge so far, home situation, cognitive intelligence, etcetera).

Originally we planned to test in mainstream education as well, but no child was found in the same class using the same method. We now plan to do this in a follow-up project where we further want to test the way of working we developed.

References

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Vision Interaction Software for the Blind

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Keywords: Visually impaired, Image processing, Braille picture, Vision interaction

1 Introduction

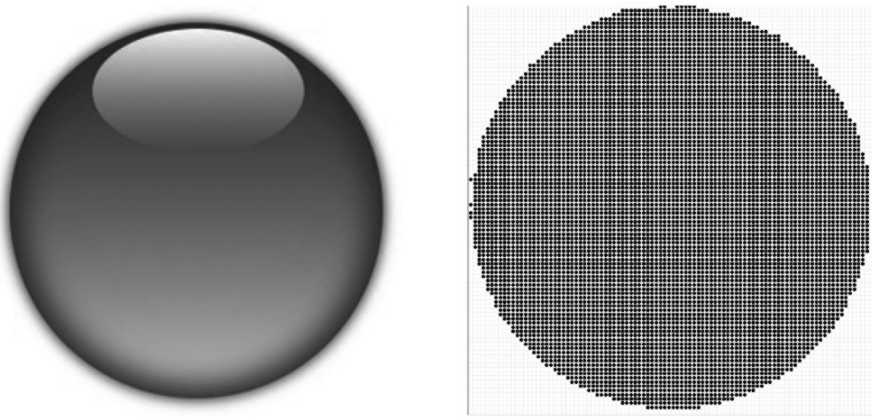
The role of human sight becomes increasingly important as information technology progresses. Presentations based on multimedia help to explain many kinds of situations. However, this form of communication, so convenient for persons gifted with sight, is inaccessible to the visually impaired. Thus, persons lacking eyesight are eager for a method that can provide them with access to progress in technology.

There has been a significant amount of research conducted over the years to devise alternative forms of communication for the visually impaired[1][2]. For instance, several types of software that allow selected visual information to be converted into a text form and transmitted as synthesized speech or Braille already exists on the market. Efforts are also underway to improve the accessibility of GUI's by combining auditory response with tactile display. The main issue here is that it is difficult to provide vision information that cannot be represented in word. In addition, most of tactile images do not provide vision information as well as sighted persons understand visual information from images.

In generally, touch is known to be slower than vision for acquiring some information due to the fact that it obtains information sequentially[3]. However, some of the raised-line patterns used in haptic recognition tasks are made in rather large-scale drawings, which may cause a burden on memory. In fact, it is not known which size picture is better for tactile recognition, nor is it known what details should be included or excluded for better haptic recognition. These questions illustrate the need for a more complete study to learn whether blind people can really make sense of a two-dimensional picture. Focusing on the Braille system, it is a method that is widely used by people who are visually impaired to read and write, and was the first digital form of writing. The average braille reading speed is about 125 words per minute, but grater speeds of up to 200 words per minute are possible[4]. Thus, those who has enough braille literacy can easily detect braille patterns. We focus on both these features and character based image technique called ASCII art in order to share vision information with blind persons.

2 Related Work

There are some existing software programs for generating braille embossed graphics, such as PictureBraille[5]. PictureBraille converts most image sources into an embosser dot equivalent. A dot graphic sample shown in Fig. 1 was produced with PictureBraille which provides tools for the conversion of most common Windows file formats, images pasted from most drawing programs such as Microsoft Publisher and Paint, scanning from print sources and automatic generation of charts and graphs.



(a) Original picture (b) Tactile graphic produced by BraillePicture

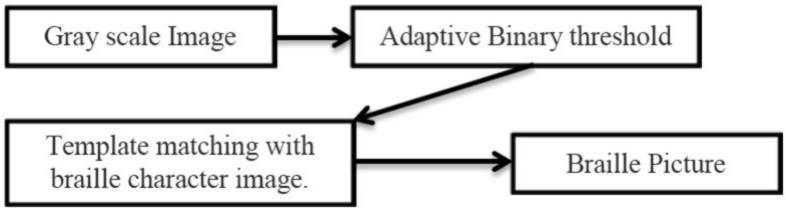
[Fig. 1] Example of a dot graphic.

Image will be considered to fall into three broad categories.

1. Photographs, painting and pictures, art.
2. Drawings and line-art. i.e. two or three dimensional representations of objects and things.
3. Diagrams and graphs

Among them, Photographs and pictures present the greatest difficulty. It is often impossible to incorporate the detail contained in such complex images and isolating the salient points can be an arduous task. This is not to suggest that it is impossible to produce tactile graphics of such images, as shown by the picture of the ball shown in the right side image of Fig. 1. The original picture shown in the left side of Fig. 1 shows the ball object. The picture has been lit from upper, causing shadows on the middle of the ball. In the tactile representation this shadowing is not shown and just shows simple circle form. Though the sighted person can consider this picture as the 3D constructed ball, the blind person may consider it as a simple circle object. Despite this is not to say that in some circumstances such graphics have no benefit, this tactile graphic cannot provide the detail texture to the blind person.

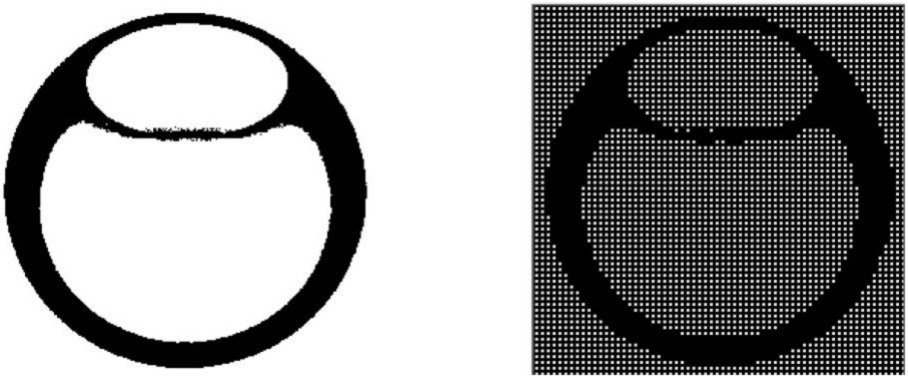
On the other hand, M. Kaleem Rahman et al. proposed image translator which converts regular images into a form that can be printed as tactile imagery on relatively low-cost embossing device meant only for braille text[6]. According to them, a text file is generated by mapping each cell block of the image to a corresponding character using the American Grade 0 braille standard is available to teach shape of objects in their evaluation results. However, their main purpose is not for providing vision information. This is the only for teaching the shape of objects by embosser graphic composed with braille characters. Furthermore, their target image is not photograph, and they do not mentioned about vision interaction between a sighted and a blind.



[Fig. 2] Our proposed rendering process

3 Rendering Algorithm

Fig. 2 shows our proposed rendering method. The main key technique here is binary threshold algorithm in order to create a braille picture with vision information. We take advantage of using adaptive binary threshold algorithm. Considering braille pattern picture, we need to make a final decision about the pixels in an image or to categorically reject those pixels below or above some value with keeping as well as texture. Then, we use a modified threshold technique in which the threshold level is itself variable. In this paper, a Gaussian model is used for produce of binary image from gray scale image. Fig. 3 (a) shows the binary image by using adaptive binary threshold algorithm from the original image shown in Fig. 1 (a). This image keeps the visual perception of texture rather than the tactile graphic shown in Fig.1 (b).



(a) Binary image (b) Braille picture

[Fig. 3] Binary image and Braille image without margin guide produced by our proposed algorithm from the original image shown in Fig.1 (a)

Fig. 3 (b) shows the braille picture produced by operating the normalized template matching algorithm with a dot template image shown in Fig. 4 (a). Fig. 4 (b) illustrates the output image composed by braille character using the American Grade 0 braille standard. To observe it, we found that our produced output image represents own texture feature.

4 Discussion

We carried out small evaluation whether the blind subject can identify the braille picture created by our proposed tool. Firstly, we presented the braille picture to one blind subject

who is one of our students. Then, the subject is confused and unable to understand that it was an image that was placed in their hands. Most tried to read the image as braille text, pronouncing the individual letters that formed the image. Even after it was verbally explained to him that it was an image, and not braille text, the subject is not able to guess the image content. However, presenting two similar images including small different visual texture each other, the subject can easily detect the different local segments on their images. This result is some interests to create the standard table between braille character and a small image segment. If the blind can learn braille character as one of image segment parts, then braille character enables them to show images or multimedia data what they want to show to the other sighted persons.

5 Conclusion

In this paper, we developed a vision interaction software between the blind person and the sighted for sharing correct visual information each other. In generally, it is really difficult to explain visual texture on the image. So, the sighted explain several of them which they can express in words to the blind. In addition, we cannot verify how image the blind guesses with our explanation. This is a main issue to share visual information each other. In future work, we will challenge to make the definition between a braille character and an image table to interact visual information.

(a) Template image (b) Braille character based picture

[Fig. 4] Template image and output image of Braille character

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Tactile Applications in Development of the Multimodal Learning Environment for the Blind Students with and without Learning Disabilities

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Keywords: tactile applications, multimodal learning environment, blind students, learning disability, modality channels

1 Introduction

The multimodal learning environment is a concept which describes an idea of creation of the holistic, integrated and self sustainable educational systems, based on the digital learning and teaching options sometimes referred as *digital learning tradition*, instead of print based learning options known also as the *textbook tradition*. At present, these terms are used rather frequently, and the actual time of so called tradition switching is still chronologically close. According to the chronology offered by Bezemer & Kress, the transition from the textbook to digital learning tradition started recently – in late 1990s, (Bezemer, Kress, 6) and still is going on up to this day (Baines, 18–23) as it is quite problematic to name at least one country where full transition from one tradition to the other has already taken place in full scale.

The development of the multimodal learning environment is related also to the creation of certain set of methodological tools and practical applications, which agree with the objective demands of the overall development and digitalization of the societies. No regions or countries are excluded from this process, and no discrimination regarding students with sensory or learning difficulties is made here either.

In the theory and practice alike, the transition from the *textbook* tradition to digitally based *multimodal learning* is a whole inclusive phenomenon originated from the technological development and science and technology innovations of the 21st century. And this transition is unavoidable, as educational and professional demands of societies fully agree with practical utilization of tangible results of these technological outbreaks.

Despite the general idea that the multimodal learning environment is a concept that describes an absolute unity of the technological options and methodological applications, suitable for every student – both with and without any kind of impairment, it must be said, however, that such integrity is still the aim of rather distant future.

Today the development of such a structure is mostly dealing with a domination of one particular perceptional channel or modality – the visual perception. In some aspects it would seem natural as more than 80 % of the information we receive and process during the lifetimes is on the visual nature, but in other aspects – not at all. „Vision being generally believed to be dominant in multimodal environments, the removal of this stim-

ulus may have a significant impact on the fidelity requirements of haptic simulations". (Levesque, 2005, 12). For rather large group of sensory impaired people with low vision (VI) or blindness, who are unable to utilize visual information, such a domination means an exclusion from the visual multimodal environment – both informative and educational.

Following a 2011 survey, the WHO estimated that there were 285 million visually impaired people in the world, of whom 246 million had low vision and 39 million were blind. 19 million children below age 15 are visually impaired. Of these, 12 million children are visually impaired due to refractive errors, a condition that could be easily diagnosed and corrected. 1.4 million are irreversibly blind for the rest of their lives. (WHO, 2011).

These children must not be excluded from the general educational system improvements and qualitative switches like transition from *textbook* to *digital learning* agenda. It would be fair enough to say that this transition means something more than a global switch – it is a paradigm change indeed, a new type of meaning making and construction of knowledge, based on multiple literacies. (Jewitt, 247, 262, 263; Bezemer, Kress, 6, 7).

For people with different VI condition – especially in early age and during school years, only skillfully designed and developed multimodal educational environment can be found beneficial and practically useful both for gaining of academic knowledge and improving social abilities.

It could be said that for all the contemporary society this is an age when ability to deal with specific patterns of multimodal judgments matters a lot, as the educational and informational space within the multimodal environment is orientated toward the integrity of the informational space, and in the center of this integrity we can find, among other, also the concept of the multimodal judgment or sense making. (Lederman, Kitada, Pawluk, 751).

Multimodal learning for the VIs must be made diverse and dynamic, and it should engage all the modalities excluding the visual one, as VIs with severe conditions, including blindness, cannot deal with it at all. Instead, they can use a lot of information provided from another sensory sources like auditory and tactile/haptic source. In case of the last the tactile applications are the crucial options both in sense of methodological and technical issues.

The long discussion regarding the "balance of modalities" within the development and improvement of the multimodal learning environment for both students with VI and without it have taken place, too.

There are different modes (modalities) of communication, instructor–learner interaction and environmental factors during traditional instruction and computer- assisted instruction (CAI) at school. "The learner in traditional classrooms produces information through speech, writing, and drawing. Learners using a computer have options including touch screens, point and click with a mouse, keyboard response, and (more recently) speech options in some software (e.g., Dragon Naturally Speaking by Scansoft)." (Mueller et al., 276).

Finding the ideal formula of "modality balance" and its technical realization is one of the crucial aspects in successful and meaningful transition from *the book to the digital*

tradition in education for the blind, too, where static perception of multi channel (modalities) information flow is gradually transforming in order to meet the requirements of the emerging overall digitalization of the informative and learning/teaching space.

2 Multimodal translation and tactile applications

The phenomenon of multi channel informational flows (multidimensional/multimodal translation/remodalization) is not new – chronologically it dates back to 1990s and practically grows out of the contemporary translation theories where the semantic and semiotic area of the classical textual translation is widened in order to include other informative dimensions – those of auditory, olfactory and tactile/haptic nature.

According to the idea of multidimensional translation, information flows can deal with various modalities, where the written text or the spoken narrative is only one of the numerous information carrying options.

Danish linguist Henrik Gottlieb is one of those researchers who developed the systematic account of the multichannel translation possibilities in mid 2000s, and he listed them into two major categories – intersemiotic and intrasemiotic ones.

Each type in its turn fell into four minor groups of the target text semiotics. In accordance to this subdivision, the groups are: isosemiotic (with the same channels as original), diasemiotic (different channels), supersemiotic (more channels than original) and hyposemiotic translation (fewer channels than original). (Gottlieb, 35, 36).

H. Gottlieb presupposed that multichannel transformations of the target text might be performed in the way of inspirational (nonverbal, deverbalizing and verbalizing) translation as well as in the way of conventionalized (nonverbal, deverbalizing and verbalizing) translation. In his system, which turns out as rather complicated, all the senses or physical abilities to perceive the information from the outside world – namely, visual, auditory, olfactory, kinesthetic and tactile/haptic, are included and made the integral parts of the holistic informative field. Moreover, H. Gottlieb tries to describe the actual forms of the multidimensional or multimodal informational alterations, especially these which are dealing with channel quantity changes. (Gottlieb, 39).

In most radical forms of informative alternations, where channel quantity is under review, the tactile/haptic modality is generally linked to diasemiotic and hyposemiotic groups. But in rare cases, however, it also shows its significance in conventionalized supersemiotic translation, too. "…translations that remain nonverbal include both linguistic entities (such interpreting between two sign languages) and non-linguistic ones, e.g. the drawing of a sculpture. Here we talk about nonverbal translation." (Gottlieb, 37).

In the making of the multimodal learning environment for the VIs based on the permanent informational transfer from one modality to another (mostly from latent – unusable visual modality to auditory and tactile/haptic modalities), the practical manifestations of multichannel translation are crucial. They are providing the practical tools for letting the multimodal environment without its actual backbone – the visual modality, to be brought into being. (Tobin, 126).

The existing gap between information field of the visual and other modalities cannot be deliberately left blank, empty and "toolless"; it can and must be filled with hybrid forms of multichannel translation with olfactory and tactile/haptic elements involved.

This idea in many aspects dates back to Roman Jakobson's early notion of intersemiotic translation or transmutation, which describes the interpretation of the verbal signs by means of non verbal sign systems. (Torop, 595).

This form of non conventional translation, according to Peeter Torop and others, meant also ability to translate literature into film or theatre productions, as well as assured translatability of word into a picture. (Torop, 596).

From this early notion later described and developed by such several authors, the very idea of multimodality as the sign communication concept was originated and later transmitted both to non electronic (*real world objects*) and electronic forms of the multimodal informative exchange. (Patomäki, 282–284).

This approach also showed the way how switching of the informative codes can actually be managed not only within their own source modality, but outside them as well, without losing the original massage of the source modality. Therefore it also lays in the foundation of the methodological and educational strata of the multimodal learning environment making for VIs, where the tactile applications represent practically existing tools of such an informative code switching.

3 Tactile applications in creation of multimodal learning environment for the VIs

Visual objects originated from the nature – or non man made objects, which can be used in the educational process without further adjustments, served as the educational addings to the book or other written texts both in visual and tactile/haptic formats for at least a century. The process of learning/teaching where tactile senses are deeply involved and are playing significant role – known as the multi-sensory learning – was strongly promoted, for example, by Maria Montessori, and it is often described as a more "natural" way of learning than just a gathering of facts from the written text. (Landua, 414).

Despite a sensory isolation from the visual informative field and therefore – visual modality, transition from *textbook* to *digital tradition* will touch upon VI and blind students, too. Conventional forms of multimodal learning in this case should be replaced by others – these non related to the visual modality and its hybrids. In contrary, it has to deal fully with auditory, olfactory, tactile/haptic and kinesthetic modalities. „At the perceptual level, the deficiency in the visual channel should be compensated by information perceived via other senses. The haptic, audio, and smell channels become powerful information suppliers about unknown environments." (Pun, et al., 2).

The definition of the role of the tactile applications (such as Braille print, 2D tactile graphics and 3D models produced in all possible technical ways) in creation of the multimodal learning environment for the blind is still unclear. However, it is obvious that tactile applications here are playing and will play rather crucial role, even in comparison with use of the auditory information – but still the level of their overall informative importance and applicability is controversial. So "If we want to preserve blind people's access to information and to spatial communication metaphores we must provide them a tool to explore three dimensional worlds mapped on a 2 D medium. Since there is no direct mapping method like ray-tracing for tactile graphics, standards for this must be defined in the near future which could then be used for tangible graphics in blind people's education and daily life." (Kurze, Holmes).

It is only possible to assert implicitly that they will gain more significant importance in the formation of a specific non-visual multimodal learning environment as the system. They will constitute a few of the most important theoretical and methodological building blocks of this environment that will manifest the unity and integrity of inter-semiotic translation from the visual to the haptic modality as well.

But, even if at this moment the idea of integrated and holistic multimodal learning environment for the blind is still a matter of future, there are elements, which relate to the domain of tactile applications and are used by the blind people in everyday life, not only during the lab tests. Of course, most of them are very useful for obtaining of the written and graphical information, thus in many cases the information has to be pre prepared and downloaded before using.

Among the most recognized and widely known tactile applications (both hardware and software) that could be regarded as the integral part of nowadays multimodal learning option for the blind are:

3.1 Refreshable Braille displays

are electronic devices used to read text tactually that is seen on a computer monitor. The refreshable Braille display is connected to the computer by a serial or USB cable and produces Braille output (with small plastic or metal pins that move up and down to display the Braille characters) for the reader. Possible providing only text, graphical information is not available, a minus is the high costs of the device. But despite its price, refreshable Braille display can be listed between the most popular and widely used electronic tactile devices for VI. In terms of perception of the written text, this device is almost irreplaceable in the creation of multimodal learning environment for VIs with severe eyes conditions. This device is in use worldwide for more than two decades. It is one of the rare fully universal tactile applications created especially for VIs, and no additional software is needed for the work with a display.

"Technological advance is a globally accepted norm from which refreshable Braille display should not be immune. We need displays that can show solid raised lines to enable the presentation of tactile graphics, thin form factor displays, displays which better simulate the experience of reading a Braille book or magazine. But, most importantly, Braille displays have to cost less, much less." (Osborn, 32).

3.2 Portable note taking Devices

PDAs (Personal Digital Assistants) may have a refreshable Braille display built into them, for example, *Palm Pilots*™, The Braille Note, Pac Mate.

3.3 Power Chord Braille Keyboard

The Power Chord Braille Keyboard enables students to practice their Braille writing skills by entering the answers to the *Speech Assisted Learning* (SAL) writing exercises on an electronic Braille keyboard. The keyboard is laid out like one on a Braille notetaker. The Power Chord Braille Keyboard can also be used for 6-key entry of Braille in any Braille transcription software program, such as Duxbury, MegaDots, or Braille 2000.

Words and characters are spoken aloud by a synthetic voice as they are entered (either contracted or uncontracted literary Braille). The simulated Braille is shown on the monitor and the student can easily toggle to show the print view.

3.4 Screen reading and Braille translating Software

JAWS; Cobra; Braille Translating Software Duxbury; Multimedia games for VI children (Sweden, TPB).

DAISY (started in 1994) during last 10 years had developed both Software (promote the DAISY Standard for Digital Talking Book) and Hardware (DAISY readers) for informational providing for people who are blind or print disabled. Progress in software production has practical importance. DAISY is extremely useful for educational purposes and widely used due to its multi functionality. If even the primary and secondary function of DAISY is not directly related to tactile applications outside area of Braille use (they are auditory and tactile (Braille) oriented), it is expected, that in rather close future classical tactile applications could have more attention paid, too. Thus, as DAISY is a software platform, the need of the "provider" – means, multimodal tactile device, will still be topical.

During creating multimodal learning environment for the VI "…the inclusion of haptic information in VR has great potential to improve blind peoples' access to virtual environments and improve the accessibility of Graphical User Interfaces (GUIs)". (Penn et al., 92).

3.5 Talking Tactile Tablet 2

Computer peripheral device designed to be ased a "viewer" for tactile materials with simultaneous audio addition. In order to use it, the users need TTT Applications, for example World Map, SAL2 Mangold Braille Reading Program for Teens & Adults, which is designed for students who are fourteen years of age or older. Each courseware package teaches specific skills that lead to mastery of the Braille literary reading code.

This technology provides students with an element of multimodal learning environment as it is normally understood. The student can improve his learning skills according to the certain age group/grade, and use the auditory and tactile/ haptic perception in the same time. It creates more close conditions to visual virtual reality or multimodal learning environment, where practically all the sense and perception channels are involved. Although, it has an important difference from fully multimodal device – it uses only certain multimodal applications which are prepared in one way/form and cannot be altered during the learning process.

3.6 PHANToM™

"PHANToM™ is the most commonly used force feedback device; it is regarded as one of the best on the market." (Nikolakis, et al.).

This device allows the user to explore details of the object – shapes, virtual materials, magnets.

"The most serious constraint when using Phantom is the lack of getting general impression of the object or space. This is caused by the single point of contact the device is based on." (Patomäki et al., 288).

"PHANToM has only one point of contact and can provide force feedback to one finger of the user or to the whole hand of the user via a stylus (depending on the version of the device)." (Nikolakis, et al.).

PHANToM™ had been laboratory tested in experimental environment during projects such as a European project MICOLE: Multimodal collaboration environment for inclusion of visually impaired children, coordinated by TAUCHI, Tampere Unit for Computer-Human Interaction (University of Tampere, Finland) and funded by EU 6th framework program, Information Society Technologies, strategic objective eInclusion. (Raisamo).

The testing of the CyberGrasp™ and the PHANToM™ haptic devices shows "Factors that had an influence were age, gender, ability to concentrate, and other skills such as fine motorics. For example, matured pen grasp proved to be a crucial skill when handling the device." (Patomäki et al., 282).

3.7 Immersion's CyberGlove® and CyberGrasp™ haptic devices

CyberGlove® is a widely used human-hand motion tracking device of proven quality. CyberGrasp™ is currently one of the very few force-feedback devices that are offered commercially, providing high quality of construction, operation and performance. The 350g CyberGrasp™ exoskeleton is capable of applying a maximum of 12N per finger force-feedback at interactive rates and with precise control. The direction of the force feedback is approximately perpendicular to the fingertips." (Nikolakis, et al.).

"The CyberGrasp device is mounted on the palm of the user and can provide force feedback to all five fingers of the user's hand. This enables the user to manipulate objects in the virtual environment in a more natural way." (Nikolakis, et al.).

"Both the haptic devices studied offer exploration of their virtual worlds via a stylus with only one point of contact at each time. The information obtained with them is thus based on movement information to the muscles, tendons and joints and not also on spatially distributed cutaneous information which is the case in natural haptics. In spite of this limitation, virtual textures and 3D objects rendered by these devices can be effectively perceived by both blind and blindfolded sighted observers. Further studies of the effectiveness of these devices for visually impaired people are highly motivated." (Jansson et al., 15).

3.8 The haptic display the Impulse Engine 3000

"This force-feedback device was developed by the Immersion Corporation and was used with software written by Andrew Hardwick. The device can display virtual textures and objects which users can feel using a stylus. The stylus is the length and diameter of a thick pen and has 3 degrees of freedom of motion, i.e. it can move in 3 spatial dimensions: forwards and backwards, up and down, and left and right. …The force is created by three motors which exert resistance against the stylus. This gives users the impression that a texture or object is present." (Jansson et al., 11).

It is necessary to point out that development of the multimodal learning environment for the blind students and the role of the tactile application in this process – in terms of theoretical and methodological and practical discourses alike, lead to another form of understanding of the multimodal learning environment as universal category, as the truly comprehensive element of the universal learning designs framework.

Here the crucial points of convergence between visual and non – visual interactivities as the very base of the multimodal learning environment creation should be found and explored in order to determine whether they can or cannot serve also as the pathways – the cross-modal bridges, in valuable communication (informative exchange via cross-modal translation) between modalities. And not only between modalities as the sums of the single or small group phenomena, but also as the holistic multidimensional concepts, too.

4 The multimodal learning environment for the blind generally could be characterized as follows:

- it is an auditory and haptically based multimodality where visual information can be included only in remodalized forms (cross-modal transfer);
- building of this environment should be focused on the maximal informational output of included modalities;
- the cross-modality translation is an action where "the human factor" still plays a significant role, and the integration of the translation results into multimodal electronic platforms is frequently problematic; (Ladner et al., Gottlieb, 58).
- the auditory element of the non-visual multimodality is more developed than the haptic one due to its long-time (historical) technological achievements;
- generally, the non-visual multimodality consists of two dimensions: the non technology based (educative toys, part of sensory room equipment and other applications leading to understanding of the multimodal principle, but not being technical themselves) and the technological ones (all technical and electronic applications/devices); (Patomäki, 283, Raisamo);
- the non-visual multimodality is more case changeable than the visual one – it is not so unified and PC centered yet;
- it is another form of HCI (human – computer interactions) where all innovative haptic devices/technologies could be incorporated and tested. (Levesque, 13; Bongers, 108, 117-125);
- "High-end environments are suitable for doing research as reliably and efficiently as possible, but due to the price of high-end devices those environments can only be used in few sites even after they have been finished." (Raisamo, 3).

But, from the end users' viewpoint this complicated structure could be reduced to following aspects of representation:

- auditory, haptically, kinesthetically and olfactory based,
- auditory and haptic interactivity fills whole informative field,

- it explores only auditory or haptically perceivable logical or cognitive structures,
- auditory information is the primary source of information.

5 Tactile applications and VIs with and without learning difficulties

"Since blind children have often other disabilities than visual impairment alone, their impact cannot be ignored." (Patomäki, 282). Students with severe eyes conditions therefore- as all another students without such problems – can suffer from other physical or mental handicaps as well as problems of social background.

Physically determined incapability to use tactual or auditory senses for widening of the informative field might be named as the most threatening problems for students with VI. But there are more. For instance, problems of the learning disability spectrum, which have rather specific and complicated manifestations in connection with major visual impairments, and, primarily, blindness.

But not only low vision or additional disabilities make students find themselves not very successful in academic sense, as "one of the reasons individuals with learning disabilities tend to have academic difficulties is a lack of skills in selecting and managing task-appropriate strategies". (Turkington,152)

Anyway, for blind students, who have some kind of learning disabilities or complex disabilities, it is an even more challenging task to perceive non-visual manifestations of the visual phenomena. To them, usage of the multimodal learning applications – particularly, tactile/haptic ones, is sometimes even impossible because they cannot put "pieces of the haptic puzzle" together in order to form an understandable and meaningful informative source out of them.

It is approved in case study testing that they normally do understand single elements of the "puzzle", but have trouble with putting them together in logical and appropriate order.

As far as the author is concerned, the topic of learning difficulties and their sources has not been widely analyzed in the special literature, but the hypothesis could be proposed here that in VI students they might result from the classical spectrum (VI students might have the same learning difficulties as students without learning difficulties – such as dyslexia, that are not related to their informational deprivation) as well as from the deficit of the primary information (which is actually the lack of information arising from the inability to perceive visual information). This conclusion follows from the author's conviction that sensory disabilities – such as hearing and visual impairment, cannot be included into the classical spectrum of learning disabilities, if even there are scholars who argue against such an approach.

As it is seen in the following example – "A range of visual, perceptual, or physical impairments that may prevent a person from reading standard print. Examples of print disabilities include blindness, visual impairment, dyslexia, and other types of learning disability." (Turkington, 186).

Thus, because identification of learning disabilities is based on measuring attributes of individuals and because measurement is not perfect, it follows that identification of learning disabilities will not be perfect. (Identification of Learning Disabilities, 430).
For VI students, the primary skills are in great importance. Unlike people who have phys-

ical ability to see and perceive the objects by means of the visual sense, they have to learn how to use their tactual sense in order to build up the haptic perceptional skills. It is clear however that the tactual perception and the haptic perception is not the same, but one follows from the other.

"During the tests it was clear that the children's fine-motoric skill development level had an effect on tracking the paths. Also the ability to concentrate on both the instructions and on working with the device had an important role. As our subjects were children their linguistic development level was a crucial factor that influenced in succeeding in exploring the materials." (Patomäki, 287).

Also the problem of short-term memory or storage of information may be particularly important in haptic and tactual perception because of the successive nature of information input. (Pick, 111).

The development of the additional tactile application for those blind students, who have learning difficulties originated from the classical source, would generally take the same path as the development of the visually based learning aids for sighted students with learning difficulties. But tactile application for those having difficulties to learn originated from the source of informative insufficiency, would take another path.

Most likely these students, especially those of the first two – three grades, would need to be aided more by means of non electronic tactile applications (like simple 2D tactile graphic, non figurative tactile graphic), starting with these rather simple and going gradually into the more complex ones. The possibilities to develop electronically based tactile options that would help them faster achieve sufficient level of haptic perception – suitable for meaningful study process, should also be reconsidered.

The process of reconsideration, in its turn, should be carried on in close cooperation between professionals in field of special education, innovative technologies as well as the tactile graphic designers, who may let the balance of the technical complexity of proposed solutions and their educational meaning to be maintained.

6 Conclusive remarks

It is doubtless that tactile applications are integral and essential elements in the development of the multimodal learning environment for the blind students with and without learning disabilities, but there are some problems or challenging points that should be brought forward in this regard. Also, there are problem points of both purely practical and theoretical or methodological nature.

The author of the paper would like to pin her attention to some of them, which, to her mind, are rather obvious, and should be solved as soon and effective as possible in the shortest terms:

- many technological improvements and haptic devices/environments still exist only in research and technical laboratories, and the process of innovation transfer from these laboratories to the educational facilities is rather slow;
- research experiments performed in the laboratory environments are frequently carried out in very small selected target groups, in which young students have definite level of the graphical/Braille competence (higher than mediocre) – but in

real life classroom the existence of selected target groups of children with the same (rather high) level of graphical/Braille competence could be found impossible;

- methodological and teaching addings to the laboratory technologies are still a challenge for educators – if even they received these technologies to use in classroom today, there would be lack of methodological tools for their integration into the mainstream learning/teaching agenda;
- the cognitive and mental abilities of the students and their previous learning (the gradual creation and improvement of overall graphical/Braille competence) is very important, even crucial to gain success in the meaningful use of modern haptic devices/ environments;
- the educator – technologist, the person both able as the teacher and tutor to the students and handy manager of the complicated technological tools, could be seen here as another problem, too; closer cooperation between the technology creators and testers and education methodologists/teachers is strongly required;
- at the moment, the multimodal learning environment for the blind – including its tactile applications – looks more like a field of split, different technologies – mostly experimental, not the genuinely integrated and homogenized virtual reality suitable for meaningful and successful educational process in the classroom.

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Haptic geometric experiences for blind children

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1 Geometric difficulties of blind students

This paper wants to add the point of view of a professional mathematician in the field of education of blind people, focusing the attention on their problems in mastering geometric ideas. Here, firstly I report some stories and facts, and then I am going to present my interpretation of them. Subsequently I will explain my research project. An experience in a 4th grade: I planned a manipulative experience in a classroom, in which there is A., severely visually impaired child, 9 years old. She is smart, and well adjusted in the classroom; her mates are very protective with her. I organized an activity offered to the whole classroom, with materials slightly modified for A.'s needs, starting with an activity about cubes. While her mates were making a cardboard cube, A. was asked to play with a cardboard cubic box, containing 27 small wood cubes. After a quick external exploration, she reversed the cubic box, and she was very surprised that in that cubic box "there were so many things!". Then she played, firstly trying to fulfil the box again and then to build the 3×3 cube without the box (this task was difficult, because of the instability of her constructions! A magnetic structure would have been better, but too difficult for our handcraft skills). There are two things that I want to report here: first of all, A. was extremely pleased. She was asking for intellectual challenges, and that was new and interesting to her. The poorness of her sensory experience was in contrast with her natural intellectual curiosity! Secondly, after a while, she said to her teacher: "Oh, is this the same thing as the cube we used in first class?". She was talking about a well-known didactic material, a cube representing 1000 small cubes glued together, where the small cubes are just represented by lines engraved on the surface of the six faces of the big cube; so, while her classmates could easily "imagine" that the cube, realized that way, was suggesting that it was obtained by glueing 1000 small cubes, she had no idea of this fact. In other words, the tool (planned for sighted children) was not sufficient to convey all the information to her. A. deeply understood it, through the use of our rough and minimal manipulative, only 3 years later.

A true anecdote [Von Prondzinsky]: A girl, 24 years old, blind from the birth, brilliantly graduated in philosophy, was following a course for sense of direction and mobility. Her tutor asked her to count the angles of a room (completely new to her). The room was rectangular, but the girl didn't stop at the fourth angle, and was continuing to count. At the 32nd angle, the tutor stopped her, and asked "what is the definition of a rectangle?". The girl answered perfectly.

Several studies point out some specific difficulties of blind students, and in particular of those blind from the birth; they have problems in translating and transferring three-dimensional objects into two-dimensional iconic form, so that they cannot understand perspective drawings; also, they have problems in enlarging an minimizing even twodimensional forms, so that they are not able to recognize different-sized shapes as being the same ([Kohanova]).

Despite of the above described difficulties, there is no reason for blindness to be an insurmountable obstacle to understand the mathematical semantics; in this context, I like to remind the example of Mademoiselle Melanie de Salignac, blind from the birth, able to master geometric facts, as told by Diderot in his "Lettre sur les aveugles": "One day I said to her: –Mademoiselle, imagine a cube. –I see it. –Place a point in the centre of the cube. –I have done so. –From the point draw straight lines to the angles; into what have you divided the cube? –Into six pyramids (she replied without hesitation) each having as its base one side of the cube, and a height equal to half its height. –True, but tell me where you see this? –In my head, as you do."

2 Concrete experiences to build mathematical concepts

I looked at the previous facts from a *geometer*'s point of view, trying to reach some conclusion from the above points.

All those examples offer a striking evidence that geometric difficulties of blind people are strictly related to the kind of experience that blind children miss most: projections and sections. Indeed, sighted people have a huge experience of sections: thinking of "seeing" somehow as "drawing in perspective", the sighted persons can easily imagine the result obtained by cutting the visual cone by a plane.

This lack of experiences explains of course the problems in understanding perspective, but also the other problems described by the previous examples. This relationship is clear in the first example: indeed, think of a sighted person imagining the cube obtained as 1000 glued small cubes: he/she is indeed "seeing" the cubes obtained by cutting the big cube along the engraved lines.

Let us consider now the second example: it seems very difficult to imagine why the girl was not able to recognize a rectangular room; but, of course, no one suggested her to explore the room by touching the angles on the floor. So, the missing experience for her was that of cutting a dihedral angle by planes, and in particular by a plane orthogonal to the edge of that dihedral angle. Clearly, a sighted person can easily recognize the floor as that orthogonal section, but, without this observation, I suppose that it would be difficult even for a sighted person to size a dihedral angle simply by touching the two planes. Moreover, having a clear idea of the behaviour of those sections is necessary even to understand how to assign a measure to that dihedral angle.

Finally, even the problem of recognizing similar (say two-dimensional) shapes can be related to lacking section experiences: indeed, a sighted person seeing two similar planar shapes can imagine them as obtained by a cone cut by two parallel planes, and the homothety between them obtained by cutting that cone by all the intermediate planes.

To recognize similarity between two-dimensional shapes can be difficult even for a sighted person, if the portion of the shape he/she can explore is too small: for example, to compare crop circle shapes, it is necessary to fly over them. A similar situation is that of a blind person that can only have the perception of "local" properties of that shape, i.e. those contained in a surface corresponding to a fingertip, while the "global" properties can be gathered from the previous ones, but cannot be perceived (it would be interesting indeed to think about this observation from the point of view of local and global properties in the sense of differential geometry).

So, the main conjecture of this paper is the following: Lacking of experiences in sections (and projections) is strictly related to problems of blind students (and persons) about the perception of geometric (mostly, but not only, 3-dimensional) facts.

3 A research project on designing mathematical manipulatives

Manipulatives are commonly recommended and used in the field of education for blind children, for several teaching purposes. In particular, several authors stress the importance of this kind of tools for giving blind children the possibility of acquiring mathematical concepts though concrete activities ([Fernandez Del Campo], [Russo], [Tindell]).

Keeping in mind the fact that the manipulatives offered to blind children are inevitably planned by sighted people, I would like to stress that it is not sufficient that an object "contains" an information. For that information to be received by a blind student, it has to be grounded on the experiences the student already knows.

A deeper thinking can help in designing better concrete tools for teaching mathematical concepts. They have to be specifically planned to offer blind students a concrete ground of experience surrogating the visual experiences they miss.

Moreover it should also be noted that sighted people know the same geometric concept from several points of view: as an example, they know – by experience – several (equivalent) properties of a straight line: it is the shortest path between two points, it has no curvature, it is the path of a bullet (or of a billiard ball) after the shot, it can glide over itself (indeed, in the plane, only the straight line and the circle have this property, which characterizes them, while in the 3-dimensional space the cylindrical helix has the same property). All these properties cannot be simply "said" to the blind person, but require a carefully planned collection of manipulatives in order to offer a haptic approach to explore them.

To the best of my knowledge there are no manipulatives focused on offering experiences about section and projections: sometimes blind children are asked to cut some soft material, but nothing else.

I made some puzzles pointing out (in a haptic form) that the same section can belong to different shapes and that the sections of a given object can be rather different between themselves.

Moreover, I planned several haptic exhibits explaining what "to see" means, offering, for example, some haptic evidence about why circles are usually drawn as ellipses (so difficult to understand for blind students, as pointed out, for example, in [Fernandez Del Campo]). These object shave been tested, in an informal way, in the Museo Omero in Ancona (Italy), and at the ICCHP – Summer University 2011. The reactions and comments of blind people were very encouraging. The comment I like more: an University student saying "Ah, if I had this object during my high school years!". Also, an adult woman, blind from the age of two, was very satisfied for having given a (haptic) meaning to the rule she received from her teacher: when depicting a chair, the image of the farthest legs should be shorter than that of the legs in front.

While planning this work, and discussing with my students about how to build these objects, to my surprise we had to question the clearness (to blind people) of simpler and simpler geometric concepts, and become aware of missing experiences which we didn't

notice before; this is how I started to feel the need for a theoretically more organized research project.

For this reason, the continuation of this work will be based on the book which is the basis of the geometry as we know it, the Euclid's Elements: I am going to re-read them from the very beginning and to realize a haptic collection of manipulatives to explore his journey through geometry.

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Development of a Tactile Star Chart Automated Creation System

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1 Introduction

Tactile star chart is an educational aid to help blind students learn about astronomy. They are useful for learning about constellation lines and the shapes of constellations. The Multi-modal Book "An Introduction to Astronomy"[1] is an astronomical textbook that includes tactile star charts. Because this is a printed book, however, users cannot change the settings of the tactile star charts. Whenever tactile star charts with different settings are required, the teachers have no option but to create them by hand. These take a tremendous amount of time and effort to complete. Therefore, the authors decided to develop an automated system for creating tactile star charts based on settings specified by the user. As the system has been built as a web application, moreover, anyone can easily obtain tactile star charts in this way.

2 Tactile star charts

Tactile star charts created by this system allow stars, constellation lines and constellation boundaries in the starfield to be observed by touch. Stars are expressed as points, constellation lines as solid lines and constellation boundaries as dotted lines.

2.1 Starfields

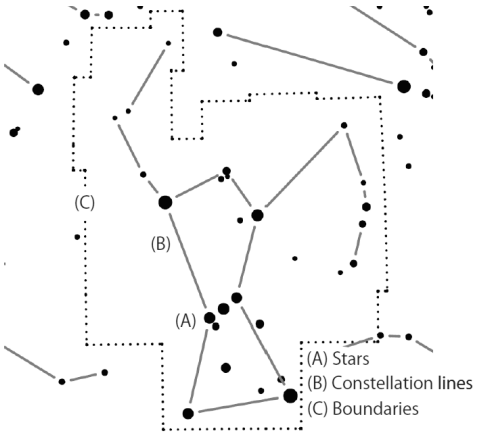
A starfield is an arbitrarily fixed area of the night sky.

2.2 Constellation lines

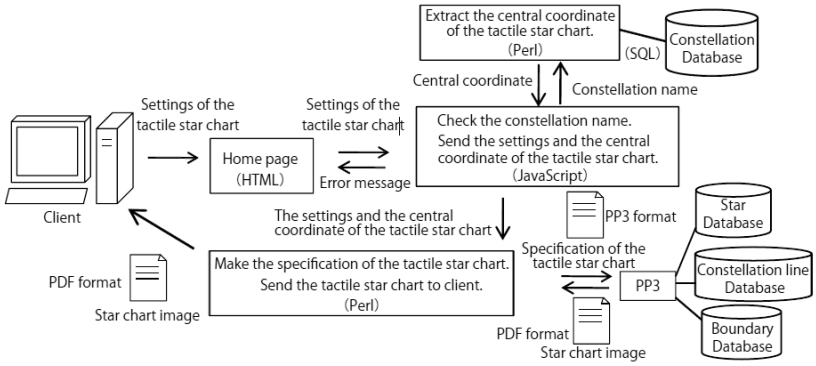
Constellation lines are lines drawn to link up stars, often forming a human or an animal. Many of these originate in Greek myths.

2.3 Constellation boundaries

Constellation boundaries are lines showing the boundaries between constellations. The entire night sky is divided into 88 constellations enclosed by constellation boundaries in polygonal shapes, each with its own name.



[Fig. 1] A star chart of the Orion.



[Fig. 2] Block diagram of the Tactile Star Charts Automated Creation System. In each block, functions and languages used in the development are described.

3 Tactile star chart automated creation system

This system is built as a Web application. Users input the constellation name and star chart settings to get the star chart. The star chart is printed on microcapsule paper and passed through a developer. The tactile star chart is completed in this way.

3.1 How the system works

Figure 2 shows the block diagram of the system. How the system works is explained based on this diagram. (Brackets show the language used.)

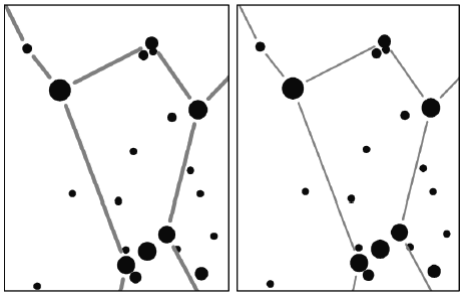
1. User designates the starfield.
   When **constellation names** are used to designate starfields, the central coordinates of the targeted constellation are extracted from the constellation database. Users can also input **rectascension and declination** to designate starfields.
2. User inputs star chart settings.
   The settings of the targeted tactile star chart are designated on the Web page.
3. Perl program makes specification of the star chart.
   The input settings are written into a text file as a specification in the PP3 format[2]. PP3 is the star chart creation program (see 3.3 "Star chart creation program PP3" for further details).
4. PP3 creates the star chart.
   PP3 loads the specification file, captures the data from three sources (the star database, the constellation line database, and the constellation boundary database) and creates a star chart image in PDF format.
5. User gets the star chart.
   Perl program sends the star chart to the user.

3.2 Tactile star chart settings

To create a tactile star chart which is easy to observe by touch, the following three points must be taken into account.

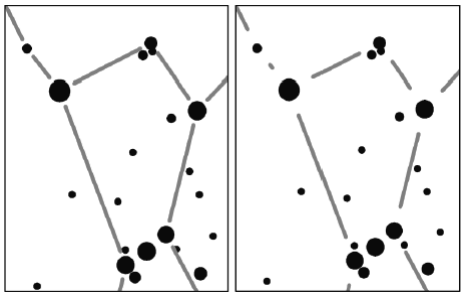
1. If the lines are too wide, they will overlap with nearby stars; if too narrow, they will be difficult to observe by touch. Therefore, the width of the lines has to be set appropriately.
2. Stars and lines are hard to distinguish if they are too close to each other. Therefore, the space between them must be made sufficiently wide.
3. A surfeit of objects makes observation difficult. Therefore, objects have to be selected.

Based on the above, this system allows the user to set the five parameters on the Web page; width of constellation lines and constellation boundaries, space between stars and constellation lines, presence or absence of constellation boundaries, magnitude of displayed stars, and scale of charts.



(a) (b)

[Fig. 3] Star charts with different width of constellation lines.
(a) Width: 0.5[mm] (b) Width: 0.25[mm]



(a) (b)

[Fig. 4] Star charts with different spaces between stars and constellation lines.
(a) Space: 0.5[mm] (b) Space: 2[mm]

Figure 3 shows two star charts with different width of constellation lines. Figure 4 shows two star charts with different space between stars and constellation lines. Users can easily create different representations of the same starfield.

3.3 Star chart creation program PP3

The tactile star chart creation program uses the PP3 (Parvum Planetarium, version 3) star chart creation system developed by Torsten Bronger. This program loads the text file with star chart specifications (width of constellation lines, magnitude of displayed stars, etc.), creates a TEX file and compiles it to generate EPS, DVI and PDF files.

3.4 Databases

The system uses four databases to create the tactile star charts.

1. Constellation database We created this database to link the constellation names with its central coordinates.
2. Constellation line database We created this database based on the Mitaka[3] (Ver.1.2.0) night sky simulator distributed by the National Astronomical Observatory of Japan.
3. Star database BSC[4] (Bright Star Catalog), a catalog of stars compiled at Yale University is used. The coordinates and magnitudes of stars are extracted from this database.

4. Constellation boundary database The Constellation Boundary Data[5] created by A. C. Davenhall is used. This database is based on constellation boundaries determined by the International Astronomical Union in 1928.

4 Conclusion

We set out to develop a tactile star chart automated creation system enabling users to create tactile star charts with various settings quickly and simply. In the future, experiments will be conducted to find the settings most suited to tactile observation. The URL of the tactile star chart automated creation system is shown below. Anyone interested in this research is welcome to try it out.

<http://tmaps.eng.niigata-u.ac.jp/~hiroki/star/en/>

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An interdisciplinary approach to alternative representations for images

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Keywords: accessibility, image description, alternative text.

Abstract

This paper presents a theoretical proposal concerning the formalization of appropriate alternatives to non-text content in web pages and digital documents. Although the use of appropriate text alternatives to non-text content is a key principle of accessible design, currently the implementation of alternative text to images on the web is far from being perfect.
In this paper we present a theoretical approach based on the assumption that the definition of the alternative representations to images could be improved by the cross-fertilization of Information Visualization (InfoVis), Library and Information Science (LIS) and Semantic Web disciplines. The article presents the conclusions of a literature review on the principal theories, models, guidelines and best practices concerning the description of images in the four disciplines cited, focusing the attention on the need to improve the accessibility, the generation of alternative representations and the retrieval of images.

As a result we identified two main contributions of the disciplines analyzed:

- *The theoretical principles that regulate the creation of alternative representation of images could be defined by the combination of models for the analysis of images offered by InfoVis and LIS disciplines.*
- *The methods and techniques supplied by LIS and Semantic Web could improve the standardisation and automation of the creation and management of alternative representations of images.*

The final objective of the paper is to outline a research approach that could represent a step towards a widespread adoption and a better description of image content.

1 Introduction

A key principle of accessible design is the use of appropriate text alternatives to non-text content in web pages and digital documents. A text alternative allows the images in a web site to be readable by screen readers or other assistive technologies, making them accessible by blind users or users with other disabilities. Although the need of text alternatives is recommended by the number 1 guideline of WCAG version 1.0 and 2.0, currently the implementation of alternative text to images on the web is far from being perfect and lots of images have missing, incorrect, or poor alternative text (Petrie et al. 2005). The reason could be that the normative only offers general recommendations regarding the technical means to include the alternative text description for images and currently there are not

commonly agreed guidelines on how to describe the image content nor standards defining the process of image description.

As an answer to this limitation, several attempts have been made to formalise the description of images by different institutions, being the most relevant the set of guidelines for describing images proposed by the NCAM (NCAM 2009) and the DIAGRAM Center (DIAGRAM Center 2012). In order to go beyond these two cases, our proposal consists of the cross-fertilization of Information Visualization (InfoVis), Library and Information Science (LIS) and Semantic Web disciplines in the definition of alternative representations to images. Each discipline approaches the description of the images from a different perspective, according to its own principles and objectives. Consequently, they suggest different but complementary solutions that can enrich a feasible method for the accessibility field.

2 State of the art

The literature review of the 4 disciplines in relation to the description of images is introduced according to the area they contribute to:

1. Theoretical principles that shape the writing of alternative representation of images.
2. Methods and techniques for the inclusion and management of alternative representations of images.

2.1 Theoretical principles

The theoretical principles that shape the writing of alternative representation of images could be defined by the combination of models offered by the InfoVis and LIS disciplines. The models offered by LIS present different layers of representation according to basic aspects of the visual content of an image (Panofsky 1983) and to the external or non-visual information that relates the image to its history and context (Shatford 1986), (Jaimes & Chang 1999). Both can help to organize the description of its syntactic and semantic visual features. The subject that accesses the image is also taken into account for his ability to interpret the image according to his previous knowledge and this could help to describe the function of the image in the context in which it is presented. These models could be used to determinate subsets of metadata schemas according to these different levels (Hollink et al. 2004). Additionally, InfoVis offers some theoretical models in which it is possible:

- To identify visual variables and discover rules of construction for the components of an image (Engelhardt 2010), which also contributes to the description of the syntactic features.
- To contextualise the creation of a representation in the process of creation of knowledge, which begins from the raw data to be represented, derives information from it, arrives to a graphic (the visual representation) and ends with the user interaction and interpretation of the image (Card et al. 1999), (Chi & Riedl 1998).This process could be reversed to obtain a textual alternative for an image, reinstating the original objective of the representation. This discipline also helps to contextualize the description in the process in which the visual information is created and managed.

2.2 Methods and techniques

Relating to the creation and retrieval of information associated to the images, LIS offers standard schemes for annotations, content guidelines, controlled vocabularies, format and presentation guidelines and also standard procedures for the retrieval of images. This standardization could foster the use of metadata for describing images and convert the metadata in a powerful alternative to the visual representations (Kawanaka et al. 2009). Together with the techniques and methods offered by LIS, the Semantic Web could provide the annotation of images at different levels of granularity and make the knowledge embedded in the image (for example in statistical graphics) explicit during the creation stage and available for the rest of the image lifecycle (Fredj & Duce 2007). Concerning the image retrieval, semantic web could partially automate and enrich image descriptions with the semantic relations provided by ontologies.

In short, the methods and techniques supplied by LIS and Semantic Web could improve the standardisation and the automation of the creation and management of alternative representations of images. They could facilitate its integration into the publishing workflow improving, at the same time, the retrieval and the adaptation of the images to different contexts of access. A formal description could also facilitate the reuse of the information included in the visual representation, for example in the process of image cataloguing and retrieval.

3 Results and contribution to the field

The current results of the investigation consist of the identification of strengths and opportunities of improvement in accessibility by the suggested disciplines cross-fertilization and the synthesis of the major contributions supplied by InfoVis, LIS and Semantic Web. When LIS, Infovis and Semantic web theories and praxis will be applied, the creation of alternatives for images could be enriched with:

- A multimodal approach to the description of images.
- Richer descriptions.
- Newer or complementary praxis and guidelines.
- Richer techniques to include the description within the image.
- Standards for the different areas covered in the description.
- Automation of part of the process.
- True inclusion of the alternatives into the publishing workflow.
- Special attention to the profile of the user, the equipment used to access the content and the general context of access.

There will also be new opportunities that will appear with this enrichment:

- A theory to attain the process of description.
- An increase of use of descriptions due to lateral benefits made clear by other disciplines (retrieval by LIS, reuse by semantic web).

4 Conclusion and future works

As we have started to show, InfoVis, LIS and Semantic Web can enhance image description and convert it into a truly implemented activity within the authoring process of a digital document. Starting from this hypothesis we should validate it making specific proposals of integration, analyzing the workflow in the publishing processes, talking to stakeholders, prototyping and evaluating a first model of implementation of the presented ideas. A possible field of application could be, for example, the biomedical field, where digital images have a wide variety of uses and applications and tend to be an increasing source of key information for decision making (Müller et al. 2004), educational purposes and research (You et al. 2011).

As a final result we expect to be able to increase and improve the use of alternative descriptions to images and their integration into the publishing workflow.

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Communicative Images – New Approach to Accessibility of Graphics

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Keywords: Dialogue systems, ontologies, images

Abstract

This paper presents a novel approach to accessible image processing. Images are integrated with a dialogue interface enabling users to communicate with images by means of natural language. Image semantics as well as the dialogue interface are supported by graphical ontologies representing formally defined and well structured knowledge base. The communication with the user is operated by the intelligent dialogue management modules that are capable to learn from dialogues. The Internet is used for retrieving information about the images and for solving more complex tasks. Some examples and applications for the people with special needs of the presented approach are included as well.

1 Introduction

Although the image recognition techniques are still far from being able to fully describe an analyzed picture, current technologies enable us to associate many useful pieces of information to images. For example, the date and time of a snapshot, GPS information, and in some cases recorded sound are often directly associated with photographs by the camera. Typically, this information is saved in the format of the image and can be exploited for image classification and semantics retrieval, see e.g. [1–3].

Most of the relevant information, however, is not directly feasible. Let us imagine a photo from a holiday ten years ago: the woman in the middle is my wife, but who is the guy standing behind her? It is apparently somewhere in the Alps, but what place? What is that peak in the background? Such pieces of information are virtually inaccessible. However, some relevant pieces of information can be retrieved using current information technologies. GPS coordinates allow us to determine where the photo has been taken. Face recognition [4–6] may help reveal the identities of persons. The orientation may help to determine some objects in the picture (e.g. the peak in the background).

The idea of communicative images presented in this paper lies in enabling the people to communicate with the images, i.e. enabling the users to get easily relevant pieces of information from the images and enabling simultaneously the images to gather relevant information about themselves from the users [7]. Communicative images learn from the communication, enlarge they knowledge base and use it in further communication. They also provide intelligent and efficient natural language dialogue with the user.

The concept of communicative images is very general and allows many applications, e.g. in image searching, e-learning, image recognition, etc. However, probably the most important and direct impact is in making the images accessible for blind and visually impaired people.

2 Building up Communicative Images and Communicating with Them

To make a standard image communicative, it is necessary to transform it into a format suitable to support structured annotation data. In our approach, the ability of the SVG format [8] to wrap the original raster image and to integrate annotation data is exploited. The general knowledge base is described by the OWL ontologies [9] that are linked from the SVG pictures via the *owl:imports* statement. In this way, the knowledge base can be shared by many pictures. On the other hand, concrete annotation data, i.e. concrete values of the properties prescribed by the ontologies, are stored directly in the SVG format in the form of XML elements. Technical details related to coupling OWL ontologies with the SVG format are discussed in [10].

SVG format enables to include auxiliary graphical data that help to localize the annotated objects in the original image. Either 2D points laying in the middle of the relevant objects or invisible (transparent) polygons determining approximate silhouettes can be exploited. This information improve the navigation in the picture during the dialogue.

Once an image is transformed into the SVG format, the system tries to acquire as much information about the image as possible, using auto-detection and image recognition techniques, e.g. face detection and recognition algorithms [4–6], similarity search algorithms searching in large collections of tagged pictures [11–13], EXIF data extraction from photos, etc. After this initial stage, the user is informed about the estimated content and invited to confirm or refute the information and to continue with questioning. New pieces of the acquired information are stored in the image ontology and reused by subsequent interactions.

2.1 Graphical Ontologies

The OWL ontologies present formal specification of shared conceptualization. They describe the semantics of data with modeling domain concepts, their relationships and attributes. In [14], we have presented a basic graphical ontology which restricts abstraction to the aspects that are suitable and utilizable for dialogue-based investigation of a graphical content. This ontology focuses on generic visual characteristics of graphical objects and enables to define several typical or usual aspects, e.g. unusual size, typical shape, dominant color etc. Using this ontology the annotator can say that some object is "mostly red, oval and unusually big", for instance. The ontology include navigational part as well, enabling to describe either general or mutual position of objects in the picture.

Although the graphical ontologies cover basic visual characteristics that are useful for generic dialogue interactions, verbal descriptions of domain-specific pictures require to employ specialized ontology extensions helping to generate domain-specific dialogues. For example, a domain model, Family, provides vocabulary and background knowledge to classify people by their relationships, similarly to the popular "circles" known from social networks. People in a photo are identified and assigned into "circles" (e.g. my family, friends, colleagues, etc.). Similar models can be found in [15, 16].

2.2 Ontologies and Logics – Formal Framework for Information Exchange

The core of the management of the dialogue strategies for the communication between the user and the image is based on graphical ontologies, as a basic source of information,

and a suitable logic standardizing syntax and semantics for information interchange. The interface between natural language and formalized ontology framework provides an engine transforming natural language into corresponding formal schemes. Typically, we can restrict ourselves to a small fragment of natural language, so that the engine can be based on relatively simple grammars in combination with the frames technology and standard techniques for misunderstanding solving. For instance, the question "*How far is it from this hotel to the nearest beach?*" is resolved using the template "*How far is it from SLOT1 to SLOT2?*". The system expects both SLOT1 and SLOT2 to be filled by the specific entries from the "objects" category. In [17], more detailed principles of the dialogue management have been formulated.

The complexity and the strength of the chosen logic is determining the complexity and the strength of the dialogue strategies. Predicate logic, the logics that are developed within the Semantic web (e.g. Common Logic [18]), modal logics, temporal logics, Transparent Intensional Logic [19], etc., can be used for this purpose. This approach enables to develop a single general scheme, into which standardized formalizations of different logics can be easily implemented.

2.3 Dialogues with Communicative Images

We present two examples in this section showing typical dialogues between the user and communicative images (*U* stands for User, *I* for Image).

Example 1.

U: [activates the dialogue with the image]

I: This photo has been taken at January 16, 2012. There is a group of people in the picture, among them your friends Peter and Eve. /In the corresponding ontology, GROUP OF PEOPLE is a predefined ontology relation. FRIEND is an ontology relation related to the user (modal ontology relation). PETR and EVE are objects of the ontology. The photo is of the type PEOPLE, therefore in the description of the environment is omitted in the brief summary./

U: What are the other people?

I: The other people are John, Mary and Michal. John is brother of Mary and Michal is a friend of John and Mary. Do you know John, Mary or Michal?

U: Yes, they are my schoolmates. /This information is encoded into the ontology format, compared with relevant ontology information, and, if it does lead to conflicts or if it does not need other explanation, this piece of information is added to the graphical ontology./

In this example, the user is assumed to be sighted. Important feature of the communicative images concept is that the annotation made by sighted people can be in further communication exploited by blind and visually impaired users. Internet and especially social networks form a suitable environment for this concept. Moreover, because communicative images gather also the information about the user, the image is able to apply special dialogue strategies when communicating with blind users.

Example 2.

U: [activates the dialogue with the image]

I: This photo has been taken at January 16, 2012. This is a view of the Brno city with the

castle Spilberk and the cathedral Petrov.
U: Where is Brno located?
I: Brno is located in the eastern part of Czech Republic.
U: What is the population of Brno?
I: The population is about 400 000 people.
U: Is there a friend of mine that lives in Brno?
I: Yes, your friend Michal Novak lives there.
U: Tell me some interesting facts about Brno. /The requests activate the search engine, which searches at the internal pieces if information encoded in the image graphical ontology, and, if this search fails, it activates real time searching Internet. If this search is successful, the relevant pieces of information are exploited to answer the request./

In this example, the user could be both sighted or blind. In both cases, the dialogue shows its functionality.

3 Communicative Images and the People with Special Needs

The concept of communicative images seems to be a promising approach in accessibility of graphics for visually impaired people, older adults or people with any constraint in communication. It provides the users with special needs with another way to explore graphics on the Internet and gives them more detailed information about the photos in the social networks or electronic news.

Moreover, the communicative images paradigm makes it possible to build other useful applications. Integration of communication images with a dialogue-based web editing [20] would enable to the visually impaired people to create their personal web pages with graphical content by means of dialogues.

In [21], Chai et al. proposed an intelligent photo album enabling to organize and search collection of family photos by means of ontologies and SWRL questioning [22]. If communicative images are implemented into this scheme, we see straightforward way to enhance its functionality. Because the photos in the album are organized by means of OWL ontology, it might be possible to employ the mechanism of generating dialogues from domain ontologies. In this way, the user could organize photos via dialogue as well.

E-learning is another field, which could benefit from communicative images. A very important feature of the presented communicative images concept is, that because of the concept is based on formal ontologies, it is fully compatible with the Semantic web paradigm and simultaneously fully supporting multilinguality.

The communicative images paradigm depends on the users cooperation and sharing data. Annotation and knowledge gained during the interaction of one user is used to enhance and simplify interaction of another user. *Crowdsourcing* present Web 2.0 technologies that could support this paradigm. If content cannot be recognized by auto-detection techniques then the blind user can ask community of sighted users for help, e.g. to describe "what is that building in this picture". Their answers are employed to annotate the picture and extend the knowledge base in the same way as results of machine-based recognition.

4 Conlusion and Future Work

Communicative images represent a new and challenging approach that utilizes and integrates current technologies. Communicative images integrate graphical ontologies and AI-based modules and allow the user to exploit images in a novel way by means of natural language dialogue. In addition, this approach promises important applications in assistive technologies, making the images on web accessible for people with some disability. In ongoing and future work, we are aiming at enhancing dialogue strategies, implementing inference methods, developing ontology management methods and testing the technologies in real online and offline environments.

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Section 3

General Web and E-learning Accessiblity, Effectivity of Teaching within the Framework of Universal Learning Design

Guidelines for Developing e-Learning System for Visually Impaired

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Keywords: e-Learning, LMS, development, guidelines, blind, visually impaired

1 Introduction

The use of the Internet and new technologies in order to enhance the quality of life of the blind and the visually impaired has resulted in greater accessibility within this particular environment. This greater accessibility has been analyzed in terms of web-site development, i.e. applying existing standards and establishing new ones with the aim of developing an e-learning system for the blind and the visually impaired.

An accessible and usable web is part of the concept of e-accessibility, one of the key elements of e-inclusion, which aims to ensure that everyone without exception is included in the information society. Given this context, e-accessibility refers to the removal of technical barriers and difficulties which the blind or the visually impaired might encounter as they attempt to become part of the information society.

2 Aims

The primary aim of the study is to define guidelines for the development of an e-learning system with the aid of existing Web 2.0 technologies. Standards which should be observed while designing the system shall be defined from the aspect of usability. The problems which have been identified are based on the research carried out in the course of working with various associations for the blind and the visually impaired in the Zagreb area. Standards which have been defined in the guidelines provided by www.3.org (Web Content Accessibility Guidelines – WCAG 2.0) are not adapted to all web content. These are only some examples: registration forms, system login forms, column design, keyboard shortcuts, direction of navigation, information architecture and content search.

The guidelines that shall be defined will meet the criteria of universal design, which is focused exclusively on:

- Flexibility in use;
- Ease of use;
- Visible information.

Furthermore, the goals of the modeling framework of assistive technologies shall also be met. Some of these are [1]:

- application in any assistive technology system;
- the possibility of classifying assistive technology systems;
- defining the basic structure of assistive technology systems (in device specifications);

- developing new assistive technology systems with the aim of meeting the needs of end users;
- supporting the process of providing assistive technology to the user, aimed at the user accepting the solution provided;

It is possible to evaluate how successfully the guidelines have been applied by methods used to measure the Quality of Life of the end users [1] [2].

3 Methodology

The guidelines shall be defined using an analysis of the Learning Management Sys-tem (LMS) currently in use in Croatia (the Moodle-based Merlin), as well as the e-Student system in use at the Faculty of Transport and Traffic Sciences. The evaluation shall be carried out using the validation tool on (http://validator.w3.org) and the AChecker tool for evaluating e-accessibility [8].

4 Current situation

According to the latest Report on People with Disabilities, there are 529,103 individuals with varying disabilities currently residing in Croatia. This figure accounts for more than 10% of the total population [6]. There is a total of 18,317 blind or visually impaired people, which is an increase of 2,044 people on the year before. According to one estimate, the Internet is used by 10% of the blind population, and this figure is rising. The estimate is based on the documents and reports produced as part of the project "Komunikacijskim štapom do neovisnosti" ("The Communication Cane Leads to Independence") [5]. Several systems serving distance learning needs are in use in Croatia; three of which will be analyzed in this paper: Merlin, e-Student and AAI@EduHr.

Merlin is the LMS which is used as the e-learning and e-teaching platform at the University of Zagreb. It is based on Moodle, the open source tool which has been further modified and adapted to the needs of its users [9].

e-Student is the LMS used by the Faculty of Transport and Traffic Sciences and allows students authorized access to a variety of teaching materials, tasks, exercises and instructions. The system was developed in its entirety at the Faculty of Transport and Traffic Sciences [3] [11].

AAI@EduHr is the authentication and authorization infrastructure of the science and higher education system in Croatia. It is also a prerequisite for using all other systems which may be part of other university institutions in Croatia [10].

These LMS were analyzed using the AChecker tool and the following errors were identified:

- Merlin
  - Known problems – 48 errors
  - Potential problems – 300 errors.
- AAI@EduHr user login system
  - Known problems – no errors
  - Potential problems – 30 errors.

- E-student
  - Known problems – 11 errors
  - Potential problems – 63 errors.

The errors are due entirely to writing HTML code correctly, which refers to ALT attributes.

5 Defining guidelines for development of e-learning systems

Ensuring that the blind and the visually impaired have access to the content of a website and can use it is defined by W3C standards. Understanding information, as well as navigation and interaction between the website and the user define the website as accessible to all current users. An accessible website also attempts to ensure that all its users (regardless of disability or experience) have equal accessibility.

5.1 Standards of LMS development

Current standards of e-learning system development stem from the fundamental principles of website design available on www.w3.org [7]. The system developed at the Faculty of Transport and Traffic Sciences (e-student) is based on these standards, but none of the e-accessibility recommendations were followed. This was also the case with Merlin.

Elements used in the development of the e-student system:

- HTML (Hyper Text Markup Language) elements
- XML (Extensible Markup Language)
- Standards in writing headings and text (<h1..h6>, <p>)
- Standards in defining the visual aspect (CSS – Cascading Style Sheets)
- Dynamic features of the website using ASP (Active Server Pages).
- Elements used in the development of Moodle:
- HTML (Hyper Text Markup Language) elements
- XML (Extensible Markup Language)
- Standards in writing headings and text (<h1..h6>, <p>)
- Standards in defining the visual aspect (CSS – Cascading Style Sheets)
- Dynamic features of the website using PHP (Hypertext Preprocessor).

The basic criteria which the systems use in operation have not been adapted either. These include the user registration and login system, information search and adaptation to other devices (mobile terminal devices or tablets).

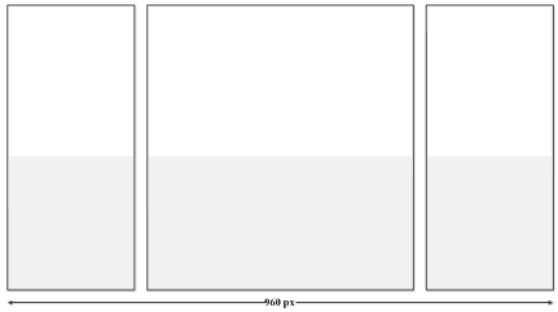
5.2 Guidelines

The guidelines define the fundamental steps/criteria to be taken/applied when developing an e-learning system for the blind and the visually impaired. The guidelines define 9 criteria which should be taken into consideration when designing an e-learning system.

5.2.1 Criterion 1 – HTML row and column design

The majority of web pages have only 3 columns (left, main and right) and 2 rows (header and footer), which poses problems for users as they navigate the page.

The design should be based on 3 columns as shown in Figure 1.



[Fig. 1] HTML column design

The columns should be of proportional width and contain predefined elements such as:

- First column 1/4 of total width – menu
- Second column 2/4 of total width – content
- Third column 1/4 of total width – additional functionalities.

The left column is reserved strictly for the main links of the web page, and tree menus or drop down menus should be avoided.

5.2.2 Criterion 2 – Keyboard shortcuts

An analysis of the systems currently in use indicates that each system has its own predefined shortcuts, which does not allow for efficient use and requires time to learn the various shortcuts.

Keyboard shortcuts should be standardized, so the following 6 basic shortcuts are recommended for navigating the website:

1. Home page – CTRL – ALT – H(ome)
2. Content search – CTRL – ALT – S(earch)
3. Top of page – CTRL – ALT – T(op)
4. Go to menu column – CTRL – ALT – L(eft)
5. Go to content column – CTRL – ALT – M(iddle)
6. Go to additional functionalities column – CTRL – ALT – R(ight).

The CTRL-ALT combination was defined in order to avoid overlap with existing shortcuts employed by operating systems and application solutions (MS Office, Inter-net browsers and more). It is also not possible to simply use a letter shortcut (e.g. the S key), because in certain cases the user would not be able to navigate the web inter-face in the necessary direction (e.g. when entering data in a search field).

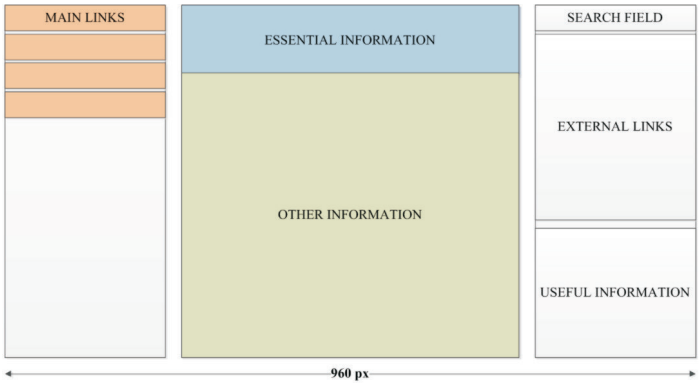
Navigating columns is based on a sense of orientation, so that the user can recognize the layout of the elements on the screen.

5.2.3 Criterion 3 – Direction of navigating a user interface

The direction of navigation should be from right to left. It is also important to limit the user to a maximum of two steps before obtaining the required information. If the user is navigating a column, navigation direction should be from top to bottom.

5.2.4 Criterion 4 – Information architecture

Information needs to be carefully selected and brief, as well as constantly available. It is also important to classify information into, for instance, essential, general and useful information. If the information is organized, users will always know where they are and what to look for. Essential information should be in the top part of the content column, while general information should always be found below. Useful information should be found in the right column, under the search field and external links (Figure 2).



[Fig. 2] Information architecture

Information which is found on the web page should not branch out into sub-information or in any other way.

5.2.5 Criterion 5 – Interface optimization

The interface should not incorporate "pop-up" or modal windows, nor should it employ flash animation. Only the necessary information should be provided. The interface should allow the visually impaired user to change the background color and the font, or to enlarge the font in accordance with WCAG 2.0 standards.

5.2.6 Criterion 6 – HTML tags

The website content (text, images, audio files) should contain descriptive tags. This is particularly relevant in the case of images, so that the description may be read by screen readers. Screen readers cannot decode documents in PDF, which is why the PDF icon with a brief description of the content should be used. The analysis indicates that ALT tags are often lacking, which renders the blind and the visually impaired unable to read the element. Descriptive tags should be clear and brief, without going into detailed descriptions.

5.2.7 Criterion 7 – Auditory feedback

The user registration field should employ an auditory warning for both correctly and incorrectly entered information. If information has been entered incorrectly, it is automatically deleted, with a focus on the field where the information has been entered incorrectly. Next, the user may reenter the information, having received an auditory warning. The auditory warning is defined through the standard auditory warnings of operating systems. A successful registration or login is also accompanied by auditory feedback.

5.2.8 Criterion 8 – Confirming data entry

Pressing the enter key does not execute the form action – it simply confirms data entry into the current input field. The form action is executed after the final input field. When the search function is used, the text needs to be entered and the enter key pressed in order to initiate a search, after which the focus shifts to the middle column, i.e. to the search results.

5.2.9 Criterion 9 – Accessibility evaluation

The accessibility of the website needs to be evaluated in accordance with the de-fined guidelines. It is also necessary to analyze accessibility using a validation tool recommended by www.w3.org.

6 Conclusion

The analysis of the e-learning systems currently in use at the University of Zagreb (Merlin and the LMS at the Faculty of Transport and Traffic Sciences) indicates a number of flaws with regard to accessibility to blind and visually impaired persons. The tools used in the analysis reported a large number of errors, although WCAG 2.0 recommendations were followed.

This paper defines the guidelines for adapting an LMS to blind and visually impaired users in terms of nine criteria. In addition to these criteria it is vital to guarantee the basic requirements of usability are met, such as:

- the exact position of elements on the page
- simple design
- the option of changing font size
- the option of changing background color (for the visually impaired)
- correct description of images
- adequate language support for letters
- in the case of video files, voice and text support must be included
- web frames have designated names
- standard web forms
- text cannot be in picture form
- if the web page uses visual verification (CAPTCHA), alternative auditory verification must be available.

The criteria were defined in the course of meetings with the users of web pages and LMS, of which there are 35 at the University of Zagreb, as well as HUPRT (the Croatian Association for the Promotion and Development of Typhlo Technology). These guidelines shall provide recommendations for their implementation within the University of Zagreb E-learning Strategy.

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Voice technologies have a power to eliminate physical disabilities

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Physical disability may not mean fatal handicap anymore

Computer voice control programs have been used in many countries and languages for some time. However, the idea of using them for systematic teaching of severely disabled people, who have to rely on others to help them almost in all aspects of their lives, is absolutely unprecedented in the Czech Republic and neighboring countries.

It was a member of our civic association Jan Nouza, professor at the Technical University of Liberec, who came up with the idea to prepare a proposal and implement this unique project called Duhový most (Rainbow Bridge). This is no coincidence. Professor Nouza and his research team have been dealing with speech recognition and developed, among other applications, three computer voice control programs named MyVoice, MyDictate and NEWTON Dictate.

Even the best ideas and intentions do not guarantee success and way from idea to its realization is not easy. In case of unique projects, which Rainbow Bridge undoubtedly is, the realization is tough. However, we are pleased to say even before the end of the project targeted on clients in Prague that the Rainbow Bridge project is successful in all respects. In fact, the project is so successful, that the lectures on controlling PC using voice commands spread to four other regions in the Czech Republic.

Rainbow Bridge – Hope for the disabled

The three-year project focuses mainly (but not exclusively) on people suffering with paresis or plegia of upper limbs or other severe disability that prevents them from performing even the minimum fine motor tasks. Using new technologies based on voice recognition we try to eliminate the health disadvantages and enable these people work with PC.

In the Rainbow Bridge project we teach our clients, who are unable or have difficulty controlling mouse and keyboard. They learn the basics of essential computer skills. Each lesson of three month courses comprises of the lecture and the subsequent group or individual training, during which the clients practice working with PC using voice commands with MyVoice, MyDictate and NEWTON Dictate, although the excellent computer voice control demonstrated by our lecturer Dita Horochovská, also suffering with quadriplegia, can be achieved only through a long and constant practice, our clients can cope with all common tasks on PC.

Software MyVoice serves as an interface between commands spoken to the microphone and standard applications running on a PC. It either complements or (in most cases) replaces keyboard and unlike interfaces embedded in some operation systems, the MyVoice offers a significantly higher degree of adaptability to the specific needs of people with disabilities. Its engine is capable of recognizing with up to 10,000 commands (single

words or phrases). The commands can be split into domain-specific groups. This helps to keep the interaction with the computer under control and makes it more robust to recognition errors. The commands can be arbitrarily modified to fit the needs and limits of the users. For example, if the user's speech is affected by moderate dysarthria, the vocabulary can be tailored so that it consists of smaller groups of easily pronounceable (and distinguishable) commands.

The assignment of the actions to the commands is again very flexible so that the user can optimize his/her vocabulary and minimize the number of utterances needed to accomplish the most frequently performed tasks.

The Myvoice is mostly used as a tool that launches and controls applications, enables typing (of letters, frequent words and phrases), and provides access to internet services. It allows for virtually any activity that is normally performed via a keyboard and mouse.

The MyDictate is distributed with a lexicon containing about 550 thousand words. The employed technology allows the program to run even on recent low-cost PCs. The recognizer outputs the ordered list of 10 best candidates, taking into account the acoustic as well as the language model score. The word with the best score is automatically added to the dictated text while the next 9 candidates appear on the list shown in MyDictate's window.

The basic vocabulary assures about 99 % coverage rate for common Czech texts. If a dictated word is not in the lexicon, the user can add it there by voice even during the dictation.

As the program is aimed at people with physical disabilities, it must be able to cope with less standard pronunciation. If this is the case, the user can employ the embedded speaker adaptation module. For most users it helps to reduce the recognition error by 20 to 25 % relatively.

Our results show that the recognition accuracy further improves when the user gets accustomed to the program. After multiple adaptation steps, the score is usually improved by 5 to 7 per cent up to 90%. One of the users, a lawyer, uses the program for dictating highly professional texts where he achieves accuracy above 94 %, now. Trained person can type by voice quite fast, with maximum speed in range 30 to 60 words per minute.

The NEWTON Dictate uses continuous speech recognition, which means it can transcribe the whole speech at a time with accuracy up to 93 %.

Similar software solution as the SW NEWTON Dictate for Czech language also exists, the SW NovaVoice. This software resulted from research performed by the chair in cybernetics, fakulty of applied sciences ZČU in Pilsen.

The state of the art worldwide is SW called Dragon from Nuance, but it is used only for group of wide-spread and often used languages like English, French, German and similar. Because of high complexity of Slavic languages the SW used for speech recognition of them has to be more robust and precise. More technical details about used SW can be found in [1] and [2].

After the course our clients can write and work with MS Word, Excel, surf the Internet, use e-mail, chat, read books, watch movies, all without the otherwise necessary assistance. They acquire skills that enable them to apply for suitable positions in the labor market according to their intellect, which is also extremely important.

There's a First Time for Everything

Our decision to prepare the project was a step into the unknown. We knew how the voice-control technology worked and we had an idea of how prepare the lectures but until the start of a pilot lecture in October 2010 we were not able to answer the question of how to offer the courses to the target group and how our clients would react and participate.

We were fortunate that at the very beginning of the project we contacted the right people who helped us significantly with the recruitment of participants of the pilot course, which was crucial for the whole project. It was Mr. Vojtech Sedlacek, founder of IT teaching in a well-known institution for persons with disabilities, Mr. Jaroslav Winter, who gave us advice and a lot of space on his web portal that is focused on helping people with disabilities (www.Helpnet.cz) or Mr. Milan Boehm, who introduced our current lecturer Dita Horochovská to us. A major role in success of our project was the personal contact of project manager, Daniela Rázková, with Mrs. Jana Hrdá of the National Council for Persons with Disabilities, who herself was one of the participants of the pilot course. Many clients found us through the company NEWTON Technologies, dealing with speech recognition, which we closely cooperate with.

Along with preparations we addressed hundreds of organizations and civic associations and asked them to spread the information about our free courses among their clients. Given the exceptional nature of the project, we appeared in most of Czech significant media, including public television and radio stations that repeatedly informed about the project. It also turned out that perhaps the most effective means of promotion of our courses were and still are the participants themselves. They recommended our courses to their friends with disabilities.

Teachers and pupils

There is no sense hiding the fact that the project team itself has learned a huge lesson when alongside with teaching and technical support had to ensure smooth running of courses in terms of logistics (transport of participants including the donations of their fare), but also necessary services (lunch delivery from a nearby cafeteria) . But more significant was the creation of friendly and trusting atmosphere, which overcame the usual initial skepticism of most of our clients.

This was successful. And it wasn't only a matter of individual attitude to the course participants and their specific needs and habits. More important was to break through the barrier which was their disbelief and distrust in their own abilities. Important role in this was undoubtedly played by lecturer Horochovská, who is quadriplegic herself.

In close cooperation with Mrs. Dita Horochovska and a scientific research group lead by professor Jan Nouza from the technical university of Liberec the company CZESHA – SERVIS, s.r.o. developed the first publication of a methodology on teaching the controlling of a PC via voice and additional teaching and learning materials for the participants of the training courses. Other lecturers suffering themselves from quadriplegia participated also on the development of the training materials and on lectures with their specific knowledge of the specific needs of course participants.

It is our great satisfaction, therefore, that all course endings were not simply an end of course, but there always was a bit of nostalgia as there is at the separation of good friends. That is why we try to keep these contacts for the future. Before Christmas 2011 we organized a meeting for all participants of our courses. Almost all arrived and we were lucky enough to see on our own how in a very positive atmosphere a new community of people randomly joined by the Rainbow Bridge project was emerging. When we talk about the community, let us add that our participants used this opportunity to exchange their email addresses and telephone numbers with a determination to remain in contact with participants of different courses.

Rainbow Bridge is a project to use

We also put an effort to provide the necessary technical consultation after the end of our courses. Many of our participants received a financial support for buying quality laptops (essential for voice technology) from municipal authorities after our intervention. We also try to help them during the search and negotiations for a suitable job. We employed one of the participants of the pilot course as an additional lecturer of voice control of PCs, another participant found a new job in the archives of the municipal office and as soon as the National Gallery in Prague provides a barrier-free access, she will start working there. Some participants have already earned their own money by rewriting hand-written texts.

One participant after the course got a regular employment as legal counsel in a well-respected high school in Prague, two other participants work on a research project at the technical university of Liberec and the company Newton Technologies on voice technology. After two years running the project Rainbow Bridge we can state that we succeeded in helping 10 handicapped people who had already been categorized by the labor authorities as not being employable due to the nature of their disability. In the ensuing years we will prove that regular employment for such people can be found. Therefore we are at the process of establishing a social company, having a business plan which is based on getting orders where voice technology can economize the cost.

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A Guide System for the People with Handicap at Public Facilities in Normal and Emergent Situation: a Case Study at Kagoshima City Aquarium

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1 Introduction

The exhibitions at an aquarium or a museum are to be "shown". However, many blind or deaf-blind people are tend to come there recently. They say they can enjoy them without seeing unless there should be some guides, touchable exhibitions and explanations in precise. Their comments have made us notice their needs which we have been unaware of. There is a recent idea named "Universal Museum" in which they provide touchable exhibitions.

An aquarium, being different from a museum, has a certain limit to offer touchable exhibitions. It should be better to ask those people directly how they can enjoy them.

We must consider, on the other side of welcoming those people, of a guide system for evacuation at an emergency as much as regular guide maps or exhibitions. The present system of broadcasting announcement and the guides by the staffs would not be proper for them.

We should offer information through terminals as mobiles , rental PDA and others, tactile maps, braille pamphlets for the blind, and for the deaf, signing and texting. Another problem is how to deal with the evacuation of the wheel chairs at an emergency when all the elevators and escalators stopped.

It is a big problem that those customers are coming everyday without any measure and it is common to all the aquariums and museums in Japan. This paper is a proposal of resolution system using electronic communication tools from a human- interface viewpoint. We take Kagoshima City Aquarium as a model case and we hope it will contribute to decrease the rate of victims of those people who need help at an emergency.

2 Background

As for the measures of evacuation for those who need help such as the handicapped or aged people in Japan, almost all of them are for a natural disaster like an earthquake, a tsunami, or a typhoon. The measures of evacuation from a house or from a building are for those without handicaps, and there are only a few researches for a nursing home for the aged.

Emergency Evacuation Planning Guide for People with Disabilities by National Fire Protection Association [1], USA is opened to public, which is further advanced in this field than that of Japan where we have no law like ADA. However it is not directly applicable to Japanese society because the notions and definitions of disability and cultural background are different from them.

3 Research

3.1 Making an evacuation manual for those who need help

These are the steps to make an proposal of the manual in the closed situation like inside of a building.

1. Experiments: Asking them to participate the experiments in the real situation of the exhibitions and also a fire drill in order to point out the problems. To prepare for the unforeseen accident in the experiment, we would provide helpers and supporters and should take some advices in advance from the organizations of those people. Repeated experiments by a few people must be necessary considering a danger of a mass at the same time.
2. Making: Specializing for KCA, checking the evacuation manual in the USA above and some evacuation manuals in Japan as a base.

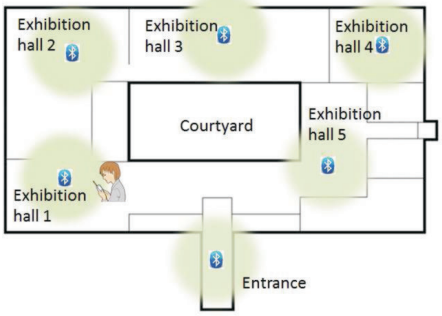
3.2 Designing an Evacuation Guide System

1. Customer's Location Estimating System: It is important to know where the customer is at an emergency. Our system estimates the present location of the customers using the customer's mobile with the Bluetooth devices in many places. The GPS system in the mobile, Skyhook Wireless [2] or Place Engine [3] is not sufficient for the closed area in a building, and a new system is needed.
2. Self-Guide System for the people with handicap: Even if we offer a customer a free mobile internalizing the location estimation system, they would not appreciate unless there is some additional value. We would offer them some applications to explain the exhibitions by voice or sign language automatically, using the location estimation system. The customer can enjoy it in an ordinary situation. Moreover for the hearing disabled people, they wear a head-mounting display and see the sign language guide through watching an exhibition or a dolphin show.
3. Emergency Announcement: At an emergency, pushed announcement would be inserted in the guide system, using sound and vibration altogether for the blind and the deaf customer. Their present locations are informed to the administration office and they would indicate them the evacuation route immediately.

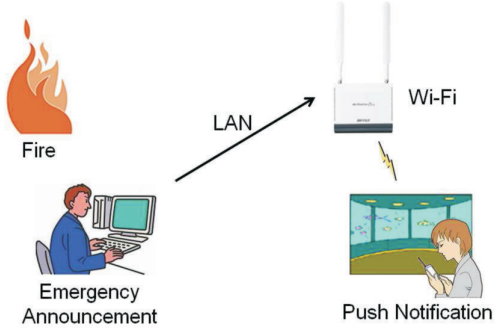
4 In the Future

Some demonstrative experiments have been done, although the results are under analysis. This report is specialized to an aquarium but we hope it will be generalized to the museums and other facilities. We regard the evacuation manual for the people who need help or support as a universal matter.

We hope we will be able to advise an aquarium, a museum or a gallery throughout our country or the world. We supposed people with handicap and the aged who need help in this paper but the foreigners must be included in a real situation since they have the same communicational problems as the handicapped people do. We excluded the foreign language here because we anticipated the problems which language to take besides English, and that of an accuracy of translation. We notice our system is applicable to it in the future to adopt the global interest of sightseeing.



[Fig. 1] Location estimation system using Bluetooth.



[Fig. 2] Emergency Announcement System.

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e-Learning Services for Persons with Disabilities on a Web-Accessibility E-learning Platform in Taiwan

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Keywords: Digital participation, Web accessibility, e-Learning for disabilities

Abstrakt

Digital participation is a basic human right for modern citizens; however, the digital division still bars people with disabilities from participating in the digital society and e-learning environment. The government in Taiwan has made many efforts to construct the Web accessibilities and focus on developing accessibilities for e-learning environment. To improve the digital participation and enhance disabled citizens' computer skills, it is necessary to develop multiple solutions for their e-learning needs. We have provided e-learning services for persons with disabilities in Taiwan. Our e-learning platform provides web accessibility functions according to the web accessibility guidelines established by the government in Taiwan. This study is to discuss the needs for persons with disabilities and to explore whether they can apply information technology to participate in digital learning.

1 Introduction

Information technology plays a significant role in our daily life. It can also assist people with disabilities to participate in educational, vocational and other daily activities in a variety of ways [1, 2, 3]. In recent years, several developed countries have devoted to constructing the Web accessibility with the purpose of promoting the e-learning environment for persons with disabilities. For example, there has been the push by the U.S. Department of Education and technology leaders to integrate technology with teaching and learning in schools. The plan noted the persons with disabilities also enjoy the equal chance to use IT or digital learning [4]. Additionally, the "Section 508" in the U.S. with Disabilities Act mandated that all students have accommodations or access to use online resources. In Europe, the e-Europe action plan developed by European Union pondered

as well the demand of digital participation for the persons with disabilities in order that they can access information and take full advantage of the information society.Additionally, the "Section 508" in the U.S. with Disabilities Act mandated that all students have accommodations or access to use online resources. In Europe, the eEurope action plan developed by European Union pondered as well the demand of digital participation for the persons with disabilities in order that they can access information and take full advantage of the information society.

Taiwan government proposed "Taiwan Digital Archives Expansion Project" in 2002 and the reactive plan of digital learning included "e-learning for all" and "narrowing the digital divide" and other projects. These projects have set up a high-quality digital learning environment. In order to minimizing the domestic digital divide, RDEC (Research Development and Evaluation Commission Executive Yuan) referenced from international standard WCAG 1.0 (Web Content Accessibility Guideline) to make the Accessible Web Development Guidelines (AWDG) in 2003. RDEC also drew up the policy and schedule to advance the Web accessibility of the government's websites. Taken as a whole, the government in Taiwan has obvious attention these issues on the policy. However, the improvement of Web accessibility and the accessibility for persons with disabilities is only providing the basis of accessing of the public information; it is still not enough for persons with disabilities to participate the digital learning.

Digital participation is a basic human right for modern citizens in most countries. In order to improve the digital participation for persons with disabilities, it is necessary to develop multiple solutions for the needs of disabled. In Taiwan, we have developed the initial Web-Accessibility e-learning solution for persons with disabilities[6]. Our solution introduces an integral concept which allows people with disabilities to take part in e-learning more easily. It includes Web-Accessibility elearning platform, Web-Accessibility e-learning courseware and Web-Accessibility tutoring services. In Web-Accessibility elearning platform, it should be able to offer universal keyboard operations and conform to the web accessibility standard. In Web-Accessibility e-learning courseware, it needs to consider demands of each disability learner in their browsing operations and cognitive learning. In Web-Accessibility e-learning tutoring services, it should be able to assist each disability student to exclude learning disorder and guide them to adaptive learning [5,6].

The purpose of this study was to promote the information access for persons with disabilities and to explore whether they can apply information technology to participate in digital learning.

2 Methods

The methods of this research are as following:

2.1 Participants

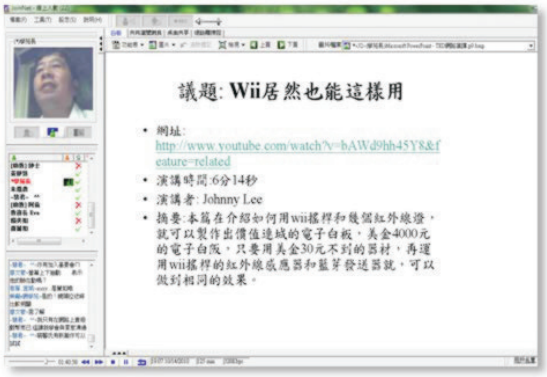
There were 402 participants with a variety of disabilities, ranging from physical disability, visually impaired, hearing impaired, psychiatric disability, etc. accessed in Web-Accessibility elearning platform.

2.2 Instrument

The Web-Accessibility e-learning platform was adopted to conduct the experiment. In this research, the Web Accessibility Validation Service established by RDEC in Taiwan was used to identify e-learning platform's accessibility functions. Machine identify results showed that the platform conformed level "double-A" to Accessible Web Development Guidelines (AWDG).

In terms of Web-Accessibility e-learning courses, there were 6 subjects (basic computer, basic office, advanced office, webpage design, pre-career introduction, proficiency Skill Test) set up in the Web-Accessibility e-learning program. Each virtual class includes 2~7 subjects and each subject had more than 1hr courseware. And the development of e-learning courses was based on ADDIE model [5].

For Web-Accessibility e-learning services, the project provided e-tutor services for asynchronous e-learning. In addition, our services also held a synchronous discussion seminar using teleconferencing platform called Joinnet for each class; each seminar lasted more than 90 minutes (see Figure 1).



[Fig. 1] Synchronous discussion seminar.

Besides the research instrument described above, in order to realize the effect of e-learning for the participated learners, the researchers designed the 5-point Likert-type scale questionnaire, the survey namely "The Web-accessibility e-learning for digital participation". The questionnaire surveys the satisfaction of participants regarding e-learning materials, user interfaces design, learning services, and learning performance. If members filled out questionnaire with high score, it reflected better satisfaction.

3 Results and Discussion

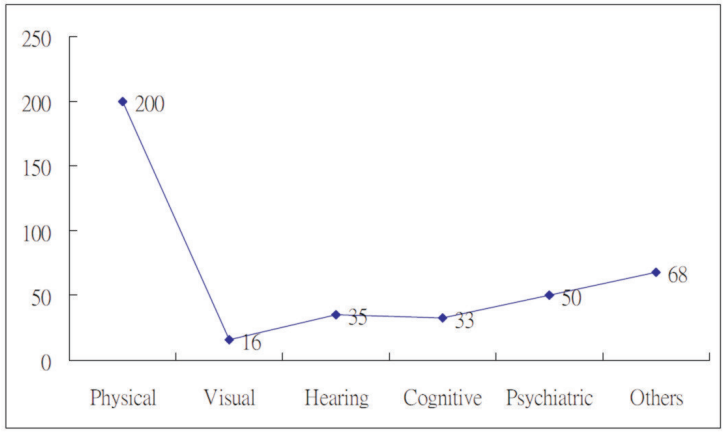
The data analysis of digital participation for persons with disabilities on a Web-Accessibility e-learning platform is as following:

3.1 Data analysis of participants

The e-learning platform served 402 participants with a variety of disabilities in this study. As shown in Figure 2, approximately 50 % of the participants were physically disabled, and the remaining ones were visually impaired (4 %), hearing impaired (9 %), cognitive

disability (8 %), psychiatric disability (12 %) and others (17 %).

There were 6 classes set up in the Web-Accessibility e-learning platform. The participants of novice would enroll the basic classes and the advanced learner would enroll in any classes. Table 1 shows the participants enrolled in each individual e-learning class. The number of participants enrolled in webpage design class was the largest. The number of participants enrolled in Skill Test class was the least. Notably, Skill Test class for certificate required mastery learning and proficient skill, so only a minority of the participants enrolled.



[Fig. 2] Participants enrolled in Web-Accessibility e-learning.

[Table 1] Participants enrolled in each e-learning class

Disability/ Course	A	B	C	D	E	F	Total
Physical	82	52	71	115	44	8	372
Visual	5	3	5	6	7	2	28
Hearing	15	13	12	20	4	3	67
Cognitive	10	4	9	8	10	2	43
Psychiatric	19	12	17	24	13	0	85
Others	29	18	30	31	19	1	128
Members (n)	160	102	144	204	97	16	723

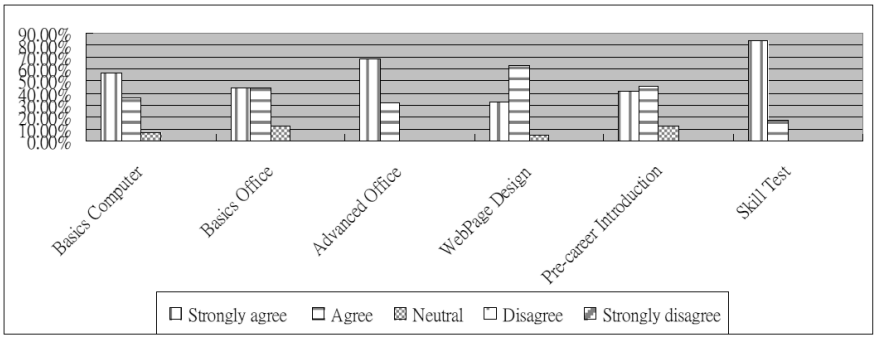
Note: Classes: A (Basic Computer), B (Basic Office), C (Advanced Office), D (WebPage Design), E (Pre-career Introduction), F (Skill Test)

3.2 Data analysis of questionnaire

'The Web-accessibility e-learning for digital participation' questionnaire enabled us to verify that the effect that participants carried on e-learning. Data analysis of participants responded to the questionnaire is as following:

3.2.1 Satisfaction of participants in content materials

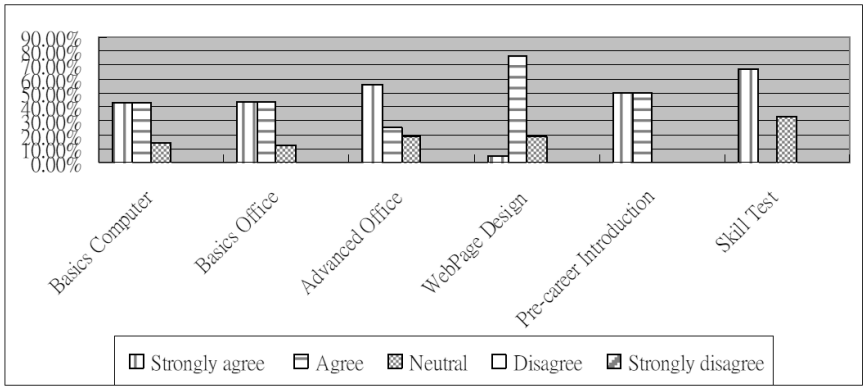
As shown in Figure 3, Over 85 % (strongly agree and agree) of the participants satisfied with the teaching materials of courses and teaching or response from the professional instructors by the Web-Accessibility e-learning platform. The results reflected the majority of participants were satisfied with learning materials.



[Fig. 3] Satisfaction of participants in content materials.

3.2.2 Satisfaction of participants in user interface

Each class had over 80 % (strongly agree and agree) of the participants satisfied with the user interface design and the stability of the Web-Accessibility e-learning platform except Skill Test class. Only 66.67 % of all respondents in Skill Test class strongly agreed that they were satisfied with user interface, but 33.33 % of them remained neutral (see Figure 4). One explanation of this was that only a few of the participants enrolled in Skill Test class and it affected the questionnaire results.

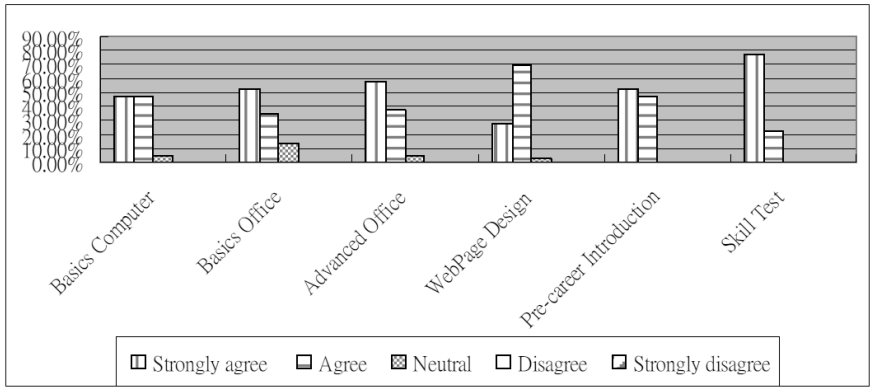


[Fig. 4] Satisfaction of participants in user interface.

3.2.3 Satisfaction of participants in learning services

Almost 87.5 % stated that they were satisfied with the service of the Web-Accessibility e-learning platform, the quality of service of the e-tutor in each class and the service of the toll free customer service line. The results had been very positive and it was also had implications for those conducting researches on participation of persons with disabilities

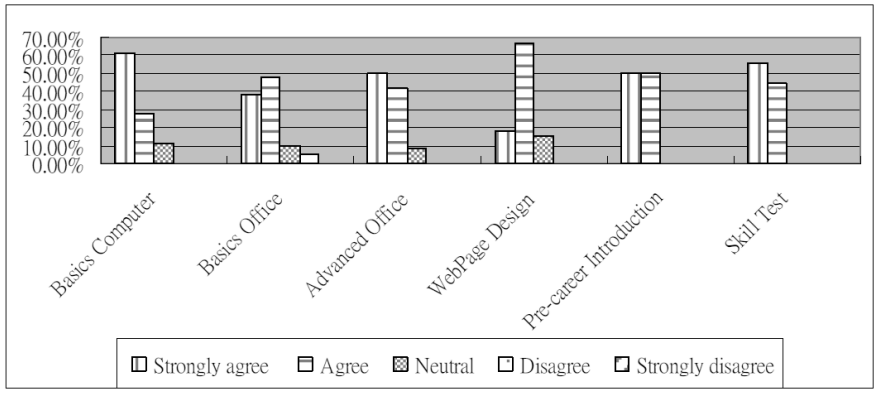
in digital learning. Probably the key drive for persons with disabilities to participate digital learning is the fact that we provided well e-learning services.



[Fig. 5] Satisfaction of participants in learning services.

3.2.4 Learning performance of participants

After participating in the Web-Accessibility e-learning, it was also largely agreed (85 %) that they were satisfied with their own learning results and knew more characteristics and advantages of digital learning. Otherwise, most of them agreed that e-learning was far more effective than traditional teaching in improving the learning results.



[Fig. 6] Learning performance of participants.

4 Conclusions and Recommendations

E-learning has become the major trend of the development with regard to education reform. With the construction of the digital environment, availability of multimedia materials and the quality of good services, the chance for persons with disabilities to participate in e-learning is being offered. Over the past years, the focus of assisting persons with disabilities in digital environment was related to computer access and the apparatus they needed. But more recently, the focus issue has shifted to reflecting the "digital participation" for them.

This research was based on Web-Accessibility e-learning platform to explore the digital participation for persons with disabilities. The present findings contribute to the field's understanding of the various forces acting on digital participation for persons with disabilities. Part of the results will depend on the quality of the instruction and materials delivered in the e-learning platform. Furthermore, the quality of e-learning services is another possible reason to support digital participation for persons with disabilities. This study should provide a descriptive basis for additional research.

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Measuring real accessibility

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Keywords: accessibility, web, visual impairement, measuring, guidelines, user testing

Application idea

Web accessibility means that people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web. The term "web accessibility" or "accessibility" in short, covers wide range of needs of people with various types of disabilities or handicap. It means people with health disabilities, users with too old or up-to-date equipment (smart phones, tablets, etc.), elderly etc. Needs of these groups vary and in some specific case are even opposing. Despite that fact, a lot of accessibility requirements are also very useful for all users – not only those with special needs – who could benefit from accessibility.

Using the term accessibility in general is than more rhetorical than corresponding with reality. Therefore we'd like to clarify that in our paper we focus on accessibility for people with visual impairment with all pros and cons, which this narrowing brings. We think that it's necessary to clarify what we mean when we talk about accessibility, which part of accessibility we focus on, which guidelines we try to follow, etc.

Most people also connect accessibility primarily connected with rules and guidelines. Of course, there are a lot of accessibility guidelines. Some of them (such as WCAG 2.0) are known and used all around the world. Guidelines are very useful for web developers because they contain techniques how to create accessible web. They can also be used to evaluate whether a web page is inaccessible. Unfortunately, none of them is able to tell us if the web page is accessible, or – even better – really accessible. But real accessibility is what users really need – not conformance with guidelines.

In this paper, we would like to show one possibility how to determine the **real accessibility of websites**.

1 Introduction

Accessibility is nowadays also often a part of laws. Risk of litigation, moral and political pressure force site owners, designers and developers to ensure that their sites are accessible. Very often they also need "a proof" of accessibility and they face the tasks of deciding what is the most efficient and reliable way of evaluating accessibility.

Accessibility is strongly influenced by a lot of factors and it's very short-sighted to narrow accessibility down only to technical factors – quality of HTML code and CSS, its validity, etc.

Other factors influencing accessibility are for example

- user disability (both health and technical),
- user knowledge of using web itself,
- used browser,
- used assistive technology,
- user knowledge of assistive technology,
- user preferences and habitual practices.

All aspects mentioned above have to be taken in mind if you want to speak about accessibility. **User-centered view and focus on user instead on technology and rules are much better and chime in with real aspects of accessibility**. Users aren't interested in compliance with guidelines. Their demand is simple – use the web and accomplish the task that they need in the easiest way.

Let's see typical internet banking. It is not fully compliant with any guidelines (e.g. WCAG 2.0), but people with disabilities commonly use it – because they need it and they have power tools (browsers and assistive technologies) and enough knowledge to do it. Other typical examples are social networks such as Facebook or Google+. Of course this couldn't be considered to be a proof that these sites are fully accessible and that using them couldn't make a lot of trouble to people with disabilities. But the fact is that in the real world they are able to use it and fulfill their needs. The question is how to learn the rate of real accessibility and the rate of discomfort.

Each webpage has its own main objective and this objective could be the key – if a person with disability is able to complete his or her task with tools which he or she has available, in way which he or she prefers, the website is accessible for him or her.

Unfortunately sometimes there's a problem that the webpage is so badly designed that this approach fails, but it's not a problem of accessibility, but of the webpage itself. Also demands of users could vary and each user could have a little bit different requirements.

On the other hand, **giving a definition and setting some rules and guidelines help web developers** to know what is best practice and learn the way leading to the true aim, because user-centered approach could be considered to be so vague, subjective and not so clear enough. And of course not every web developer has the possibility to do user testing with people with disabilities.

Accessibility metrics provide a valuable role in establishing the extent to which a web resource can be effectively used by people with specific access needs. Measuring accessibility should not be restricted to web pages; but rather the extent to which goals can be completed by disabled people relative to other members of the target audience. This can include alternative equivalent routes, using alternative online resources if necessary or alternative access means (e.g. screen readers or screen magnifiers). This definition of course contains more subjective, experiential issues, that may modify the apparent impact of a specific accessibility barrier – but real life isn't only black or white.

2 The R & D work and results

There are typically two approaches how to measure the web accessibility. "Conformance review" approach that relies on some checklist and "user testing" approach – some form

of user testing by people who have different disabilities and/or who rely on different assistive technologies.

Conformance review is a typical way of evaluation of web sites accessibility. In general, this involves someone with expert knowledge checking whether the site as a whole, or more commonly a selection of pages, comply with some guidelines (predetermined checklist of criteria) such as WCAG 2.0. This process is sometimes called "accessibility audit".

User testing is usually carried out by a group of users with different disabilities, and different levels of skill in using the internet and their required assistive technology. These users undertake a series of typical website tasks. Their actions are observed (and sometimes recorded) by the evaluator with the aim of identifying the accessibility barriers that may be encountered. Sometimes home testing, when users perform website testing from their own homes could be used. This means that testers use their own access technologies in the testing process and therefore exactly emulates how disabled individuals will be accessing your website.

Both approaches have their strength and limitations, and none of them can provide a reliable declaration about the accessibility of a site on its own.

Measuring **real** accessibility, or better – finding appropriate metrics and system, how to measure real accessibility – is a quite new issue. Especially in the Czech Republic, where commercial consultation agencies focus on conformance reviews only, because they usually have no possibility to do user testing with handicapped users. That's why they very often decrease the importance of user testing and strongly prefer conformance review only.

We would like to emphasize that we are not talking about compliance with some guidelines (e.g. WCAG 2.0), because these approach is outdone and we try to find a solution that is more realistic.

The Blind Friendly Web project, in which both authors of this paper are also involved, was founded by Czech Blind United in 2000 and since this year it has been dealing with the accessibility on professional level. This project was the first and the only ones in the Czech Republic that concentrate on so called real accessibility that considers not only meeting the technical criterions, but the real needs of the users as well. In 2006, TyfloCentrum Brno, o. p. s. started cooperation on this project and now is self running this project. TyfloCentrum Brno, o. p. s. is now the only in the Czech Republic that has got a team of visually handicapped testers who test the web accessibility actively.

At the very beginning of Blind Friendly Web project (about 2000) we had relied only on guidelined approach to the accessibility. After some years, when we often had met limitations of this approach, we started to **combine "guidelined" and "user-centered" approach**. Now our typical web accessibility test contains results of both approaches. Accessibility expert evaluates web for conformance with some methodology/guidelines and group of 6 users with various visual impairment undertakes some (3 or 4) typical website tasks.

This combination brings more realistic view on web accessibility. Users evaluate the possibility to fulfill their needs and the accessibility expert can find barriers that users aren't able to find – for example a blind tester isn't able to assess sufficient contrast of text and background color.

Our testing model unfortunately has one weakness, that we would like to "fix" – ideal user group should cover all (or let's say all major) groups of users with disabilities – not only users with visual impairment. But on the other hand – it's better to have one group of testers than none.

And it's also clear that this approach could not cover all the potential groups of users. But the wider the group is, the bigger is its impact.

Our solution for now is following. Accessibility expert in a specific way "stands in for" disabilities, that aren't covered in user testing, because guidelines are usually more general and cover needs of more than one group of disabled users.

3 Conclusion and planned activities

Based on our experience and despite the weakness mentioned above, the **combination of "guidelined" and "user-centered" view is now the best solution how to measure real web accessibility**.

We are planning to focus more on this topic and try to set up a methodology solving all the problematic aspects that were mentioned above. The biggest challenge now seems to be set the main objective of the page in such way that this

The second one is to educate and teach people that accessibility is not only the one that covers all needs of all users (it's an unreachable ideal), but that it's not a bad thing or a shame to cover needs only of one group of users from the whole target group.

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Teaching Languages Accessibly Using an Open Source Web-Based Tool

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Keywords: Xerte Online Toolkits, Xerte, accessibility, online, Leonardo, e-TALIA

Abstract

The primary theme of this paper is about using technology, Xerte Online Toolkits (XOT), which allows disabled students to have direct control over selecting their browsing preferences. It includes developing employment prospects for disabled students and the use of open educational resources for accessible practice. The use of the technology takes place within the context of a European project, Leonardo e-TALIA, founded on the transfer of innovation. The outcome of the project is the production of online language learning objects for people working in the hospitality sector. The technology used is Open Source and the objects will be available to all. This paper focuses on the transfer of innovation that takes place to enable the creation of the learning objects using XOT. Examples of the best aspects, some unique features and the limitations of the technology that were found during this process are discussed.

1 Introduction

Xerte Online Toolkits [1] (XOT) is an Open Source, award-winning [2] application that is used to build and publish web-based learning objects (LOs). XOT puts the disabled students in charge because it allows students to make their own adjustments on a variety of settings. These settings include font, letter size and contrast. Its page templates include narrations and related audio clips. The use of Xerte has been made easier by the addition of a user interface (the Toolkits).

The e-TALIA project [3] is a Leonardo [4] "Transfer of Innovation" project and has seven partners from six different European countries. The objectives of the project include building upon the innovative blended e-learning used in the coordinating institution and working collaboratively with European partners. An outcome of the project is to develop a set of online LOs that could be used for language learning in small to medium enterprises (SMEs) within the hospitality sector. A criterion for the LOs was that they were required to be developed using free or Open Source applications.

1.1 e-TALIA Project Stages

The first stage of the e-TALIA project comprised a literature review of the current situation of language and intercultural needs and the modes of course delivery for SMEs in hospitality. In addition, several partners carried out a customer survey to determine the needs of SMEs in the hospitality sector concerning training in language skills and intercultural awareness. [5-6]

Having determined the customer needs, the next stage was to transfer from the promoter partner (Coventry University) to the other partners some experiences in developing blended e-learning training. The partners' best practice would then be used in order to provide a training solution.

Having agreed on the appropriate technologies to use, the LOs were built and assembled into courses. At the time of writing, the e-TALIA LOs are being piloted by employees of SMEs in the hospitality sector. Results from these will inform the project of any amendments which could be made to the LOs.

The stage of the project that is reported in this paper corresponds to the transfer of innovation from the promoter partner. It describes how Xerte Online Toolkits was presented to partners who then used it to create their language LOs.

2 Work and results

2.1 Challenges

Some of the challenges associated with the transfer of innovation on the outset are highlighted here. The partners were distantly located: Poland, Germany, UK, Ireland, Spain, and Belgium. Two-day meetings were scheduled during the project but they were few and far between, so face to face time was precious.

The LOs that were to be produced were about language learning and inter-cultural differences. Language and cultural differences were also apparent during the meetings! The language of the meetings was English, but Anne was the only native English speaker. When we assembled for the first meeting, one cultural difference was clear: hugs from the Spanish partners, handshakes from the Polish.

The Polish partners, who were to create the LOs, were already experts in creating online learning for languages, but using their own preferred applications. So XOT needed to be presented to enable its adoption.

XOT does not have the high learning curve that Xerte alone has. It has a special user interface to enable the construction of pages of the LOs based on pages. However, as it is not a WYSIWYG (What You See Is What You Get) interface, it is not obvious to a new learner how a page is constructed.

2.2 Why Use Xerte Online Toolkits?

XOT is an Open Source tool, making it eligible for consideration in the project. XOT has templates that enable audio and multimedia which are useful creating for language LOs. XOT is continually being evolved and extended, for example in the Xenith project [7]. Finally, XOT has inbuilt tools to enable students to change settings according to their browsing preferences, emphasizing its accessibility.

2.3 Facing the Challenges

There are many resources that show people how to use XOT and some of these were compiled into a special XOT LO and made available to the partners. However, it was decided that a better solution would be to keep within the context on language learning and to display a set of examples that used XOT. The content of the examples was based on LOs

that had already been created and used by Rosario in her Spanish courses. Those LOs had been made using methods which were not free or Open Source, so were translated into XOT LOs.

Many different XOT templates were used. These reflected the content of the original LOs and also illustrated the way that XOT could use different media to make learning more accessible.

Having created a selection of LOs, the next stage was to help the partners learn how to use XOT. As the partners would most likely be adopting similar templates, it was decided to create screen capture videos to show them exactly how the templates were used and highlighting other features of XOT.

2.4 The XOT Examples and Accompanying Screen Capture Videos

Table 1 compares the times taken in the screen capture videos. It was intended that the videos would be viewed in order, so more detail was given to showing the features, editing and construction of the LOs 1 and 2.

[Table 1] Lengths of the examples constructed and their corresponding videos.

Example	Pages	Length of video (min)
1. Cultural briefing	3	5
2. Greetings	9	12
3. Appointments 1	16	3.5
4. Appointments 2	17	2

Some of the features of XOT used in the examples and videos are as follows:

- Embolden text by right clicking the text and choosing from the menu
- Assemble and view components of a multi-choice question from the template
- Observe that the users can choose the font from their own computers, text size, screen size and color scheme
- Timeline/Matching Pairs template
- Tabbed Navigator with audio template
- Gap Fill (as Drag Drop) question template
- Transcript Reader – this enables highlighting of the text that is being spoken
- Quiz template

2.5 Transferring Innovation

At a partner meeting, the LOs and some of the accompanying videos were presented. In addition, Anne sat with the Polish partner to deliver a one to one session. The turning point was unexpected: we explored a template called YouTube Feed which enabled the LO designer to put in a search term and the student would see an embedded list of YouTube videos that corresponded to the search term. They used it on several LOs, labeling it "Webquest", as an exercise to do after the main content.

The construction of the LOs has not been without its problems; there were difficulties in installation, thought to be due to linking XOT to a multi-user environment.

3 Impact

Results so far show that the Polish partners were able to create LOs that incorporated a variety of XOT templates and they have reported that XOT is a good solution to creating language learning objects, due to its accessible ethos. Demonstration courses comprising individual learning objects that were created using XOT are on the project's web site.

XOT has been introduced to people in five other European countries. The use of XOT's accessibility features has been successfully expanded for use within language learning.

Innovation has been transferred successfully and language and culture learning objects have been created using XOT. These can be developed further according to the feedback that would be received after the piloting stage of the project. It is envisaged that the learning objects could be incorporated within a Moodle course.

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The Use of Personas in the Design of an Arabic Auditory Training System for Children

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Keywords: Children, Design, Personas, Auditory, Learning difficulties, SpLDs, UCD, Usability Testing, Assistive Technology

1 Introduction

Children with Specific Learning Difficulties (SpLDs) provide much greater challenges to user-centered design than more traditional user groups [2, 3]. It is essential to encourage designers, who are often older and more technology-oriented, to develop a relationship with and empathy for, children with SpLDs to account for their needs in the design of interactive systems [3]. It is recommended that children with SpLDs be fully integrated into the design process. Researchers, however, need to take care to be sensitive to the different manifestations of learning difficulties, as well as the characteristics, sensory capabilities, and attitudes of children with SpLDs to computers and to being included in the design and development of interactive systems [3]. This paper emphasizes the impact of using personas in the context of a persona-driven testing and evaluation of an auditory training system designed for Arabic-speaking children with hearing impairments or SpLDs.

2 Personas in the design of assistive technology

Cooper has defined personas as "fictional characterization of users" [1]. Personas have been used to guide the creation of user profiles in interaction design [1, 4]. Moreover, personas have been shown to be effective in providing interaction designers with realistic ideas and grounded understandings of users throughout the design process [1, 6, 7, 8, 9]. Sadly, there are numerous misconceptions about what personas exactly are and how they are created [1]. But, Cooper's experience tells "the keys to being effective with personas are always the same," and that is by starting from the right research, identifying the behavioral patterns from the data, building personas around those behavioral patterns, and using them to drive almost everything about the rest of the process [1]. Designing a system for children with SpLDs is more challenging to system developers who may have misunderstandings or little experience in interacting with children with SpLDs, which may lead them to base scenarios on users similar in behavior to the developers themselves. Personas are more valuable to use in the design process for those systems [3, 10]. Moreover, creating personas for these children and users with other difficulties can promote the awareness of their needs in a lively, illustrative, and expressive way which builds empathy for the target users [3, 11]. However, the impact of using personas in the evaluation phases in UCD cycles has been inadequately examined.

3 Understanding users with SpLDs

Specific Learning Difficulties (SpLDs) is a term used to refer to difficulties in a student's ability to process information for learning and skills' development. Some types of learning, and tasks, may be easy, while others can be extremely difficult [12]. Auditory discrimination is considered to be a problem across a spectrum of SpLDs and not limited to only one. Technology solutions for these user populations include auditory rehabilitation programs in English such as AUDIX [13], Hearing your Life [14], Sound and Way Beyond [15]. The Arabic available programs are limited to Rannan [16] and Lucid Cops [17]. These programs often require trained professionals for effectively integrating them in rehabilitation programs and for monitoring progress. Anecdotal evidence from our field studies have shown that speech and language pathologists have inadequate technology support for auditory therapy programs for Arabic-speaking population, particularly in rehabilitation programs in the local dialects which are the spoken languages rather the formal Modern Standard Arabic (MSA). This has motivated us to design an interactive Arabic language program that is envisioned to extend rehabilitation therapy beyond clinics and to provide effective solutions for improving auditory skills of individuals with auditory discrimination difficulties in home environments.

4 Sada

Sada is an Arabic auditory training system which consists of games that aim to improve auditory discrimination skills for children with auditory related problems. These training skills are needed across a wide spectrum of disabilities and disorders and not limited to a specific user group. The concept of our software is considering a breadth-first approach in addressing the needs of Auditory Rehabilitation by focusing on one skill across disabilities rather than a depth-first approach that focuses on multiple skills aimed at one disability. This approach is depicted in Table 1.

[Table 1] Skills which need improvement for each difficulty/disorder

Skill	Cochlear implants	ADHD	Dyslexia	APD	Autism
Visual Attention		✓			✓
Auditory discrimination	✓	✓	✓	✓	✓
Auditory Attention	✓	✓		✓	✓
Phonological Processing			✓	✓	
Language processing			✓	✓	✓

The system is comprised of games designed in local dialects and in Modern Standard Arabic (MSA). Target user populations include children with cochlear implants, Atten-

tion Deficit/Hyperactivity Disorder (ADHD), dyslexia, Auditory Processing Disorder (APD) and autism. A User-Centered Design (UCD) approach was adopted. In this project, domain experts, children, and caregivers were included in the requirements' discovery, design, and evaluation phases. Based on the design team's understanding of the characteristics and needs of each type of target users, a persona was created for each user type in the design phase of the system in a data-driven approach [7]. Involving children as design partners was not feasible due to the constraints of the project. To account for individual differences in testing, personas were used as aids for designers in the design phases. Moreover, these personas were again used in planning for usability testing of the system and in the analysis of the usability testing results.

5 Personas in the design phase

Creating personas for each category of target users, has helped in designing the system with a clear image of the child-user in the minds of the design team by focusing on the limiting characteristics and accessibility needs as noted by Lawton [5]. This in turn, led to produce a user-specific design involving the profile characteristics of each child users and their adaptive strategies in using technologies in different aspects of the design (e.g. visual design of the interface, modality, and difficulty levels of games). For example, the interface and pace of the games were designed to allow configuration and customization by end users with default settings adapted to each user category's needs. The characteristics of each category of target users used in creating personas are described in Table 2. Personas were validated by domain experts in SpLDs and Speech and Language Pathologists.

[Table 2] Characteristics of target users used in creating personas

Case	Characteristics Relevant to the Design of Sada	Refs
Children with cochlear implants	• The ability to listen and distinguish between sounds is low. • Difficulties in listening to a specific sound for too long.	[18]
Children with ADHD	• Variability in manifestations – Inattentive, but not hyperactive or impulsive. – Hyperactive and impulsive, but able to pay attention. – Inattentive, hyperactive, and impulsive (the most common form of ADHD). • Attracted to bright and energetic colors.	[19, 20]

Children with Dyslexia	• Reading skills are one/half grade or more below grade level. • Difficulty with Language processing. • Inconsistent listening comprehension. • Often associated with attention/concentration deficits. • Some font types are harder to read than others.	[21, 22, 23]
Children with APD	• Have trouble paying attention to and remembering information presented orally. • Have problems carrying out multistep directions. • Have poor listening skills, and need more time to process information. • Have low academic performance, or behavior problems. • Have language difficulty such as in reading, comprehension, spelling, and vocabulary.	[24]
Children with Autism	• Have difficulty communicating with speech or with gestures. • Have difficulty understanding what others are saying to them. • Show interest in very few objects or activities and play in repetitive ways.	[25]

6 Personas in the testing phase

In the testing phase, our personas were mapped to real users with similar profiles. Evaluations were conducted with a sample of five children with SpLDs in a local public school. Two of those children had ADHD, another two had Dyslexia and the last one had a learning difficulty which was very similar to the difficulties experienced by children with cochlear implants based on the assessment of the SpLD specialist. Planning for testing sessions was facilitated using personas by which tasks for each class of target users were determined based on the characteristics of each persona. During each testing session, in order to complete each task, participants have been noted to interact positively with the system. In testing sessions, the observational analysis was guided by the characteristics described in the matching persona. For example, the case for the child with ADHD, we drilled down in design considerations relevant to visual appearance of the interface, engagement in the games, and inattentive behavior in certain parts of the tasks.

Using persons has proven to be a very effective approach in planning the evaluation for the design team, facilitating the testing and evaluation processes in terms of accom-

modating user needs in the session and analyzing the findings from these usability sessions in post-session analysis. That was apparent throughout the process in which testers were matching intuitively each of the personas with the children participating in usability testing sessions.

7 Conclusion

Using data-driven personas in both the design and testing phases of Sada was effective in supporting the design team's understanding of target populations with considerable individual differences. Validating the personas with domain experts was effective in supporting the utilization of personas in usability evaluations with real users. This project contributes with insights into the integration of personas in UCD cycles and addresses the limited understanding of the efficacy of this approach and adds to the research available on utilizing personas in the evaluation of assistive technology for children.

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Approaches to Creating E-learning Educational Tools Reflecting the Students with Special Needs

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Abstract

In spite of support and a series of measures concerning the integration and inclusion of people with special needs they are still many people who, due to their specific needs, are socially excluded and suffer a lack of opportunities to participate fully in the life of the majority society. Number of persons with special needs is almost 10 % of the population of the European Union. It is clear that even a group of university students will contain a significant minority of students, for which is needed to respect their specific needs. The question is whether this really happens and whether universities offer students with special needs suitably adapted forms of education. One of the modern forms of education is definitely an e-learning, which is more and more integrating into ordinary school life. It looks important that even this form of education has to reflect a group of students with special needs. Presented article is analysing the field of educational tools used in e-learning from the perspective of evaluation of their characteristics and quality, especially in terms of their ability to evaluate specific tools suitable for students with special needs.

1 Introduction

In Europe, a consensus was reached upon the use of a unified term of e-learning, which, according to the information at the e-learning portal for Europe Elearningeuropa.info, is understood as the *application of new multimedia technologies and the Internet in education, in order to improve its quality by enhancing access to resources, services, the exchange of information and cooperation* (Simonova, 2010).

According to this definition, e-learning covers not only a wide range of tools that are used for the presentation or the transfer of the educational content and for the management of studies, but also an entire spectrum of communication channels. The tools are used via LMS (Learning Management System), which is a prerequisite for the implementation of a truly effective learning process through e-learning. LMS thus represents a virtual 'classroom' environment comprised of tutorials, quizzes, study instructions, exercise plans or discussion forums (Mauthe, Thomas, 2004). Apart from LMS, properly structured and didactically adapted educational texts, *referred to as e-learning supports* (Paulsen, 2003) contribute significantly to the implementation of e-learning. To get a clear and permanent definition of the term, it is therefore necessary to focus on the structure and the arrangement of individual elements that such a teaching material is composed of. Study materials for distance learning, in both classical form and the form of e-learning, have gradually evolved from textbooks. In terms of the text structure, a classical textbook (Möhlenbrock, 1982) is composed of two basic components, i.e. text components ('writ-

ten text') and extra textual components (graphical components). It should nevertheless be noted that e-learning supports have their own unique characteristics as they are intended for a particular form study, characterized above all by a higher level of independence and individuality (Bates, Poole, 2003). A characteristic feature of thus structured electronic study supports designed for e-learning is the fact that their nuclear structure is enhanced by various interactive and multimedia elements, i.e. animation, multimedia records, dynamic simulation, sound recordings, etc.

Modern information and communication technology therefore able to offer students with special needs educational tools, that can help them in overcoming the difficulties arising from their special needs. The interest of teachers and students is more frequently focused on the educational content, which is not just the text and static image information, but also the dynamic image information, animations, simulations, or even the virtual reality (Marešová, 2009). According to the changing form of educational content and its structure, it is also necessary to change used tools and evaluation strategies by which the educational content and its structure is evaluated. If there is a possibility or an intention that the educational tool will be used in the education of students with special needs, it is needed to extend also the valuation of this area. The following text will describe currently the most commonly used approaches to evaluating e-learning training courses namely from the perspective of readiness to evaluate specific tools suitable for students with special needs.

2 Current attitudes to evaluating e-learning courses

Conventional approaches to evaluation of training courses (at the time also known as "training programs") based on Kirkpatrick the 4th level model. The four level model of educational evaluation were later reworked and in the year 1993 updated in the book called Evaluating Training Programs: The Four Levels (Kirkpatrick, 1998). The current system of evaluating the effectiveness of e-learning courses is based on the basic postulate of distance education, that the education is education of adults and can therefore be applied only in the corporate sector but also in the tertiary sector and lifelong learning (Bednaříková, 2008).

Other systems are based on a qualitative concept of evaluation, for example in the European quality promotion policy, which the European Commission launched in 1994. The concept of total quality management – Total Quality Management – (Blecharz, Zindulková, 2005) is based on the business field, but is also applicable to the university education. Thanks to projects such as the e.g. SEEQUEL, there are already existing Conceptions of quality in e-learning (Seequel, 2004) or the General framework for quality in e-learning (Anderson, McCormic, 2005). The quality management system is gradually constituted.

There are also questionnaires for assessing e-learning from this perspective (e.g., Quality on the line: benchmarks for success in Internet-based distance education, project SEEQUEL) and some are even from Czech location, e.g. Evaluation Standards of Faculty of Economics of West Bohemia in Pilsen (Eger, 2005). This attitude to the evaluation of e-learning is based on the overall results of comparing the effectiveness of education and identifying, regardless of the qualitative aspect. It looks at the whole process of education

as a single entity and does not differentiate the own educational process, its phases, the arrangement and structure of learning content or its form. Neither of these evaluation systems does not reflect needed groups of students with special needs and does not contain adequate tools for assessing the quality from this point of view.

3 Current attitudes to evaluating learning materials for e-learning

Another attitude in the evaluation of e-learning (with which the authors of this article identify) is based on the fact that it is also possible to assess and evaluate the individual building blocks of e-learning. One of these basic pillars there are the e-learning study texts with a high rate of use of multimedia and simulations, which are nowadays beginning to use cyberspace and the virtual reality. Even in this attitude to the assessment e-learning there (both at home and abroad) has been done a number of studies and carried out research investigations focused on the quality of standards of e-learning components. There is very interesting work of M. Simonson, S. Smaldin, M. Allbright and J. Frydengerg (Frydengerg, 2002). From the Czech production can be mentioned the publication of Květoň K., Koníček L., Bauerová D. (Bauerová, 2007), E. Mechlová, J. Šarmanová and M. Malčík (Mechlová, Šarmanová, Malčík, 2008).

Even though these concepts of evaluation of e-learning study texts are very relevant and balanced, we must say again, that neither of these evaluation systems does not reflect the target group of students with special needs. According to this article authors' opinions it is necessary to make an appropriate assessment tool that would eliminate this deficiency.

4 The procedure for drawing and verifying the e-learning study supports' assessment system

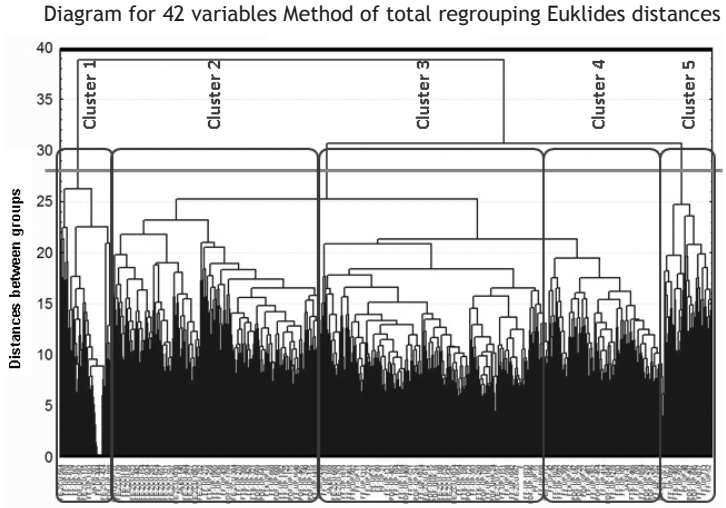
We can say that during the analysis of existing systems for evaluating electronic learning texts, we did not find totally adequate system that would be effective for the quality assessment in practice. Because of this, we have defined theoretically and on the basis of realized education research verified a new system for evaluating electronic learning texts, which allows a wide application of all necessary aspects of evaluating. There are also some links to support management systems or control systems during the study, which in conditions of distance learning are implemented by LMS systems (Klement, 2010).

The theoretically drawn evaluation system was subjected to a statistical analysis aimed at the verification of the main assumption of our research that *the proposed system of the evaluation of educational materials for distance learning and e-learning can be divided into six basic groups of evaluation criteria*. This assumption was subjected to a proving process based on the use of multivariate (multidimensional) statistical methods, cluster and factor analysis (Klement, 2011). The research sample for this survey consisted of 1625 students from eight tertiary institutions within the framework of the Czech Republic, who have experienced training through e-learning. For the research sample structure see the Table No. 1 below.

[Table 1] Structure of the research sample

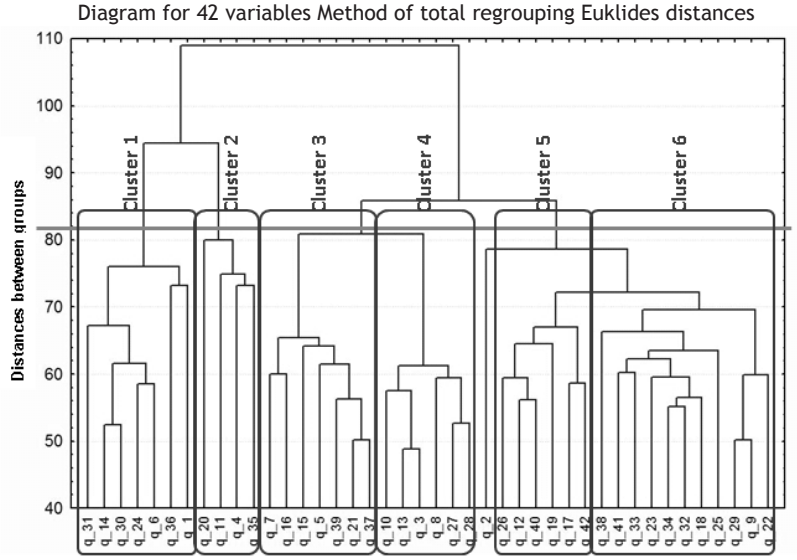
Structure of the research sample n = 1625								
Tertiary institution	Respondents				Age range			
	students approached	students engaged	of which women	of which men	15–30	30–45	45–60	Not stated.
Cyril and Methodius Faculty of Theology, Palacky University	108	31	17	14	18	7	4	2
Faculty of Economy University of West Bohemia Plzeň	1148	417	323	94	374	24	4	15
Faculty of Physical Culture, Palacky University	571	109	45	64	81	16	4	8
Faculty of Arts, Palacky University	2045	698	465	233	216	189	257	36
Justice Academy, Kroměříž	247	23	11	12	14	8	0	1
Faculty of Education, Palacky University	2008	287	205	82	200	58	13	16
Faculty of Education, University in Hradec Kralove	39	32	24	8	2	17	13	0
Faculty of Law, Palacky University	77	28	17	11	15	10	1	2
Total	**6243**	**1625**	**1107**	**518**	**920**	**329**	**296**	**80**

The first step in the verification of the above-mentioned research was the implementation of the cluster analysis, which helped to analyze the assessment of individual evaluation criteria by the respondents. The result of this analysis is shown in the Graph 1 below.



[Graph 1] Cluster analysis of the assessment of particular evaluation criteria by the students

The outcomes from the above mentioned cluster analysis showed that following the degree of similarity of their responses as regards the assessment of particular criteria, students fall into 5 basic categories. Therefore, we performed another cluster analysis focused on whether it would be possible, in a similar way, to classify the actual evaluation criteria into 6 groups, according to the research assumption set-up. The outcomes from this phase of the cluster analysis are shown in the Graph 2 below.



[Graph 2] Cluster analysis of the assessment of the evaluation criteria

As shown in the graph above, it was really possible to classify the evaluation criteria into six groups, i.e. areas of assessment. The claim was subsequently substantiated via yet another analysis, the factor one this time. It made use of a number of eigenvalues superior to 1 as a means for the determination of extracted factors, thus achieving the value of 6, which again corresponded to the research assumption mentioned above. For the outcomes from this phase of the factor analysis see the Table 2 below.

[Table 2] Eigenvalues and the percent of variance illustrated by factors

Factor	Eigenvalues; Number of variables – 42 *Extraction: Main components; Rotation: Normalized varimax*			
	Eigenvalue	**Total variance (%)**	**Cumulative eigenvalue**	**Cumulative variance (%)**
1	9,55567	22,75162	9,55568	22,75162
2	6,01052	15,16792	15,5662	37,91954
3	3,20373	8,29462	18,76993	46,21416
4	2,16622	5,72911	20,93615	51,94327
5	1,34233	3,19602	22,27848	57,67238
6	1,26789	3,01879	23,54637	60,69117

As the six extracted factors explain for 60.69% of the total variance of the assessment, it was possible to claim that the set-up research assumption could be accepted and the proposed system of the assessment of electronic study supports ascertained (Klement, 2011).

5 Proposal for an evaluation system of e-learning study texts reflecting the students with special needs

The results were processed using multidimensional statistical methods of cluster and factor analysis. On the basis of the research we have shown that there are 6 main fields of evaluation, each containing three to five the most important evaluation criteria (a total of 42 observed characteristics) necessary for the relevant assessing of properties of e-learning study texts:

- The criteria focused on the student's personality (psychological aspects).
- The criteria focused on student learning (educational aspects).
- The criteria focused on educational content and its form (multimedia, visualization, abstraction).
- The criteria focused on the specifics of e-learning tools (the element character of e-learning).
- The criteria focused on the technical aspects of e-learning.
- The criteria focused on the ergonomic aspects of e-learning.

Even though we have to prove a proposed system for evaluating electronic study texts using the statistical methods, we have to say again that methods of this system does not currently reflect the target group of students with special needs. In another research work we want to fill this gap and extend the evaluation system to include tools for assessing the quality of e-learning study texts, even if it is intended for this group of students. System structure will therefore be extended to another field of criteria:

- The criteria focused on consideration groups of students with special needs.

It is already clear that this field of evaluation criteria will continue to be divided in more detail on the criteria of the target group reflecting hearing and visual disability (physical disability, psychical illnesses and mental disability are not resolved at this stage). Definition of observed characteristics and their verification on the basis of statistical methods is the main focus of further research work of the authors of this article. In connection with this there is an intention to create a national (Czech) or international team of experts who would be involved in this research, both on theoretical and application part. This article is thus also a challenge to all those interested in cooperation.

Within the framework of target group of students with hearing disabilities the research will be primarily aimed on identifying the various elements of didactic e-learning study materials for distance learning and recognition of their importance for students with hearing disabilities. It would be needed to take care about the internal heterogeneity of the community of people with hearing disabilities, between on the one hand people are deaf or hearing impaired post-lingual (with acquired deafness), which are the users of the natural majority language, on the other person pre-lingual severely hearing impaired (deaf), which are native users of sign language. Due to the limitation of language compe-

tence pre-lingual deaf in the national majority language, makes these people considerable difficulties in the current study materials. Even the standard distance learning texts are in their character, graphic and typographic treatment, as well as using and evaluating of interactive elements themselves for deaf readers more appropriate, however, there opens the question of whether it is possible some of the components of distance learning texts further develop and adapt to specific needs of deaf students (eg. reinforcing the importance of an overview of key terms and extend their interpretations, the explanatory of foreign terms, etc.).

In the case of the target group of students with visual impairments should be, apart from a group of students with hearing impairments, particularly focused on typography and technical proceedings of distance learning texts. Even if this target group is necessary to take account of the various categories of persons with visual impairment (from partially sighted people across people with disorders of binocular vision to the people almost or totally blind) and their specific needs. Classical text structuration using marginal and distant icons located on side of the page seems to be inadequate when a blind student uses to view contents of his computer the voice output (screen reader), as well as inability to recognize content of graphic and picture symbols included in the text (diagrams, drawings, photographs, graphs, etc.). The aim of the research will again identify all potentially problematic elements of distance learning texts and experimentally verify the optimum method of substitution.

6 Outline of a way to test the proposed system for evaluating of e-learning study texts reflecting the students with special needs

Extended evaluation system described above will be subjected to statistical analysis aimed at verifying the research premise: "the system of evaluation of educational materials for e-learning can be divided into 7 basic groups of evaluation criteria." This premise we will prove using the multivariate (multidimensional) statistical methods, cluster and factor analysis. The evaluation will be performed with quantitative methods, and as the default research method will be used the factor analysis (McDonald, 1991). Another research method to be used in verifying the evaluation systems is the cluster analysis (Pecáková, 2008).

There is a presumption that the research sample of this survey will be the group of students with special needs from Palacky University in Olomouc, who have completed training in the full-time and combined forms of study using LMS Unifor through using the educational materials intended for e-learning. We think, however, that to ensure really valid results, it is necessary to verify our assumption in the wider research sample, so we are fully prepared to accept any offer from colleagues form Czech and foreign schools. Collecting the research data will be managed by an interview – qualitative methods.

7 Conclusion

The area of supporting students with special needs manifests through all levels of education. In the case of Czech elementary education it is currently primarily about developing inclusive education, which brings with it the need for restructuring educational content

for students with special needs. These students also can take advantage of the possibilities of managed self-study, which in the case of elementary schools is not common yet. Here, therefore, e-learning could help to solve these difficulties. In this area could be evaluation system, if will be tested on this sample of respondents, a good guide for teachers for developing learning support materials.

In the case of tertiary or secondary education it is a rather providing of a wider range of forms of education, which may contribute to increasing comfort and level of education for students with special needs. Here appears the e-learning as are very promising. Necessity is that there are adequate tools for evaluation of educational instruments intended for this form of study.

The facts mentioned above we perceive as a stimulus for a further discussion and as well as an incentive for a responsible and balanced attitude to the specific needs of students with special needs implementing e-learning, even if only a small part of their study. There is an intention of the authors of this article on building of some national (Czech) or international team of experts who would participate in further research, both on theoretical and application part. This article is thus also a challenge to all those interested in cooperation.

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Multiuser Virtual Environments and People with Special Needs

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Objective

This paper evaluates multiuser virtual learning environments that were designed or used specifically for the education of people with special needs. The good practice examples are analyzed and also our own experiences with the multiuser virtual environment Second Life in the seminars at Faculty of Education, Palacky University in Olomouc.

Background

A multi-user virtual environment (MUVE) is defined as a virtual 2D or 3D simulation environment representing the real space (Brdicka, 1999). It represents the integration of existing forms used by online communication and becomes a medium through which it is possible to create social interaction very close communication in real space. The popularity of 3D virtual worlds in recent years has grown rapidly. For example in one of the most famous virtual worlds, Second Life, grew from 230,000 residents in 2006 to the present more than 13 million (BeVirtual, 2008), of which the Czech Republic has tried SL about 30 thousand users. According to Gartner Research (Gartner, 2007), in 2011 more than 80 % of active Internet users will be a member of any part of the virtual worlds. Some authors argue that these virtual worlds redefine the Internet as we know it today (Kluge, Riley, 2008). Indeed, the signals can be recorded in terms of more use of video and share 3D virtual environment and computer games, which today represent real-world simulation.

Effectiveness of communication is increased if the characteristics of the media are in accordance with the processes of communication – the immediacy of feedback, variability of symbols, the number of possible ways of communication, testability, replicability and others (Riha, 1999). Collaborative hypermedia environment that represents MUVE, meets most of the above aspects – they are the object-oriented systems, where communication takes place in real time, for example, through audio or video conference or in the immediate interaction through its 3D graphical representations (avatars). Unlike previous types of communication (e-mail, text or video) that are mostly used for communication isolation, communication in all these types of MUVE integrates and enhances the effect of online communication. User moving in MUVE can monitor the communication of individual participants, he can move to a specific participant, all of which can communicate very much like the real environment.

This aspect of communication options similar to the real environment without the necessity of personal presence in the communication situation provides a strong motivational moment for the use of these technologies by people with special needs. Interactive software also encourages active involvement in learning and gives the user the experience of control over the learning process. This is especially important for people with learning difficulties. Learners can work at their own pace. They can make as many mistakes as

they like without irritating others and the computer will not tire of the leader attempting the same task over and over again, or get impatient because they are slow or engrossed in particular details. It also showed some studies – Standen et al. (1998) describe a study which involved taking 19 pupils aged 14–19 years with severe learning difficulties to a supermarket to find four items on the shelves and take them to the checkout. Nine pupils spent twice-weekly sessions carving out a similar task in a virtual supermarket. The remaining pupils had the same number of sessions using other virtual environments. There was no difference between the two groups on their first visit to the real supermarket. Yet, on their return visit, those who had practised shopping in the virtual supermarket were significantly faster and more accurate than those who had not.

According to statistics suffer from some type of disability approximately every tenth citizen of the Czech Republic (Chvátalová, 2010). Numbers of research projects focused on the use of ICT by person with special needs were provided in the Czech Republic in the last decade. These include communication with eg Project Database Systems for Handicapped-based natural language (P. Slavik et al, project GACR), Blind User Adaptive Navigation in a virtual environment (V. Nemec et al., project Ministry of Education), presentation of virtual acoustic scenes for navigation in real environments using augmented reality for the visually impaired users (A. Sporka, Ministry of Education project), Interactions of Visually Impaired Users in Virtual Environment with surround sound (V. Nemec et al., CTU project) and other.

Multi-user virtual environment Second Life (SL) can be one of the suitable options for the education of persons with various forms of disability – such as persons with reduced levels of visual perception, which can use voice chat, while deaf people can enjoy classical chatting, people with disabilities can be in SL through their avatars move (walk, run, fly) equally with other colleagues, and not at the level of the social groups experiencing feelings of otherness. Creating of social communities in these environments can help these people feel free from traditional prejudices encountered in real life. In addition to their own education it is possible to use SL as a space for an information platform for communities of people with special needs, for conferences and lectures.

The SL has appeared first projects focused on a group of people with special needs – for example IBM has launched a project called Aira (Accessible Rich Internet Application), which is based on the possibility of complementing objects in SL labels and information relevant reader can then interpret the blind users or the Virtual Ability Island (Island of virtual capacity), focused on people with the different types of disabilities etc.

Methods

We used the method of analysis of available literature, Internet resources and selected multi-user virtual environments in order to gain an overview and evaluate the effectiveness of some virtual environments for people with special needs. Based on these findings, we implemented a multi-user virtual learning environment Second Life in teaching of the seminar New Media and Cyberculture at Faculty of Education, Palacky University in Olomouc. Following the completion of training, we investigated the attitudes of respondents to the teaching in the environment by a questionnaire method.

Results

Our results suggest that work in multi-user virtual environment is a particularly strong first motivational stimulus for learning, but a very important role play also the user skills, because a lower level of ICT skills also led to more negative attitude to learning in multi-user virtual environment. Based on the analysis of examples of good practice and self-assessment of questionnaire surveys, we set some of the aspects that must be respected especially for students with special educational needs with regard to learning in MUVE. Our intention for the future research is to provide the teaching in MUVE with a group of students with special educational needs.

Conclusion

Virtual education is beneficial for students with disabilities, because they form a more level playing field than teaching face-to-face. Virtual worlds allow users with special needs to have an access to teaching and learning materials from their home. It can help them keep abreast of relevant information and also give them the sense of belonging to common study groups, where it would be more difficult to implement in a real environment. Possibility to participate in the presentation through a virtual world from home or workplace offers these users a comfortable environment. The flexibility of virtual worlds significantly improves their opportunities for learning and work cooperation.

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Dealing with Changes in Supporting Students with Disabilities in Higher Education

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Idea

Following a study on the "Social situation of People with Disabilities in Austria" carried out by the Austrian government (Federal Ministry of Labour, Social Affairs and Consumer Protection) within the framework of the annual "European Union Statistics on Income and Living Conditions" (EUSILC) 1 survey, 18 % of all Austrian citizens without a formal recognized disability finish their education after compulsory education (9 years of school). Within the group of people with disabilities, a significantly higher amount of persons (46 %) finish their educational path after compulsory school. The "Matura", the formal certificate that entitles people in Austria to enter Higher Education (e.g. university or university of applied science) is reached by 30 % of all Austrians without a formally stated disability and by 11 % out of the group of people with disabilities. As information on disability is subject to special data security regulations, this information is not asked when people enrol for Higher Education. There are of course numbers given by disability support structures (installed at most Austrian Higher Education institutions) but it is up to the individual with a disability or chronic illness to get in touch with these structures and "re-appear on the screen". Therefore, there are no formal surveyed numbers on people with disabilities studying and/or finishing their studies and reaching a career different from "traditional" jobs but numbers given by disability support services throughout Austria that are, again, far smaller than the number within the group of people without a disability. Out of own experiences, this group is further diminishing during their time in Higher Education until successfully entering the first labour market at a position corresponding to personal abilities, knowledge, skills and competences. Many issues are to be sorted out before, during and after Higher Education – issues resulting from specific needs that might arise from a disability or chronic illness, issues connected to a specific study scheme, connected to Assistive Technologies (AT) and Information and Communication Technologies (ICT) in use… but first and foremost issues that should be part of a most flexible, interactive and reliable support framework in order to create possibilities and facilitate pathways.

State of the Art and Necessary Steps Beyond seen from Austrian perspective

In 1991, the institute Integriert Studieren at Linz University was founded as "Endeavour Informatics for the Blind" and first formal Austrian offer for students with disabilities, following experiences and expertise of a similar scheme at Karlsruhe Institute of Technology[1]. The 2 students supported worked already with Braille Displays and PCs (MS DOS™) and were supplied with study literature in accessible formats.

1 http://epp.eurostat.ec.europa.eu/portal/page/portal/microdata/eu_silc
(Panel size 15.000 persons in 6000 households – last lookup in January 2012)

In these first years, blind and partially sighted people from all over Austria came (or, more precise, 'had to come') to Linz and wanted to study computer science – even if this field of study was not the best one for them. Today, the institute works as function unit in supporting the university board in various issues connected to "disability" at Linz University.

To get an overview, the following table shows the distribution of disability forms on the institute's student population. There are 3 people out of these 60 individuals characterizing their constraints as "multiple disability / combination of different disabilities" where only the most influencing has been counted:

[Tabel 1] Distribution of disability forms amongst the institute's students population (N=60, where 3 people characterized themselves as affected by a multiple / combined disability where only the most influencing has been counted)

Form of Disability	**Numbers**
Blind / Partially sighted	24
Motor / Manipulation	14
SPLD	4
Psychologic constraints	2
Deaf / Hard of Hearing	3
Chronic Illness	2
Speech / Language	1
„Not to be published"	10
Total	**60**

Since 1991, as described above, a continuous and ongoing change has taken place, caused by:

- The rapid progress in ICT / AT facilitating more and more ways of transport and representation of knowledge and information, facilitating the inclusion of more and more people with most diverse forms and combinations of disabilities into secondary education that led to
- "New" forms of disabilities entering University. Connected to this,
- The numbers of people with disabilities entering University rose and of course that led to
- Additional fields of Study and universities our students with disabilities are interested in, resulting in
- Changes in:
  - Work and workflows
  - Services provided
  - Tasks fulfilled and
  - Funding needed

This paper will discuss the changes faced in supporting students with disabilities at Linz University and the methodology used compared to other support schemes around Europe presented within the EU wide "Higher Education Accessibility Guide" (HEAG) installed by the European Agency for Development in Special Needs Education[2]. As the (online) survey amongst 100 support structures from Austria, Belgium, Croatia, Czech Republic, Denmark, Estland, Finland, France, Germany, Greece, Iceland, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Romania, Sweden and UK that we designed to collect further information is running in the moment, first results will be available for the final paper and stable results for a possible presentation in July. First feedback from 20 institutions (from Austria, Czech Republic, Sweden and Germany) shows that the institute's working group "social inclusion" and its service offer follows a quite different approach, therefore it will be described on the following pages in more depth.

Methodologies Used to Comply with the Changes Faced in Daily Work

As described above, the most influencing changes resulted in necessary adaptations in the following areas:

- Work and workflows
- Services provided
- Tasks fulfilled and
- Funding needed (primarily for personal assistance, e.g. sign language interpretation)

New technical / technological developments helped in solving some of the issues, other requirements had to be tackled by changes and adaptations in the basic organisational structure of the support scheme or adjustments in the provision with accessible study materials / study literature had to be evolved from 1:1 or face to face personal assistant settings to a user-centred, self administrating and transferable (i.e. independent from University, field of study, disability form and
number of students supported), highly available web based toolset, an experience also reported by some of the answering institutions from our survey.

The core idea in short words is to provide a web based tool / literature database where the students enter the study materials they need. If available, the students may download the adapted materials directly, otherwise a standardized workflow is triggered. This workflow reaches from putting a query to publishers in order to get the texts needed in digital formats over the adaptation process until the provision of the ready materials – based on "open document" files – easily convertible to diverse formats: "simple .doc / .html" over .xhtml to .mp3 and finally also Daisy versions.

R&D Work and Results

Within the first years of supporting blind and partially sighted students at Linz University, the provision with study materials / study literature and accessible working environments were at focus. With the rising number of (prospective) students there was a need to expand and transfer the service scheme to other supportive structures, universities,

2 http://www.european-agency.org/agency-projects/heag (last lookup in January 2012)

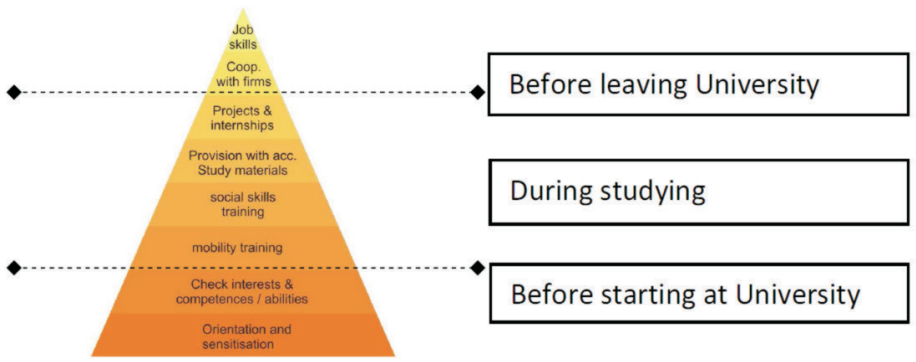
forms of disabilities and fields of study. Simultaneously, the administrative effort and the support expenses (in terms of time) for this process had to be reduced but in the same time tailored to the individual needs and nevertheless made efficient, manageable and affordable.

Another issue was the experience that the dropout rate of students with disabilities was – even with the best adapted study materials and technical / technological framework – reasonably higher than in the "mainstream population". Evaluations showed that – in most cases – there was a lack of:

- **Social skills**
  - Necessary to build up personal relationships and communicate own needs resulting from the disability and getting part of / build up supportive peer groups that are crucial in order to succeed at University, as "lone fighters" are always at the risk of failure caused by the far higher effort in studying and getting further
- **Communicative skills**
  - Strongly connected to the social skills needed for studying effectively – but in most cases not learned during (even integrative) first / secondary education
- **Sound knowledge of studying at university level, planned fields of study and necessary ICT / AT skills**
  - It is necessary to get in touch with prospective students as early as possible in order to counsel them in using ICT / AT efficiently and work with them on finding and choosing a study field corresponding to their skills, competences and interests. that finally, amongst other issues (health related, related to financial issues or other influencing factors), led to the observed reasonably higher dropout rate.

Therefore, an additional service, the working group "social inclusion" was installed, responsible for supporting the students in this additional issues as well as doing research on the topic.

The following scheme was developed in order to complement the already implemented institute's technical / technological support:



[Fig. 1] Support pyramid for students with disabilities at Linz University showing that most support is needed when starting

This model acts already before the formal start at university by contributing to activities like the "International Camp on Communication and Computers"[3] and provides interested people with information and strategies on the efficient use of ICT / AT as well as informing them on studying and possible support structures available. Before starting at university, there is also an orientation phase where the prospective students get to know the university, the campus, the people involved in supporting them and the support offers in terms of what the institute does and what is left to the individual.

During their studies, a variety of offers (besides the "traditional" provision of accessible study materials) is provided, ranging from incoming/outgoing evaluation, monthly team / students meetings, development dialogues, (inclusive) social events like cooking together, over organised excursions and events to specific trainings like "Body language, mimics and gestures / communicating disability", "assessment centre training", "presentation skills" and individualised mobility training. Another important part of our activities concentrates on the provision of possibilities to test oneself within scientific / professional settings (projects and internships in connection to projects carried out at the institute or with partnering institutions like employment services), that often already opens important doors to a later professional entry. Before leaving University, the activities concentrate on the successful career entry and a smooth transition into the labour market. Co-operation with firms, partners and employment services gives the necessary basis. This two activities seem – following first feedback from our survey amongst study support structures in Europe – to be the most promising approach and will be at scope in the final version of this paper and the presentation in July.

Following this scheme, informal experience shows that the risk of dropping out can be reduced to personal factors (health related issues, financial issues,...), what has to be evaluated and monitored formally during the next years as the first students that entered this new scheme is now preparing to finish their studies.

Impact on or Contributions to the Field

In designing the support structure as flexible, expandable and transferable as possible, the impact on the quality of support provided at university level can be estimated as high. Together with keeping the administrative scheme as efficient, user centred and accessible as possible, more time and resources can be put in necessary activities in the field of social inclusion what leads to a smaller dropout rate and a complete package of support provided.

Conclusion and Planned Activities

The scheme of service provision for students with disabilities and chronic illness at Linz university is rather open, flexible and expandable to different needs, disabilities, AT and ICT used and fields of study. This leads to a higher number of students that can be served and therefore get the possibility to study and choose an educational path and a career corresponding to their personal skills, competences and interests.

3 *ICC, International Camp on Communication and Computers*: http://www.icc-camp.info (looked up in January 2012)

During the next year(s), new activities like preparatory language courses for deaf students in order to enable them to write essays, mentoring or peer group counselling / learning support groups ("Tandem Learning") have to be implemented and the scheme has to be evaluated and benchmarked with other support structures (partially concentrating on a single form of disability or just dealing with the provision of accessible study literature / accessible study materials) in terms of resources needed, "output" of students, contentment of students and university partners involved.

Creating a welcoming environment: Developing strategies for post-secondary course websites based on universal instructional design

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Abstract[1]

The authors produce a set of learner-centred teaching guidelines using Universal Instructional Design (UID) and accessibility standards for application to postsecondary course websites. The principles of UID are found in the Universal Design (UD) perspective that views people as individuals with varying abilities and preferences. Based on the perspective of Universal Design, Universal Design in Higher Education (UDHE) identifies physical spaces, information technologies, services, and instruction which allow instructors to adopt inclusive choices. In this presentation, we are concerned with the instructional aspect of UDHE, Universal Instruction Design, and how the principles of UID are applied to web-based course sites. Teaching strategies based on the principles of Universal Instructional Design help to fill a gap in teaching by providing insight into developing specific teaching strategies to provide effective instruction for a diverse audience of students. Instructors who employ UID principles consider the potential needs of all learners, identifying and removing unnecessary barriers to teaching and learning, while preserving academic rigor. Data acquired from students in eight undergraduate courses in social work and disability studies assisted the authors in assessing their course websites and their application of the principles of UID in compliance with consumer accessibility standards.

By targeting varying learning needs, the authors aim to help faculty to adopt instructional practices for course websites that strengthen a learning-centred approach. As a result, faculty will also focus on learning obstacles that face students with varying needs in addressing the diverse learning needs of all students.

1 Introduction

The presenters partnered with a group of faculty through a university-wide learning community seeking to improve instructional strategies for course websites. This paper about accessible course web sites, and was produced in consultation with the Centre for Teaching and Learning, Student Disability Services, University of Windsor Accessibility Committee, and the School of Social Work, University of Windsor, Accessibility Planning Committee. Disabilities impact the lives of persons who live in Ontario, a central province in Canada. Human Resources and Skills Development Canada (2010) reports that in 2006 14.3 % Canadians identified as having a disability. The Ontario Ministry of Community and Social Services (2008) indicates that the number of people with disabilities is increasing and will continue to grow as the population ages.

1 This paper was made possible by a Centred on Learning Innovation grant from the University of Windsor.

The definition of disability includes both visible and non-visible disabilities, covering a broad range and degree of conditions. A disability may have been present from birth, caused by accident or developed over time and include, but is not limited to, physical disabilities, mental disabilities, learning disabilities, mental disorders, hearing or vision disabilities, epilepsy, drug and alcohol dependencies and environmental sensitivities (Ontario Human Rights Commission, 2008). Ontario's legislation, *Accessibility for Ontarians with Disabilities Act* (2011), proposes development, establishment, and enforcement of accessibility standards to support persons with disabilities across a broad array of services, such as education, by a 2025 deadline. The economic and social health of a country is positively related to postsecondary education attainment, making access to postsecondary education, across the disability spectrum, critical. This paper will offer suggestions to help instructor improve accessibility through effective teaching strategies using UID not only because it is the right thing to do, but also the smart thing to do.

2 Literature Review

Canada has seen a steady increase in enrolment in colleges and universities. Data regarding the number of persons with disabilities attending postsecondary institutes in North America ranges from 5 % to 11 %, and are often based on self-reports or responses from on-campus professionals who provide disability related services (Fichten, Asuncion, Barile, Robillar, Fossey & Lamb, 2003, p. 75). As postsecondary enrollment and awareness of accessibility concerns increases, diverse learners and their needs are being spotlighted as universities and colleges endeavor to attract and retain students.

In an average classroom with 50 students, those who require diverse teaching and learning methodologies range from 32 % to 58 % of the student population (Bryson, 2003). There will be a wide range of learning needs present, likely including: four with auditory learning disabilities, one to two with visual or hearing impairments, one with lower ability, two to four with mental health issues, two to four with attention deficits, one to three with medical conditions, one to three with mobility limitations, and three to eight who are underprepared (Bryson, 2003). Attention must be paid to the needs of these diverse learners. The importance of accessibility in postsecondary settings in Ontario is highlighted in this article through the exploration of guidelines and effective strategies instructors can utilize to promote accessible course websites for all students.

3 Accessibility Legislation

There exists legislation to protect those with disabilities and promote accessibility for all. At a provincial level, the 2005 *Accessibility for Ontarians with Disabilities Act* (Accessibility for Ontarians with Disabilities Act (2011), developed to recognize the history of discrimination against persons with disabilities in Ontario and benefit all Ontarians through development, implementation, and enforcement of accessibility standards to a variety of services. This development supports accessibility standards that positively influence access to postsecondary education. Also at the provincial level, the *Ontario Human Rights Code*, through the recognition of every person in Ontario's dignity and worth, protects Ontarians from discrimination and promotes equal rights and opportunities (Ontario Human Rights Commission, 2008). Those institutions that provide public

and private education are required to ensure their facilities, as well as the services they provide, are accessible for students with disabilities (Ontario Human Rights Commission, 2008). At a national level, the *Canadian Charter of Rights and Freedoms* addresses accessibility concerns. The *Canadian Charter of Rights and Freedoms, Section 15(1)* states that "persons with disabilities the right to equal protection and equal benefit of the law and without discrimination by government, their agents and delegates" (Department of Justice Canada, 2011, p. 4).

Although various provincial charters and legislations prohibit discrimination based on having a disability and advocate for the rights of persons with disabilities, there is no specific legislation or policies that apply to standards within postsecondary institutes. However, the majority of colleges and universities throughout Canada are mindful of their obligation to adhere to disability policy and povide some specialized facility, policy, service or equipment to students who identify as having a disability. Nevertheless, the extent to which policies are followed or services and equipment are provided varies, as there is no governing body in place to ensure students with disabilities in postsecondary institutes are receiving the assistance and/or accommodations they require. Therefore, when accessibility standards are put into place, their implementation can often be based on goodwill rather than the obligation to meet accessibility standards (Embry, Parker, McGuire, & Scott, 2005).

4 Teaching Principles and a Learner-Centred Approach

Chickering and Gamson (1987) proposed widely recognized, evidence-based teaching practices in the *Seven Principles for Good Practice in Undergraduate Education*. The teaching principles encourage student-faculty contact, active listening, stressing time on task, providing prompt feedback, communicating high expectations, developing reciprocity and cooperation among students, and respecting diverse talents and ways of learning. The principles aim to reduce and/or remove instructional barriers from teaching methodologies. Keeler and Horney (2007) underscore the implications of instructional barriers for diverse learners. They suggest potential negative consequences include limited comprehension of curricular material, inability to participate, frustration, lower grades, inability to complete course, and ultimately lack of success in the course overall. A traditional learning approach retrofits instructional materials for students with special needs, to a point where they are no longer consistent with the original curriculum's content and rigor (Boone & Higgins, 2007, as cited in Sapp, 2009).

A learner-centred approach represents a shift to meeting students' needs by incorporating their perspectives and allowing for shared decision-making between student-instructor in the learning process (Hubball, Gold, Mighty, & Britnell, 2007; Weiner, 2002). Utilizing a learner-centred approach maintains academic rigor and includes associated learning goals such as providing clear learning expectations, helping students make use of their knowledge, and promoting principles of accessibility (Galka & Gold, 2006). Educational improvements and reform, catalyzed by the educational standards movement and increased student diversity, mark the need for a new framework to increase accessibility.

5 Universal Design and Universal Instructional Design

Universal Design (UD) presents a practical framework congruent with the perspective shift to increased accessibility for all. The Center for Universal Design (2011) describes products and environments designed to accommodate all people to the greatest extent possible, as the framework for UD. The universality of this framework translates into the benefit of decreased need for additional adaptations or specialized designs for individuals. Universal Instructional Design (UID) is UD's practical application to education that supports accessibility for all (Bryans Bongey, Cizadlo, & Kalnbach, 2010). Rather than the traditional approach of individualized educational modifications/adaptations, UID is applied to all instructional products and environments (Burgstahler & Cory, 2008).

UID is an easily executed, learner-centred approach that aims to remove barriers to teaching and learning. Utilizing a UD framework for development ensures outputs, such as physical, social, and learning environments, are created to meet the needs of diverse populations from cultural, socioeconomic, ethnic background, gender, and ability perspectives (Curry, Cohen, & Lightbody, 2006). By providing the widest spectrum of learners with seamless and inherently functional and general education curricula, the need for individual variations is minimized when using this design (Burgstahler & Cory, 2008; Hitchcock & Stahl, 2003). UID involves good teaching techniques, inclusiveness, accessibility practices, and application of technology (Bryson, 2005). The Principles of Universal Instructional Design, as listed in Burgstahler and Cory, recommend that instructors plan for equitable use, flexibility in use, simple and intuitive use, perceptible information, a tolerance for error built in, and low physical effort. Burgstahler and Cory also recommend instructors plan to consider size and space for appropriate use, create a community of learners, and create an inclusive climate. Incorporating these principles promotes the consideration and potential needs of all learners, identifies and removes barriers to teaching and learning while maintaining academic rigor (Coomber, 2007; Burgstahler, & Cory).

The principles of a UID framework support recognition learning by providing multiple, flexible methods of presentation; strategic learning by providing multiple, flexible methods of expression and apprenticeship; and affective learning by providing multiple, flexible options for engagement (Hall, Strangman, & Meyer, 2009; Hitchcock & Stahl, 2003). UID presents learners with clear expectations and unambiguous instructions to develop their abilities to self-educate (Weiner, 2002), so they may experience minimized barriers and maximized access to course and instructional materials (Hall, Strangman, & Meyer, 2009). A UID framework incorporates effective teaching techniques, inclusiveness, accessibility practices, and application of technology (Bryson, 2003).

6 UID, Accessibility and Course Websites

In today's academic environments, technology has begun to play an increasingly widespread and invaluable role. In general, technology is advantageous to all learners because it has potential for flexible, supportive, and adjustable experiences (Hitchcock & Stahl, 2003). By increasing communication, student collaboration, active learning, feedback, time on task, and providing different methods of learning, technology cost-effectively advances the Seven Principles for Good Practice in Undergraduate Education (Chickering

& Ehrmann, 1996). As the role of technology becomes more prominent and important, concerns of technological accessibility take the spotlight. The value of accessible course websites to postsecondary students and their education institutes is evident. The learning experiences of students are improved by access to course resources and tools, increasingly found on the web, specifically course websites (Leung & Ivy, 2003). The diverse needs of postsecondary learners have consequently increased the demand for accessibility in postsecondary websites. Instructors are encouraged to utilize UID to address these needs.

Elias (2010) applied the UID principles to course websites. By ensuring the availability of useful and accessible instructional materials to all learners in identical or equivalent formats Elias promotes *equitable use*. Elias ensures *flexible use* by considering the abilities, preferences, schedules, and levels of connectivity of diverse learners, and providing learners with choices regarding instructional methods. By focusing on being *simple and intuitive* the designs are easily understood by everyone. For information to be *perceptible*, necessary information is effectively communicated to all learners. In cases of learners' accidental or unintended actions, *tolerance for error* is highlighted when adverse effects are minimized. *Low physical and technical effort* is promoted by designing efficient, comfortable websites that minimize physical or mental fatigue of its users. Learning environments that promote interactions between students, faculty, and administrative services are important to developing a web-based *community of learners and supports*. Additionally, student-instructor feedback creates a positive instructional climate. Components of course websites to which these principles may be applied include course notes, syllabi, schedules, access to grade information, links to added resources, assessments, feedback, chat rooms, discussion boards, and virtual office hours (Bryans Bongey, Cizadlo, & Kalnbach, (2010).

There are numerous advantages to using a UID framework with course websites. Utilizing UID for course websites is consistent with the goals of current accessibility legislation. A UID framework promotes equal rights and opportunities amongst learners by increasing accessibility to teaching material and learning methodologies, consistent with the *Ontario Human Rights Code* (2008) and the *Accessibility for Ontarians with Disabilities Act* (2011). Additionally, UID principles are also consistent with the *Seven Principles for Good Practice in Undergraduate Education* and the idea of promoting a learner-centred environment. Using UID principles promotes universal accessibility to instructional materials for all students. When accessibility concerns amongst postsecondary students are appropriately addressed, rates of student recruitment, engagement, and retention are observed to increase (Ministry of Community and Social Services, 2008).

Access and comprehension are the two primary issues learners with disabilities encounter in regards to technology-based instructional materials (Rose, Hasselbring, Stahl, & Zabala, as cited in Sapp, 2009). Course websites are increasingly invaluable technology-based instructional methodologies. Sponsored by government bodies and industries that support accessibility, including Canada's Assistive Devices Industry Office (Canadian Assistive Devices Industry – Information Sources, 2011), the Web Accessibility Initiative (WAI) focuses on providing support to people with disabilities by developing strategies, guidelines and resources to assist in making the Web more accessible (Web Accessibility Initiative, 2011). The WAI works with organizations around the world, with its prime focus in five main activities: 1) ensuring that core technologies of the Web support ac-

cessibility; 2) developing guidelines for Web content, user agents, and authoring tools; 3) facilitating development of evaluation and repair tools for accessibility; 4) conducting education and outreach; and 5) coordinating with research and development that can affect future accessibility of the Web (Web Accessibility Initiative, 2009, p. 1). Additionally, the WAI promotes core evaluation tools for accessibility, conducts education and outreach, and coordinates research and development.

Web Content Accessibility Guidelines 1.0 (2012) explain how to make web content accessible to people with disabilities. The primary goal of these guidelines is to promote accessibility. However, following them will also make Web content more available to *all* users, whether they use a desktop browser, voice browser, mobile phone, automobile-based personal computer or constraints they may be operating under such as noisy surroundings or under- or over-illuminated rooms. Following these guidelines will also help people find information on the Web more quickly. These guidelines explain how to make multimedia content more accessible to a wide audience.

Web Content Accessibility Guidelines 2.0 (2011), based upon recommendations of the WAI, has 12 guidelines that are organized under four principles in regards to material being perceivable, operable, understandable, and robust (Caldwell, Cooper, Guarino Reid, & Vanderheiden, 2008). For each guideline, there are testable success criteria. Perceivable guidelines provide a text alternative for non-text content, and provide captions and other alternatives for multimedia, create content that can be presented in different ways, including the use of assistive technologies without losing meaning. The operable principle makes all functionality available from a keyboard, gives users enough time to read and use content, does not us content that causes seizures, and helps users navigate and find content. The understandable principle recommends text be readable and understandable, and content appear and operate in predicable ways. The final principle, robust, suggests we maximize compatibility with current and future user tools. By applying a UID framework to course websites, instructors are compatible with many of the Web Content Accessibility Guidelines 1.0 and 2.0 in the aim to facilitate comprehension amongst diverse learners.

Learning management systems are website environments which allow instructors to apply pedagogical implementations such as UID. A few of the numerous learning systems that use learning management systems within postsecondary institutes are discussed below.

Desire2Learn. Desire2Learn Incorporated is a leader in learning management systems, providing innovative solutions to postsecondary institutes around the world. Focusing on research, development, service and support, Desire2Learn believes that "learning technologies should never limit learning opportunities" (Desire2Learn, 2011, p. 1). In ensuring their system and tools are user-friendly and easy to navigate, Desire2Learn uses assistive technology to support the learning needs of all (Desire2Learn, 2011). Desire2Learn is consistent with WAI guidelines, providing standards that are a result of a close collaboration with experts and students with disabilities. The tools provided through the Desire2Learn system, are easily customizable, providing users with the option to simplify their use of the system. For example, shortcuts, settings and layout options can be easily tailored to meet the needs of individual users. Desire2Learn also provides the public with a Web Content Accessibility Guidelines checklist, identifying the guidelines that

the system is able to support as well as areas that not currently supported by the system (Desire2Learn, 2011).

Blackboard Learn. In recognizing that traditional classroom-centred learning is less applicable in postsecondary institutes, Blackboard Learn provides a core set of tools for engaging and assessing learners inside and outside the classroom (Blackboard Learn, 2011). Blackboard Learn focuses on providing four main components to its users: fostering student engagement, supporting educational efficiency, delivering open and extensible learning, and connecting student instruction with institutional improvement (Blackboard Learn, 2011, p. 1). These components increase the connection and communication between instructors and students and students and their peers, while also allowing for more time to be dedicated to the success, achievement and retention of students. Using legislation about disability and standards set out by the WAI, Blackboard measures and evaluates its accessibility levels, aiming to ensure the accessibility of all its products and services (Blackboard Learn, 2011). To help with their goal of achieving accessibility, Blackboard Learn also offers a Blackboard Accessibility Grant, "a program to support work enabling education for students with disabilities" (Blackboard Learn, 2011, p. 1). In addition to this program, Blackboard Learn also has an accessibility interest group that meets regularly to discuss topics surrounding issues of accessibility that helps to guide and improve the standards of the system (Blackboard Learn, 2011).

Sakai. Sakai is a learning management system, used by over 350 educational institutions, that provides open software to support users in teaching, learning and research. This system is highly customizable, allowing instructors to use a number of methods and styles based on their teaching goals (Sakai, 2011). Similar to Desire2Learn and Blackboard Learn, Sakai offers many tools and features that aim to meet the teaching and learning needs of instructors and students. Using Web Content Accessibility Guidelines, as well as standards of their own, Sakai provides a detailed checklist of priorities related to accessibility, disclosing if the system's features do or do not meet these identified priorities.

Collaboration and Learning Environment Windsor (CLEW). Collaboration and Learning Environment Windsor (CLEW) is a customized learning management system based on Sakai, developed by the University of Windsor (University of Windsor, 2011). Aiming to enhance interaction, support teaching and learning, and support research and collaboration, CLEW is customizable and learning-centred. Some features of CLEW that instructors use include the ability to post lecture notes or PowerPoint presentations on-line, make announcements, and guide learning through online lessons. CLEW also creates opportunities for discussing group work in discussion forums, accepting assignments on-line, forwarding confidential feedback and grades, and providing instructors with training opportunities. Through the Centre for Teaching and Learning, instructors are provided with a checklist to help ensure that their CLEW sites are accessible and ready to use when the semester begins. To aid in the understanding of how the system operates, as well as to ensure instructor's CLEW sites are accessible, instructors are provided with many resources, such as a 'How To' library, training videos, personal consultations and workshops (University of Windsor, 2011).

While there are many similarities amongst these learning management systems in recognizing and approaching the importance of being accessible to the greatest number

of users possible. These systems are working towards developing systems that are accessible to all users (Blackboard Learn, 2011; Desire2Learn, 2011; Sakai, 2011). Some of the main issues for exploration, regardless of the web based system used and developed from the literature review, include clarity of materials, efficacy of organization, timeliness of posting, and other concerns, such as, legible font and size, color contrasts, audio to assist navigation through the web site, links to other websites and self-help tools.

7 Using Teaching Evaluation to Assess Course Websites

In the fall 2010 semester at the University of Windsor, the authors had 350 undergraduate students' evaluate their views on CLEW's accessibility, in order to assess this learning management system's accessibility-related strengths and weaknesses. This student sample was recruited from eight courses, six in social work and two in disability studies. The students were asked to answer twelve questions supplemental to their existing end-of-term course evaluations. Authors developed questions reflective of UID recommendations for online learning, best practices associated with UID and the Learning Opportunities Task Force of the Ministry of Training, Colleges, and Universities, and accessibility standards as outlined by the AODA (2005). From these resources, twelve questions were developed. The rating scale options included: (1) extremely poor, (2) very poor, (3) poor, (4) adequate, (5) good, (6) very good, (7) outstanding, (0) not applicable. These questions (see Table 1) were added to the existing course evaluations.

7.1 Results

Table 1 Student Evaluation of Course Web Site Results

	Courses A to H								
Questions	A	B	C	D	E	F	G	H	A*
How well did the web site postings facilitate your learning?	5.3	5.3	6.7	6	4.6	5.7	6.1	5.6	5.7
How well was the course material presented on the course web site in an organized, well-planned manner?	5.2	5.5	6.5	6	5.1	5.9	6	5.8	5.8
How well did the instructor communicate clearly and effectively on the course web site?	5.5	5.6	0	5.3	5	6.1	5.8	5.7	4.9
How 'readable' were the course web pages (i.e. font, font size, use of white space/web design, etc…)?	5.5	5.6	6.9	6.2	5.2	6	6.1	5.8	5.9

How responsive was the instructor to difficulties you may have experienced with the web site?	5.8	5.6	5.9	5.4	5	6	6	5.7	5.7
How well was the course web site organized to promote your learning?	5.2	5.4	7	6.7	4.9	5.9	6	5.7	5.9
How well did the web site explain content clearly?	5.5	5.5	6.6	6.1	4.9	6	6	5.7	5.8
How well were you able to easily navigate the web site to find information about the course?	6	5.9	5.8	5.9	5.2	6.2	6.3	5.9	5.9
How well did the web site provide clear guidelines and expectations for assignments?	5.3	5.4	5.4	5.6	5.4	6	5.9	5.9	5.6
How well were course materials posted in a timely fashion?	5.8	5.5	6	5.6	5.4	6.4	6.3	6.1	5.9
How well did the web site accommodate different technical systems through the use of multiple formats?	5.2	5.6	4.3	4.8	4.7	6	6	5.6	5.3
The value of the overall course web site learning experience was…	5.3	5.4	1	6	4.7	6.2	6.1	5.9	5.1

*Average

The high ratings reflect the course website's accessibility and usefulness. Overall, scores averaged a rating of 5/7 (good) or somewhat better (see Table 1) from students in the eight social work and disability studies courses participating in this student. Questions that received the highest ratings (4, 6, and 8), directly referred to CLEW's accessibility and usefulness. Questions that received the lowest ratings (3, 11, and 12) referred to communication, reflected in CLEW's ease of use, adaptability of its technology, and its general usefulness. These results begin to highlight the strengths and weaknesses of CLEW and its adherence to UID and accessibility.

8 Limitations

The sample of course evaluations for this study was restricted to social work and disability studies courses, possibly biasing the results. Ratings may be reflective of students' evaluations of their instructors rather than CLEW's accessibility. As participation was optional, students did not consistently answer all twelve questions. The average ratings were influenced by the presence of outliers.

There are also limitations to the evaluation instrument. A number of questions may be considered double barreled, including two or more concepts, thus, presenting oppor-

tunities for misinterpretation by respondents and then those subsequently interpreting the results. For example, question 5 may include responses from students who did not experience any difficulties with the web site and/or from students who experienced difficulties but did not seek the instructor's help. These responses may reflect an averaged response (to the two or more concepts) or an extreme response (to only one concept). Some questions may be considered repetitive, evaluating the same underlying concept. For example, question 1 and question 12 essentially evaluate the same concept, with only subtle distinctions. When these distinctions are not prevalent, a low degree of concordance between the questions is reflected. One representation of this influence is in course C's responses to question 1 (average of 6.7) versus question 12 (average of 1). The wording of some evaluation questions allow for multiple interpretations. For example, students may interpret question 7 with a focus on the content (whether the instructor communicated effectively) or with a focus on delivery and use of technology (whether the manner of information delivery facilitated understanding). Finally, the scale utilized in this study was not appropriate for all the questions. For example, questions beginning with "How well…" cannot be answered using the current adjective-based scale; it must be answered using an adverb-based scale.

9 Discussion and Future Direction

The results support instructors who utilize course websites. Overall the average ratings were fairly high (5 or higher) and better than anticipated outcomes. The high ratings received on questions 4, 6, and 8 indicate that CLEW is compliant with Web Content Accessibility Guidelines 1.0. However, these high ratings of CLEW regarding accessibility do not indicate whether this learning system is capable of performing within a UID framework. One factor in these results is possible student bias, in that these students taking social work and/or disability studies courses may be have more knowledge of and attuned sensitivity towards concerns about accessibility. Would students from other disciplines or students using other course designs or learning management systems provide different evaluations of their course website's accessibility? The low ratings received on questions 3, 11, and 12 indicate potential accessibility barriers. These barriers may be inclusive of communication barriers via course website, difficulty of CLEW's use, its lack of technological adaptability, and its limited usefulness. These low ratings may also be indicative of weaknesses of the learning system, course instructor, or both.

This review of course evaluations creates an excellent starting point for future evaluations of accessibility and course websites. Future studies should elicit responses from students in various disciplines. Future studies should seek further responses by students with disabilities regarding the accessibility of course websites, and may be further compared to students without identified disabilities. Also, future assessment of course evaluations should consider assessment for each course in regard to the principles of UID and the Seven Principles for Good Practice in Undergraduate Education. These two factors may provide insight to better understand results. For example, a course website may score low on UID, its eight principles, and the Seven Principles for Good Practice in Undergraduate Education, but high on student responses, or vice versa, translating into lower validity. Future studies should address and better manage low response rates. The

extent to which results may be attributed to the learning management system, as opposed to the instructor, should be addressed in future research.

Future research should review and revise student evaluation questions. Questions that received low ratings should be further explored. Those questions reflective of two or more concepts should be split into multiple questions that only reflect a singular concept. Repetitive questions may be reordered to be sequential to one another and reworded to highlight their differences. Questions that elicit responses not compatible with its rating scale should be reworded. To further develop and revise these questions, focus groups may be utilized. These revisions will create less confusion and provide more accurate responses, thus increased validity and reliability. Future research may consider questions of possible barriers in the implementation of UID in a learning management system's course design, and how much effort this implementation would require.

In conclusion, challenges to introducing effective teaching and UID principles on course websites may be reflective of the learning system, the instructor, or both. Adopting awareness of and proper application of UID for diverse learners requires an ongoing proactive best practice for instructors as well as experience and training. Hopefully, the assessment of course evaluations will assist instructors in examining and adjusting their course web sites to reflect good teaching strategies and the principles of UID as well as compliance with accessibility standards.

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