Accessible E-Learning and Educational Technology - Extending Learning Opportunities for People with Disabilities

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Extending Learning Opportunities for People with Disabilities

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Abstract:

The article describes possible barriers in e-learning and educational technology for people with disabilities. It starts with an overview of the different ways disabled people work with computers and assistive technology. Then several examples of creating accessible content and communication are provided. But because accessibility is not only about following technical standards and guidelines it is pointed out that accessible e-learning is more than just technology, using concepts of universal design of learning and instruction for a better e-learning experience for everybody. The article finishes with an outlook on the challenges and possibilities of an accessible e-learning 2.0.

1 Introduction

Access to information and communication for people with disabilities through modern technology is acknowledged as an important requirement for social inclusion in the European Union and beyond. People with disabilities need to use information and communication technologies as much as everyone. Within the higher education and further education they are confronted with the use of virtual learning environments (VLE), learning management systems (LMS), web-based trainings (WBT) and other e-learning applications and educational technologies. These technologies have to be accessible in order to enable people with disabilities to take part in education and the live-long learning.

Many options have been developed to realise human-machine interaction for people with different abilities (and disabilities). Some may have visual restrictions and therefore use a keyboard with Braille display or speech output systems like screen reader. Others may have physical disabilities, and use keyboard with switch access instead of mouse or keyboard. Or they have cognitive and neurological disabilities, making it hard for them to concentrate, to understand complex navigation structures or to read complex text [1].

While there are many different disabilities that can affect the use of computers and the participation in e-learning, seven main groups of disabilities can be distinguished in order to make e-learning and educational technology accessible for all:

- visual disabilities
- hearing impairments
- physical disabilities
- speech disabilities
- cognitive and neurological disabilities
- multiple disabilities
- aging-related conditions.

Judy Brewer describes a fictive scenario of a deaf student taking university courses [1]. When the university administration decides to use multimedia and audio lectures inside the courses, it becomes inaccessible for the deaf student. Only after providing transcription of the audio files the student is able to finish the courses. As an advantage the transcriptions are also useful

for students with English as a second language, helping them to better understand the topics. The new text-based transcriptions are also better indexable then the original audio files. This short fictive example makes obvious, how e-learning and educational technology can be made accessible. Two main parts need generally to be considered and adapted [2]:

- the software being used for e-learning; e.g. LMS/VLE with communication and assessment tools
- the content and learning material uploaded to the LMS/VLE.

2 Creating accessible e-learning and educational technology

E-Learning today is mostly understood as a complex arrangement of different materials, activities, communication und collaboration of learners. The internet allows rapid and easy distribution of web-based trainings, of all the material to the learners and simplifies communication between learners and tutors. An e-learning-scenario can therefore be described as an arrangement consisting of three parts [3]:

- Content: material ranging from simple text to complex multimedia and learning-objects
- Communication: everything from face-to-face to chat and discussion-boards; communication can either be one-to-one, one-to-many or many-to-many, being synchronous (for example a chat) or asynchronous (e-mail or discussion-boards)
- Construction: learners work with different materials, taking notes, writing essays, doing presentations or work together on a project.

Making e-learning and educational technology accessible means that all these three parts of the three-component-model must be taken in consideration and made accessible. Creating accessible materials starts with text documents, presentations and other documents that you provide to the learners. Although creating accessible content for e-learning is not the same as creating accessible web content, the Web Content Accessibility Guidelines [4] are a good starting point for information and techniques on creating accessible e-learning as well. Accessible content must take four design principles into account [5]:

1. Perceivable
    a. Provide text alternatives for any non-text content so that it can be changed into other forms people need such as large print, Braille, speech, symbols or simpler language
    b. Provide synchronized alternatives for multimedia
    c. Create content that can be presented in different ways (for example spoken aloud, simpler layout, etc.) without losing information or structure
    d. Make it easier for people with disabilities to see and hear content including separating foreground from background
2. Operable
    a. Make all functionality available from a keyboard
    b. Provide users with disabilities enough time to read and use content
    c. Do not create content that is known to cause seizures
    d. Provide ways to help users with disabilities navigate, find content and determine where they are
3. Understandable
    a. Make text content readable and understandable
    b. Make Web pages appear and operate in predictable ways
    c. Help users avoid and correct mistakes that do occur
4. Robust
    a. Maximize compatibility with current and future user agents, including assistive technologies

While these guidelines are intended for web documents, these design principles and the detailed guidelines can be applied on the creation of accessible e-learning content as well.

- Text documents: Whether you provide essential texts in the formats of Microsoft Word- or OpenOffice.org-Writer, always make sure that the documents are well structured, all images are provided with an ALT-Text and the contrast of colours used within the documents suit the needs of people who are colour blind. There are several tutorials in the internet, describing all the essential steps for making text documents fully accessible for all ([6], [7]).
- PDF: While early versions of pdf were not accessible, creating accessible pdf-documents today is easy if the original document is already well-structured and provided with alternative text for images etc. Creating accessible pdf-documents from scanned text is more complex. You can easily create a pdf consisting of scanned images of an article for example. Such a pdf contains the text in an image format and is not accessible for people working with screenreaders. Scanned text must be therefore converted to a text format using text recognition. For more information on how to create accessible pdf documents take a look at the detailed instructions at Adobe.com [8].
- Presentations: Microsoft PowerPoint and OpenOffice.org Presenter can be used to create presentations that are at least partially accessible. Again it is important to start with a well structured document, using page layouts and document templates, providing text alternatives for images and using proper font sizes. However, making animations accessible is rather complicated - if not impossible. At least they are not accessible for currently available screenreaders. So either you resign to use animations or you provide a text description of the animation. Another way to make presentations accessible for all is the use of web-based presentation tools. Again, these tools do not support complex animation of text or visual elements [7].
- Video, audio, multimedia: Any time-based multimedia presentation must be provided with a synchronized equivalent alternative (e.g., captions or auditory descriptions of the visual track) with the presentation [4]. In case you use a video to exemplify a statement, provide captions as text version of spoken text as equivalent alternatives for people who are deaf or hard of hearing and auditory description of the most important visual events for those who are blind or partially sighted. Podcasts or other audio must be provided with a transcript as an equivalent alternative. While most video players like QuickTime, Windows Media Player or some FlashVideo-Players are capable of handling captions and even additional audio tracks, containing the auditory description, the production itself remains a rather complex task and should be done by professionals.
- If you use programmatic objects like a virtual laboratory or other simulations, these objects have to be accessible, too. Whether these objects are written in Java or Flash, most of the current web-based technology can be made accessible. Lifestream remains an exception.

The communication and construction normally takes places within a lms or vle. Several commercial as well as open-source lms label their product accessible. Take a look at the vendors' website whether their lms is accessible or not. Vendors of commercial lms often provide detailed information about the accessibility laws and standards their products meet. Open-source lms often provide even more detailed information about the accessibility of the software. For example Moodle (http://moodle.org), one of the most popular open-source lms, provides detailed information about the current status of the accessibility compliance of the software (http://docs.moodle.org/en/Accessibility). Other popular lms claiming to be accessible are Blackboard (http://www.blackboard.com), Fronter (http://www.fronter.info), Claroline (http://www.claroline.net) or .LRN (http://dotlrn.org). The lms ATutor (http://www.atutor.ca) is special, because it was developed with emphasis on accessibility

whereas most of the other lms were made accessible to certain extends because of the demands of the U.S. accessibility law Section 508 or because of a community of developers who realised the importance of accessibility.
You can also check the accessibility of the lms yourself. As most lms provide web-based interfaces, the guidelines of the WAI can be used to check whether the lms is basically accessible or not. While this works for most elements of the lms, some parts of a lms need to be checked differently. For example, most lms provide a chat for synchronous communication. These chats can be written in Java, Flash or JavaScript. Hence, you cannot test the accessibility of a chat with exactly the same guidelines as the accessibility of a webpage. Furthermore, one of the critical aspects of chat accessibility is whether the individual user can control the scrolling and refreshing of messages. Or does sound alone convey important information, for example the notification that a private message is arrived? There are several guidelines for accessibility testing of chats, but also synchronous and asynchronous communication and collaboration tools ([9], [6]).
The operability of the software can be a critical aspect of lms accessibility. Because current lms are complex software products, it is already complicated for non-disabled students to navigate inside an e-learning course without initial training, to find the text for the next exercise, to start a new thread in a discussion-board or to write a text in a wiki. Therefore, an adequate navigation is essential for people who use assistive technology for surfing the web and accessing a lms. The navigation should provide an overview of the different parts of the lms and each course within the system. The navigating inside a course should allow direct access of all the tools and content, either grouped by the subjects of the course or by type of the tool and content. Also make sure that the navigation is device-independent and works without additional plugins or scripts, because otherwise you might block out people using the computer with special input devices or who disabled the browser's script execution.
Another important part of lms accessibility is the creation of new online courses and course material. In most lms you can create text-based material for your students and even place images inside the text. However, can you also provide an alternative text for the images? Does the editor of the lms support this or even prompts the author to provide equivalent accessible information? It is not sufficient to only test the front-end of a lms, but you should also test the back-end of the lms for accessibility. This can be accomplished with the W3C's Authoring Tool Accessibility Guidelines (ATAG) for example.

3 Beyond technology

While e-learning and educational technology is based on the use of computers, software and other information technology for learning, not all aspects of accessibility can be handled by technical guidelines and standards. After all, e-learning is about learning, instruction and didactics and therefore the accessibility of this aspect has to be taken into account, too.
How can an e-learning based course be planned so that all learners, whether disabled or not, can participate? This is where the Universal Design of Instruction (UDI) respectively the Universal Design for Learning (UDL) comes in.
Universal design (UD) is a design principle developed by Ron Mace, but similar concepts have evolved and been expressed in other countries as well [10]. Products, buildings, services and environments developed in accordance with the principles of UD are usable by all people without the need for adaptation or specialized design, regardless of age, abilities or circumstances. While UD is an approach with implicit support for the use of people with disabilities, other people benefit, too. Sidewalk curb cuts for example have once been designed to make sidewalks and streets accessible for people using wheelchairs, but are also beneficial for parents with prams or kids on bicycles. The same goes for low-floor busses or captions on TV, the latter being useful for everybody watching TV in a noisy environment for example.

Universal Design for Instruction (UDI) respectively Universal Design for Learning (UDL) is the design of instruction and learning "to be usable by all students, without the need for adaption or specialized design" [11].
Applying the principles of universal design to instruction and learning means the design of instructional materials and activities that make the learning goals achievable by individuals with different abilities, with different language skills or learning styles. The principles of UD ([12]) are listed below together with an example of UDI/UDL in the context of e-learning

1. Equitable Use: The design is useful and marketable to people with diverse abilities. For example, the lms used for an e-learning course is fully accessible to all students, whether they browse the web with a web-browser or a screenreader.
2. Flexibility in Use: The design accommodates a wide range of individual preferences and abilities. Students could for example choose between a podcast or the transcribed text in order to get the information necessary for an assignment.
3. Simple and Intuitive: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. You could for example provide a course structure that is as simple as possible, with clear information about what text to read next or which forum to visit for this weeks discussion.
4. Perceptible Information: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. As an example, every video used within an e-learning course or a web-based-training should include captions and audio descriptions.
5. Tolerance for Error: The design minimizes hazards and the adverse consequences of accidental or unintended actions. Automated tests within an e-learning course should not only give feedback whether an answer is wrong or right, but also why an answer is wrong.
6. Low Physical Effort: The design can be used efficiently and comfortably, and with a minimum of fatigue. This might be hard to achieve for e-learning, but what about the number of mouse clicks that are necessary in order to post a message in a discussion-board? How long does it take a student to submit an essay via the lms? Try to enable direct access to important functions, especially to the assignments and content of the current week or topic.
7. Size and Space for Approach and Use: Appropriate size and space is provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility. Within an e-learning course environment, you could for example make all important elements for the course or the most important tools for the learners easily accessible on every page.

UDL and UDI result in flexible learning materials and activities that provide alternatives for people with different abilities. Most important is that these alternatives are built into the learning materials and activities and not added on. Thus principles UDL and UDI can be applied to the overall design of e-learning and educational technology, but also to individual lectures, activities within an e-learning course or online discussions. For example, make sure that all activities and materials are fully accessible to all students, provide more than one activity to achieve a certain course goal. Encourage all students to participate in discussions, but also make sure that the communication method used is accessible to all. Sheryl Burgstahler gives several examples of instructions that employ principles of universal design [11].
UDI and UDL extend universal design, because it not only means that the access to information is improved, but the access to learning is improved as well. Digital media play an important role in this improved access to learning. One of the main qualities of digital media is their versatility, which means that information can be presented in any of several media, for example as text, image or audio. Digital media can also be easily transformed from one media

to another, enabling the instructors or learners to adopt media to their own needs or the needs of the individual learner [13].
Creating accessible e-learning and educational technology is more than just making content, tools and learning-management systems accessible. For full accessibility, the learning activities and the whole learning environment must be accessible, too. Coming back to the three-component-model used to describe an e-learning scenario, all three parts have to be accessible. That means creating accessible content, enabling accessible communication and accessible construction. The last could be the most difficult part, because construction includes the activities of each individual learner as well as group tasks. UDI and UDL provide principles for accessibility of instruction and learning, but it is up to the course designer or lecturer to know about the different abilities of students and to come up with alternatives in case of inaccessibility. The use of the principles of UDI and UDL do not relieve educators of the responsibility of addressing the needs of each individual student [14].
But what is all this good for? Why should e-learning be made accessible and what can e-learning do for people with disabilities?
According to Rolf Schulmeister e-learning can be used to overcome certain barriers in learning [15], which can increase the value and is one of the big advantages of e-learning. There are four barriers that can be overcome:

1. Time barrier: E-Learning can be used to by the learners to allot their time, to learn when they want to learn. You can also enable them to travel back and forth in time, making it possible to examine the development larvae of flies a in fast motion or to view fast events in slow motion.
2. Space barrier: In traditional learning settings all learning objects like books, laboratories or media have to be present where the learning takes place. In e-learning, learning objects can be distributed all over the world, made accessible to learners via internet. Such virtual learning object are for example virtual laboratories for chemistry or physics, a virtual patient or an simulated organ for future physicians or even virtual field trips to places all over the world. By using virtual learning objects real objects can be made accessible to more students, who otherwise could not afford for example a trip to the ancient pyramids of Egypt. E-Learning allows learners to access rare resources and expands their learning space.
3. Analog-digital barrier: Digital content offers the possibility to combine different media such as video, audio, text and images. This enables learners to interact with digital content, using different digital media for their learning process more easily than analogue media. Computers can be used to make media accessible for people with disabilities, enabling them to work with media which have not been accessible for them before or only with support of other people.
4. Norm barrier: One of the biggest advantages of e-learning is that norm barriers can be overcome, resulting in a growth of learning opportunities for all people. E-learning allows a more individualised and personalised learning. For people with disabilities it can expand the scope of learning opportunities.

While all these four barriers can be overcome by the use of e-learning, most important especially for disabled people is to overcome the norm barrier. But this can only be achieved by making e-learning accessible. Only accessible content for learning, accessible communication between all learners and accessible construction of personal as well as shared knowledge can lead to expanded learning opportunities for people with disabilities. This is why e-learning and educational technology have to be made accessible for all.

4 Implementing accessible e-learning and educational technology

During the European Year of People with Disabilities 2003 an expert group of the European Commission declared:

> *Accessibility should be dealt with in a global and integrated way, cutting across all policy areas (construction, health and safety at the workplace, Information and communication technologies, public procurement, education etc.). [...] It should be achieved by a co-ordination of all actors involved (from the areas of social policy, physical planning, Information and communication technologies, construction, transport and others).*
> *[19]*

E-learning and educational technology can therefore be considered barrier-free if they are accessible „for people with disabilities in the general custom way, without special complications and in principle without assistance“ ([17], §4, translation by the authors).
This can only be achieved with the collective effort of all stakeholders (e.g. staff developers, senior managers, students, lecturers, learning technologists, support services) [14]. However, while accessibility is often oversimplified as working according to guidelines and policies, the main objective should always be „to address the needs of the students“ ([14], p. 207). That means that it is not sufficient to simply follow some guidelines, but to assure that accessible e-learning and educational technology also includes pedagogical approaches and organizational development.
Jane Seale offers a contextualized model of accessible e-learning practice, especially in higher education institutions [14]. She questions who is responsible for the accessibility of e-learning and educational technology, who are the stakeholders, what is the context like and how does the relationship between stakeholders and the context influence the outcome in regards of accessibility?
In a university there are several stakeholders, for example students, lecturers, learning technologists and support workers as well as staff developers and senior managers. Each of these stakeholders has a different view on the accessibility of e-learning and a different responsibility. The students for example are the ones who use e-learning and educational technology for learning, mostly with their individual view on the accessibility. A student who is blind has a different view on the accessibility of e-learning than a student who is physically handicapped and needs an alternative keyboard to use the computer. The students have certain responsibilities in making e-learning at the university more accessible. They could for example provide other stakeholders with important information on barriers within existing lms or other educational technology.
The same applies to the other stakeholders. Each of them has a different view of disability and accessibility, depending on their responsibilities within the organisation and their job function. Lecturers are responsible for the accessibility of online courses for example, not for the accessibility of technology, the latter is in the responsibility of learning technologists and support workers.

The contextualized model of accessible e-learning practice is complemented by drivers like legislation, universal guidelines of accessibility and universal standards as well as mediators

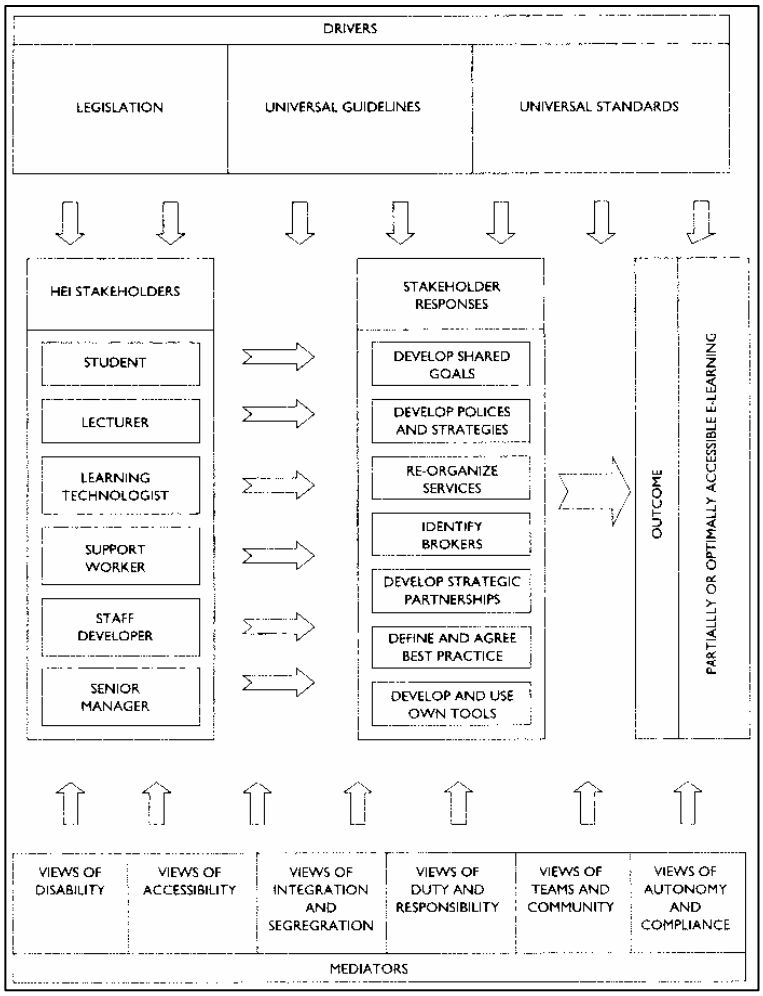

Figure 1: A contextualized model of accessible e-learning practice (Seale 2006)

like different views of disability and accessibility, of duty and responsibility. These drivers and mediators influence the stakeholders and their responses and the outcome, but are not necessarily rules to which the stakeholders adhere to.

Seale views the model not as a guideline on how to create accessible e-learning practice in higher education but as a model to better understand what influences the outcome. Creating accessible e-learning and higher education is not just about following legislation, guidelines and standards, it is not about individual views of accessibility and disability, but about several stakeholders working together, developing shared objectives, policies and strategies, re-organizing services, developing strategic partnership and defining best practice. The model shows that fully or partially accessible e-learning and educational technology can only be achieved by all stakeholders working together on the planned outcome.

The next step could be to develop an accessibility reference model, defining practices and processes, offering a set of use cases to describe common solution patterns for accessible e-learning and educational technology and defining service profiles of services needed in order to make e-learning and educational technology accessible within an organisation.

5 The “German Alliance for barrier-free Information Technology ” – AbI-Project

In order to support the implementation of barrier free information technology in Germany the “Alliance for barrier free Information Technology” (Aktionsbündnis barrierefreie Informationstechnik - AbI) has been established with support of the federal government

(BMAS) [18]. More than 50 members have joined the alliance, in order to join forces for the further development of accessible web in Germany. In cooperation with the partners AbI concentrates on labour related content, education, web-based information, etc. to support the implementation. The work package "Further Education/E-Learning" of the AbI-Project includes

- the development of guidelines for accessible e-learning content, e.g. accessible text documents, presentation documents, rich media, multi-media
- a web catalogue of accessible and barrier-free e-learning courses
- the development of a catalogue of criteria for the evaluation of e-learning tools like learning management systems or web-based-trainings.

The development of guidelines is currently work-in-progress. Two guidelines for accessible text documents and presentation documents are finished, based upon the adaptation of the WCAG-guidelines and testing the results with common assistive technology like screen-readers. Furthermore the AbI-Project developed a guideline on accessible chats, analyzed different chat software and provides an accessible chat, adopted from AChat (http://www.atutor.ca/achat/index.php), translated to German and modified to meet the requirements of the German BITV. The chat is available for free download and use (http://www.wob11.de/veroeffentlichungen7.html). The next steps will be to develop guidelines on accessible multimedia and rich media and providing an overview of accessible open-source lms.

Furthermore the development of two e-learning courses at the "Fakultät Rehabilitationswissenschaften" at the University of Dortmund will be accompanied in order to acquire knowledge of how to ensure the accessibility of e-learning within higher education. This offers opportunity to develop an accessibility reference model of the creation of accessible e-learning within higher education. Several stakeholders will work together in order to develop prototypes of e-learning courses to support different kinds of courses like lectures, seminars or tutorials.

6 Future perspectives – towards accessible e-learning 2.0

Without accessible and barrier-free e-learning and educational technology a new digital gap will appear, hindering people with disabilities to take part in current and future developments in higher and further education. This is especially connected with the exclusion from the much demanded life-long learning. Thus assuring that current e-learning and educational technology is accessible for people with disabilities is not enough. Current trends in e-learning 2.0 go to the use of blogs and wikis, towards e-assessments and e-portfolios. The web 2.0 terminology is adopted to e-learning 2.0, speaking of user generated content, self-paced learning and informal learning. Nowadays, you can make audio or even video comments to a blog, web-based-training is no longer developed by specialist, but online via new tools like Udutu (http://www.udutu.com). With all these trends it is more important not to stop by making today's e-learning accessible, but to ensure that tomorrow's possibilities can extend the learning opportunities for everyone, including people with disabilities.

But what should be considered in order to make e-learning 2.0 accessible? E-Learning 2.0 is different from e-learning 1.0 because the main components consist of web2.0-applications like wikis, blogs, bookmarkings, services like ZOHO or Google Docs and mash-ups rather than the classic lms or courseware [19]. You access the content via web-page or rss, delivering the news directly to your computer or any other device connected to the internet, for example a pda or cell phone. While these are mainly technical aspects, there is also a shift of roles for students, content producers or trainers. In e-learning 2.0, the learners are the main content producers, the populate wikis with texts, collaborate on essays via Google Docs, exchange their newest research results via blogs and so on. It is all more learner-driven, a shift from teaching to learning, and the trainers role will be that of a coach, giving hints and

feedback and guidance to the individual learners. This will also change the aspects of accessibility in several ways.

- E-Learning 2.0 consists of many different applications, some are web-based, some will be installed on computers and other devices. You will not only have to check the accessibility of one lms, but of the many web-services used for e-learning. This could make it more complicated to ascertain the accessibility of an e-learning environment. On the other hand you could create a mash-up, accessing all the different web-services from one central interface. This could even enhance the accessibility, because you provide the central interface and can take the needs of every student into account, allowing even more flexibility in creating accessible e-learning and educational technology.
- The students are the content producers within e-learning 2.0. That means you have to provide guidelines to them on how to create content that is accessible to all and to prompt the students to provide accessible content. Hopefully web2.0-applications will make it easy to create fully accessible content and support accessible authoring practices as well as the creation of accessible content.
- There will be several stakeholders who are responsible for accessible e-learning 2.0. This could not only lead to accessible content, communication and construction. Students will work together on wikis or essays, correcting mistakes and inaccessibilities and hereby they learn about the needs of people with disabilities. This could also make accessibility self-evident.

Looking at the ageing societies, considering the changing labour environment and the requirement of lifelong learning, it becomes obvious, that the need for flexible learning platforms for all is increasing. More and more professionals (with disabilities) will have the need for efficient and up to date further education. Technology provides a suitable platform, but also threats if not used carefully. Concepts for development of resources and skills will be needed to implement UDL/ UDI and to avoid the creation of barriers towards participation in (E-)learning.
This article pointed out possible barriers in e-learning and educational technology used today and ways to avoid these barriers, making e-learning accessible for everybody. It also made clear that it is not a job for technologists only, but takes the effort of all stakeholders working together in order to achieve accessibility.
Making e-learning 2.0 accessible will be an even more challenging task. This is mainly because there will no longer be a central author who can ensure the accessibility of content and technology. But e-learning 2.0 is still an upcoming way of learning, and so there is still the chance of integrating accessibility into the processes of developing the future learning technology and scenarios. Hopefully this will make accessibility an implicitness, enabling everybody to take part in tomorrows challenge of lifelong learning.

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