

May 2017

# Inclusive E-Learning - Towards an Integrated System Design

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**Abstract.** At first sight there seem to be issues combining technical accessibility guidelines and educational needs when designing inclusive E-Learning. Furthermore Universal Design for Learning seems to contradict individualization. In this paper we address both issues with an inclusive E-Learning design for the LAYA system, which targets disabled and non-disabled learners.

**Keywords.** Universal Design, Universal Design for Learning, inclusive E-Learning, accessibility, educational technologies

## 1. Introduction

Education is a basic human right for everyone, no matter if they are disabled or not. Nevertheless people with disabilities often encounter barriers in various forms, that hinder their full participation. There are different approaches to change this situation like legislation, organisational development, change in teacher attitudes or technology use. As digital technology use has risen intensely within the last years, the accessibility and inclusiveness of learning media has become a necessity. However the implementation of such systems is not yet satisfying. Especially systems that aim beyond accessibility for inclusion are rare. With regards to the possibilities and flexibilities that digital learning can offer (e.g. independence of time and place) not only for disabled people, the development and technical and scientific steering of inclusive systems needs to be advanced. There are already existing design principles, which should be considered for the above-mentioned scenarios. One such principle is Universal Design, which is defined as “the design of products and environments to be usable to the greatest extent possible by people of all ages and abilities.” [1, p. 11]. Adapted to education, this approach is called Universal Design for Learning. The U.S. Department of Education defines UDL in the Higher Education Opportunity Act (HEOA) as follows [2]:

“The term UNIVERSAL DESIGN FOR LEARNING means a scientifically valid framework for guiding educational practice that:

(A) provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged;

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May 2017

and

(B) reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient.”

Other countries like Germany do not define design guidelines for learning by law but, aside from signing the UN *Convention on the Rights of Persons with Disabilities* merely state a legal framework by describing the realisation of accessibility in its' variable facets.

This paper looks at the development of an inclusive E-Learning platform - for disabled and non-disabled persons and thereby contributes to the improvement of inclusive learning. In the next section the state of the art for design guidelines and accessibility for E-Learning systems is described. This overview identifies two research gaps, which are addressed afterwards in section 3, where a design approach for an inclusive E-Learning system that is currently being developed is introduced. Section 4 concludes and summarizes the paper content shortly, gives an overview of limitations for the developed system and gives a prospect of further plans.

## 2. State of the art

When talking about inclusion in education there are a lot of possible barriers that need to be overcome to provide learning access for all students. There are different ways to approach this topic. One possible way to go is to face barriers on the individual level by providing special support for single learners. Assistive Technology (AT) follows this idea and strongly focuses on the best possible support for mostly disabled learners, so that they are able to participate.

Following the already mentioned definition and different publications [3,4,5], UDL addresses curriculum and learning environment and is not focused on an individual level. As Rose et al. wrote more than ten years ago AT and UDL seem to be “much like two sides of the same coin” [6, p. 507]. They say that, for educational success, both perspectives have to be taken into account and need to be further developed.

UDL has three main principles [7], which are formulated on the basis of neuroscience research: The first principle “Provide Multiple Means of Representation” is about the necessity to provide content in different representation forms to allow not only disabled students but also different learner types to gain access to the learning topic. The second principle “Provide Multiple Means of Action and Expression” asks to take into account the heterogeneous usage of and knowledge expression in learning environments. The third principle “Provide Multiple Means of Engagement” demands variable ways and approaches to support engagement in learners.

Especially the first one “Provide Multiple Means of Representation” can be supported by e-learning. It offers the opportunity to provide different forms of representation within one system and thereby supports teachers in planning and realizing curricula and classes for heterogeneous learner groups.

Rose and Meyer [4] describe the necessity of flexible instructional media for realizing UDL. They argue that advantages of digital media are *versatility*, *transformability*, the *capacity for being marked* and the *capacity to be networked* [4, p. 77 ff.]. Thereby digital media can support flexibility for different aspects of a topic for teachers and learners.

If digital media or learning platforms are supposed to be suitable tools to support UDL

May 2017

and inclusion, accessibility should be one of the first steps to be taken into account for conceptualization and development. The Web Content Accessibility Guidelines (WCAG) offer support how to realize that for websites on a technical level. These guidelines apply to web-based platforms as well and can be transferred easily. However, they are no sufficient substitute for direct user feedback and usability evaluations. Furthermore, educational aspects are not part of the WCAG either. With rising awareness for accessibility, there are projects like the European MOOCAP project. This project started with a free MOOC about understanding users' needs and supporting them by accessible and inclusive design [8]. More MOOCs are planned on topics like "Accessible Gamification", "Assistive Technologies", "Accessible Mobile Apps" and others.

Hashey and Stahl [9] outline the difficulties for teachers in providing accessible learning environments by describing different aspects of accessible online learning for students with disabilities. They thereby show the rising awareness for and development in this field. Nevertheless, practical solutions are very often adapted specifically to certain groups or media [10,11,12]. For instructors and teachers this results in a kind of jigsaw if they want to satisfy the needs of inclusive learner groups.

Jane Seal [13] argues that seeing universal design approaches and individual design approaches as contradictory, as is still often the case, does not help to improve participation in learning. She prompts to combine those two approaches to reach the best online learning solution for disabled students. Thereby she follows the aforementioned perspective of Rose et al. [6] as well as the conclusion of Rose and Strangman [3].

Inclusive E-Learning is a desirable goal with the widespread use of digital learning media. About ten years ago, Abbott [14] already used the term e-inclusion for the use of digital learning support for students with learning difficulties. But the combination of the terms *inclusion* and *E-Learning* is rather new and still very rare. As summarized by Seal [13, p. 2015 ff.], if inclusion and E-Learning are mentioned together, inclusion is mostly seen as a possible outcome of E-Learning use for disabled students and rarely as a process. As the debate is just starting, there is no common understanding of inclusive E-Learning so far.

Inclusive E-Learning is in line with different concepts and approaches mentioned in literature like *Education for all* [15], *multimodality* [16] or the aforementioned concept of *e-inclusion* [14]. Most of these approaches are more or less close to the Universal Design idea. Especially in AT user-centred design approaches and development are common as described by [17,18] for instance.

There seem to be two main issues in research and practice that are not yet solved satisfactorily for inclusive E-Learning. The first one is the gap between technical guidelines and educational needs. Guidelines like the WCAG support the creation of accessible websites from a technical point of view, educational ideas and concepts, however, are not included. Existing learning software on the other hand is developed according to educational needs, but is rarely accessible for variable learners with variable disabilities. In the research field of E-Learning, accessibility is a term, which is occasionally mentioned by references and recommendations to follow the WCAG. Inclusion, however, is neither a topic in technical guidelines nor in E-Learning research or practice so far.

The second issue seems to be the combination of Universal Design approaches and individual design in online learning contexts as mentioned by [13]. There are E-Learning platforms like Moodle or Blackboard, which are widely used in educational contexts. They are developed for "average" learners and are made more accessible for students

May 2017

with disabilities. One might tend to say, they are following a universal design approach - one platform for all. There are other approaches, which are more individual, like platforms developed for special target groups like blind people, deaf people or people with autism. The first one ignores that there are people with special needs, which might not have been considered in existing learning platforms and therefore can not use those partly or at all. The second approach finds individualised solutions, which suit the special needs of certain learners, but exclude them by separating them from the other learners. Educators try to overcome this gap every day without clear instructions or guidelines how to do so for using E-Learning platforms.

### 3. A design approach

In this paragraph the aforementioned research gaps - (1) technical guidelines vs. educational needs and (2) universal design vs. individual design approaches - are addressed by an inclusive design approach for the LAYA (Learn As You Are) platform. The design is based on personas, which are fictional characters developed from real data [19]. Oriented towards Schulz' and Fuglerud's description of personas with disabilities [20], five fictional characters were developed, based on interviews with persons with variable disabilities [21]. The interviews included questions concerning computer and mobile device usage, experiences with E-Learning, barriers and known problems in everyday life with a focus on computers and mobile devices, usage of AT, expectations and requirements towards an inclusive E-Learning system and others. Additionally information from accessibility guidelines and W3C user stories were taken into account for the development of the personas. Following this methodology future users are involved and special needs and requirements are included right from the beginning. The LAYA system is still in development but already in a prototypical state. A first pilot study with two users from different user groups has been made so far. One of the next steps are larger scale user studies, to make sure the system does not lose sight of their needs.

To address the first research gap, technical accessibility guidelines need to be combined with educational concepts like exercises, tests or feedback. One could of course try to adapt existing E-Learning platforms but as Hashey and Stahl [9, p. 71] write "[...] digital environments designed without accessibility in mind are nearly impossible to retrofit due to the cost, expertise, and technology required for such an undertaking.". There are platforms like Moodle or Opal, for instance, which have been adapted according to accessibility requirements afterwards. Nevertheless, it seems legitimate to alternatively develop a system, which is built with a focus on accessibility right from the beginning. Therefore the involvement of people with disabilities is key, especially if the long-term goal is an inclusive system. LAYA aims at development into a framework that allows the usage of one learning management system for as many different learners as possible and is therefore suitable for use in inclusive learning groups.

The system itself has a modular structure and consists of different components that allow the provision of different representation forms. Content can be presented as text, video (with subtitles, captions and descriptions), picture or audio. As mentioned before this is demanded from different guidelines like the WCAG from a technical perspective. But it is also according to the first and second principle of the Universal Design for Learning guidelines, which have a strong focus on education. The different representations

May 2017



Figure 1. Screenshot LAYA system: parallel videos

address different senses and different options for perception and therefore allow access for people with disabilities on the one hand and for different learner types on the other. These advantages of “multimodality” are also named by Bruce et al. [16], although with a slightly different focus on literacy. Figure 1 shows a screenshot from the LAYA system with two videos playing at the same time. In the example the term burnout is explained with pictures, audio and subtitles in the main video (center) and a sign language interpreter in the second one (right bottom corner). Users have the possibility to switch the videos to focus their preferred video.

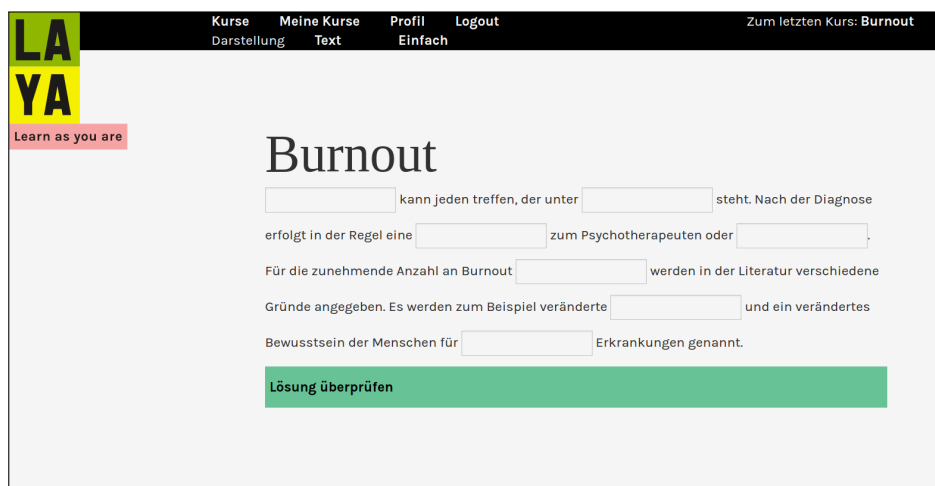
Other accessibility features are the possibility to navigate the system by keyboard, which is useful for people who can not use a mouse, for instance or the possibility to choose between different contrast and color profiles for pictures. This contributes to the second principle of UDL, as it provides options for physical action.

The frontend of the system includes typical E-Learning features like exercises. Currently single- and multiple choice are implemented, as well as free text input and clozes. Further exercise forms to come are drag and drop and marking tasks. Although still text-based, the mentioned formats will include pictures and audio in the near future. Another typical E-Learning feature is feedback by the system. For the implemented tasks, immediate automatic feedback is available with an exception to longer free text inputs. Those have to be evaluated by instructors manually. For the automatic evaluation, instructors need to deposit a sample solution for each exercise.

The system consists of two parts - a user view and an authoring tool. Both parts are developed to be not only accessible but inclusive. The inclusiveness of the authoring tool is not only useful for instructors with special needs but also for peer contributions. The idea is to have a platform for learners and instructors with and without special needs. Instructors or contributors can upload content files or embed videos (currently from Youtube and Vimeo) as content into courses. Further, textual content can be inserted manually into the system with the possibility to supply different language levels. This feature supports the provision of textual content in “normal” and simple language, which is a requirement of the WCAG and UDL guidelines.

May 2017

The LAYA system can also contribute to closing the second research gap between UD and individual approaches in inclusive learning related to E-Learning. The framework itself can be seen as a UD approach that takes accessibility, multilingualism and different learner types into account. It facilitates one system for heterogeneous users on the one hand and its adaptivity allows users to adjust the system to their personal needs on the other. The individual approach can be realized further through the provided learning material. This is explicitly a “can” as content design depends on each instructor and his or her adaption of learning material to individual needs. The platform provides the necessary flexibility and structures to create different representations and levels of content. Figure 2 shows a screenshot of a cloze exercise (in German) with free text fields as clozes. The content is based on the explanation videos for the term “burnout” as shown in figure 1. The text level of the exercise can be classified as “normal”, but users have the possibility to switch to simple language. There not only sentence structure and complexity of terms are reduced but also the option how to fill in the clozes. In this version drop-down menus with three possible answers are offered for each cloze. Thus a reduction of complexity is possible with regards to content as well as by exercise design options. This option allows users to choose their preferred level of complexity and thereby contributes to the third UDL principle by preventing excessive demands and allowing options for self-regulation. For this specific exercise (figure 2) users can check their solutions immediately by a click on the button below the exercise. In the future, instructors will be supported during content creation by hints. These will contain recommendations how to present and design content, based on guidelines and best practice recommendations for accessibility and UDL. Hence this system contributes to supporting teachers in addressing heterogeneity in classes. It helps them to provide variable material for all their students without using different platforms.



The screenshot shows the LAYA system interface. At the top, there is a navigation bar with the LAYA logo on the left and menu items: 'Kurse', 'Meine Kurse', 'Profil', 'Logout', and 'Zum letzten Kurs: Burnout'. Below the navigation bar, there is a sub-menu with 'Darstellung', 'Text', and 'Einfach'. The main content area features the title 'Burnout' and a paragraph of text with several blank spaces for user input. The text reads: '[ ] kann jeden treffen, der unter [ ] steht. Nach der Diagnose erfolgt in der Regel eine [ ] zum Psychotherapeuten oder [ ]. Für die zunehmende Anzahl an Burnout [ ] werden in der Literatur verschiedene Gründe angegeben. Es werden zum Beispiel veränderte [ ] und ein verändertes Bewusstsein der Menschen für [ ] Erkrankungen genannt.' Below the text is a green button labeled 'Lösung überprüfen'.

Figure 2. Screenshot LAYA system: clozes

*May 2017*

Responsiveness is another feature that is integrated into the system and allows a use, not only on computers, but on mobile devices as well. For users this adds to the possibilities of choosing individual preferences and adapting the system to personal needs. The system is built modular and flexible to allow further expansions and additions in the future. It is open source and therefore accessible for everyone. Currently LAYA is focused on self-directed learning but perspective possibilities for cooperative learning will be investigated and implemented as well, which will contribute to principle three of the UDL guidelines.

#### **4. Conclusion**

This paper presents a design approach for an inclusive E-learning system. As described in the previous section, the design follows common guidelines like the WCAG and UDL and is based on personas. The flexible usability allows variable disabled and non-disabled learners with different preferences and needs to learn in the same system, which contributes to UDL. On the other hand the systems adaptivity suits individual preferences and the authoring tool allows creation and provision of variable individualized learning material. Therefore it seems realistic to combine technical approaches to accessibility and educational concepts for E-Learning as well as universal and individual design within one E-Learning system.

It is planned to allow users to change background- and text colour in the future, which is especially useful for visually impaired people. Besides currently a gamification concept for one specific course is developed, which can add to the third UDL principle. To further contribute to inclusion, communication and collaboration within the system are needed. This is not yet realized as the authoring tool and further exercises is still under development. Before communication and collaboration can be integrated into LAYA further research is necessary. There are questions that need to be answered first: What forms of communication are inclusive or can be made inclusive? Is synchronous communication possible? What can collaboration between disabled and non-disabled learners with different representation preferences look like? These few questions are just a very small extract of the gap that exists for cooperative learning formats in inclusive E-Learning. They allow a glance at the research that still has to be done.

In a next step evaluations are planned with different user groups. There will be studies in vocational education and at university in teacher education in a first step. As requirements of schools are slightly different, further adaptations like the integration of a teacher role, need to be deliberated and implemented before studies can take place. Currently these studies are planned for computer science and history classes. The different studies will show if the presented design fulfills the expectations towards usability and inclusiveness. Furthermore they will evaluate if the described combination of accessibility guidelines, educational aspects, UDL guidelines and individual approaches can support the learning process of platform users satisfactory. Especially for vocational education there will be a higher number of participants, which may allow to state representative results. An adaptation of LAYA is planned, according to the findings of the evaluations.

May 2017

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