

Prototypical implementation of an accessible vocabulary trainer

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Abstract

This paper presents a prototype that aims to make education accessible to all. The chosen learning topic focuses on youth language to overcome language barriers and create better access to society for those who are not fluent in German. The results are based on a systematic literature review and the development of a prototype tested using the BITV tests.

The key findings are that accessibility should be a strategic goal set and repeatedly promoted by senior management. This way, it does not become less of a priority, which has often proven to be a weakness because the accessible elements of software are not necessarily needed for its core functions. With the insight of using an agile participation model, accessible applications can be completed in a shorter average time in the future. The project also demonstrates the importance of accessibility awareness in software development.

Keywords: Digital accessibility, software management, usability, user experience

Introduction

As part of the "Accessibility" module, a prototype for a learning application that can be used to practice vocabulary was developed in collaboration with a student working group*. The learning application was presented as part of a project using a prototype and aimed to give everyone barrier-free access to education.

In addition to individual reasons, the motivation of the working group can be summarized as the desire to design future development work in such a way that as many people can use the end products as possible. Accessible design should not only apply to project work but should become a permanent concept in software development.

Those who do not suffer from a physical or mental disability themselves or accompany someone in their environment in their daily lives can hardly be aware of the numerous barriers that these people experience. While the use of online media is taken for granted by most people and can be learned intuitively, it can be challenging for people with disabilities to use. Many online media are even inaccessible to them, as the operation of the services has not been taken into account by people with disabilities. This leads to exclusion, which can exacerbate the suffering of those affected [1].

In order to gain a better understanding of the types of disabilities and the associated barriers of online media, the working group set itself the goal of expanding its knowledge in this area. Future designs and products should be created with the knowledge gained so everyone can use them.

This paper reports on the process of creating an accessible learning application. The conception, prototypical implementation, and review using BITV tests are discussed.

The long-term goal was to develop an application where users could train various learning topics, such as languages or dialects. The project work focused on the learning topic of youth language. Youth language, or slang, refers to how certain social, professional, or similar groups express themselves. By learning youth words or German slang, language barriers between different age groups are to be broken down, and people who do not have a good command of German will be given better access to society. The term "swag trainer" was used for the selected learning topic.

The application's target group includes people interested in learning German dialects and youth language. In the project, a target group was selected for the learning topic of youth language with the Swag-Trainer. All adults aged 18 and over can be interested in learning the common youth language. The leading target group is interested adults aged 35 and over. However, younger adults may also be interested in learning the youth language, for example, if German is their second language.

The application was not intended exclusively for people with disabilities but was designed to include them. People with different disabilities were considered. Many different types of disabilities should be considered in software development [3]. The project focused on the following groups of disabled people:

- Visually impaired or blind people,
- Hearing impaired and deaf people,
- People with motor disabilities,
- People with mental disabilities.

The explicit inclusion of disabled people in the target group should not be the main characteristic of the target group or define it per se but merely emphasize that the application should be usable for all people aged 18 and over.

2 The Swag Trainer

The project aimed to design an application that provides older people with barrier-free access to learning the so-called youth language and various German dialects. Youth language is an

expression that teenagers and young people currently use in their language usage. By learning the youth language, users acquire "swag." The word swag comes from American rap culture and, in youth language, stands for a particularly cool and casual vibe. The "Swag-Trainer" application is designed as a web application and can initially only be accessed via the Internet browser.

3 Functions

The following chapter describes the functions of the Swag-Trainer. There are currently many different specifications and recommendations regarding digital accessibility (Fig.1). Some of these overlap with each other.

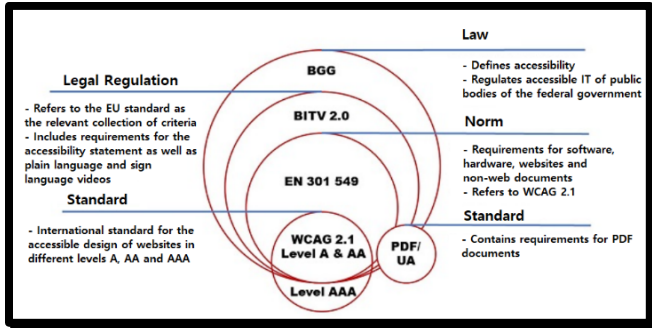


Figure 1 Guidelines on digital accessibility [13]

Helpful tips and recommendations for implementing digital accessibility are presented in [4]. The work on participatory technology development [6] also shows possible implementation scenarios about management methods in software development, some of which the working group has taken up.

3.1 Log-in function

Access to the application is low-threshold and does not require prior registration. Users can play through the first lesson without having to register. Once users have played through the first lesson, they are prompted to create a user account with a pop-up. The user account allows users to save the progress of the respective learning path and continue where they left off. In addition, unique settings for sound effects, font size, and color scheme can be saved here and automatically set when logging in.

3.2 Adjusting the font size

Two control elements in the top left-hand corner of the screen allow users to enlarge or reduce the content displayed on the website (Fig. 2).

This allows people with a visual impairment better to recognize the texts and other elements on the page. In addition, the icons and controls are more prominent and more accessible to click for people with visual impairments or motor impairments.

The font size for subtitles for videos and audio files can also be changed using the two control elements so that people who are hard of hearing or deaf can read along without barriers.

3.3 Sound effects and audio content

Users are given additional feedback on actions with the help of sound effects. For example, a correct answer is signaled with a sound that differs from the sound for an incorrect answer. There is also a sound effect to signal the successful completion of a lesson. The sound effects are at most five seconds each. In addition, the

volume of the sound effects can be adjusted in the settings or switched off entirely so that they do not disturb users navigating the site using voice output.



Figure 2 Registration interface with option to change the font size

Background music is not provided so that users can concentrate better, and the audio playback is not affected by the text-to-speech functionality of the screen reader.

3.4 Lessons and learning paths

In the application, users can choose between different learning paths and lessons. A learning path consists of several lessons that reflect the difficulty level (Fig. 3). Learning paths differ according to dialects and user restrictions.

3.4.1 Accessibility learning path

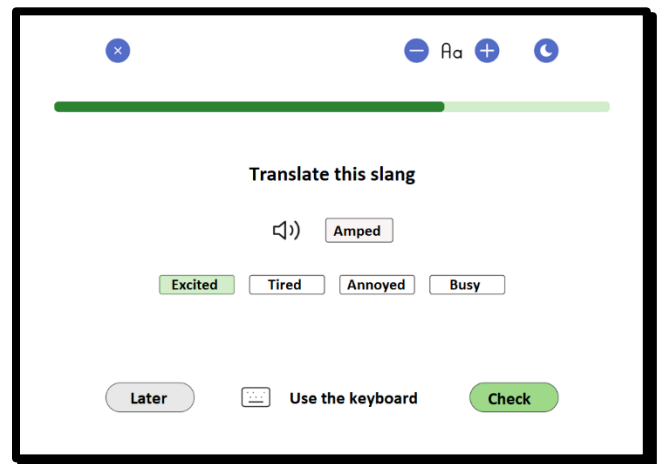


Figure 3 Simple learning path with multiple choice selection

For people with disabilities, the accessibility learning path can be selected if this information is not already read by the API of the user's device. Cookies are used to save the settings in the user account. Access to the API of the smartphone accesses the following values for an Apple product, for example:

- deactivated the automatic brightness setting of the iPhone,
- activation of the "intelligent" dark mode,
- activation of the "one-hand mode" of the iPhone,
- make the user interface of the iPhone static,
- activation of user-defined "Back Tap" actions,
- communicate with Siri via text and,
- enable the app to be called up,
- access to the hidden magnifying glass app.

3.5 Visualization using graphics and symbols

The vocabulary to be selected is visualized in the application using graphics.

They are used to visualize the vocabulary and enhance the website's look graphically. The website can still be used if the graphics are not displayed for an unknown reason.

The functionalities on the website are visually supported by symbols so that people with learning disabilities can navigate the website intuitively. When selecting the symbols used, care was taken to use familiar symbols. The symbols were placed on the website so they are a certain distance apart, easy to click on with a computer mouse, and easy to hit for people with motor impairments who work with a computer mouse or a particular input device. In addition, the clickable symbols can be controlled and activated using the keyboard.

The ALT attribute is used for symbols and graphics. The ALT attribute is a text stored on the website describing a graphic or symbol. The ALT attribute can be read aloud to users by a screen reader and is essential, especially for people with visual impairments.

The title attribute is also used for the graphics. The title attribute adds an additional note to a graphic in the form of a short text displayed when the user moves the computer mouse over the graphic. The text also briefly explains what happens when the graphic is clicked on [8].

3.6 Labeled controls

For all clickable controls, care was taken to choose a label that is understandable for users and describes the function of the control. The label was explicitly assigned to the control element so that a screen reader could determine the name of the control element. Therefore, it is also accessible to visually impaired people [9].

3.7 Keyboard operability

The Swag-Trainer can also be operated without the computer mouse, using only the keyboard. Users can navigate from one clickable element to another using the tab key. For each selected element, a frame is placed around the element so that users can see which element is currently selected. The clickable elements can be activated with the Enter key. When navigating with the Tab key, care has been taken to define a logical order for the elements so that users can see how they are moving. Navigating in the opposite direction is also possible by pressing the Shift key and the Tab key simultaneously.

Keyboard operability is particularly important for people with motor and visual impairments, as using a computer mouse can be challenging.

4 UX Elements

The following chapter describes the UX elements used for the swag trainer. Some of the elements go beyond the prototype.

4.1 Visibility

The design of the swag trainer was geared towards differentiating the various elements by color, shapes, and symbols. That means that people with color blindness can use the application without barriers.

In terms of visibility, it was ensured that all critical information and control elements were easily visible and easy to recognize. To this end, attention was paid to the use of high-contrast colors, the avoidance of cluttered layouts, and the provision of sufficient font sizes. Users can switch the contrast on and off via a control element in the top right-hand corner of the screen.

4.2 Progress bar

The progress bar shows users where they are in the respective lesson (Fig. 4). Each time a step is completed, the pointer on the progress bar moves further to the right. Another element below the progress bar shows the step the user is currently at in text form.

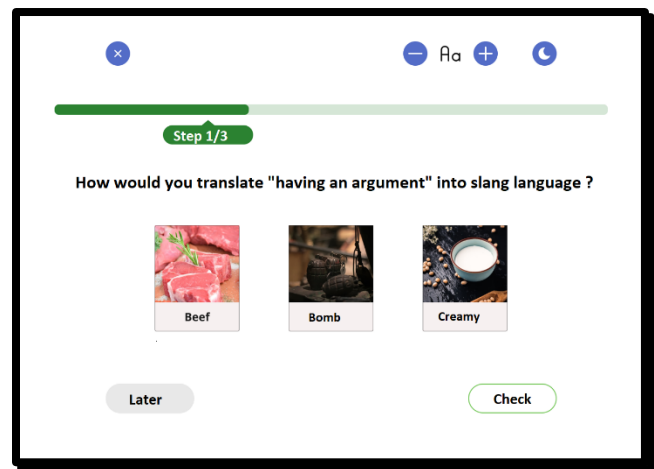


Figure 4 Selection of a vocabulary with progress indicator

Each time a step is completed, the pointer on the progress bar moves further to the right. Another element below the progress bar shows the step the user is currently at in text form.

4.3 Playback speed

The speed of the videos can be adjusted by setting the playback speed. For people with cognitive impairments, watching a video more slowly to understand better what is being said can be very helpful. This makes it easier for them to follow the video conversations and understand the vocabulary better.

4.4 Audio and visual alternatives

When integrating audio and visual content, care was taken to provide alternatives in the form of transcriptions and subtitles. For the graphics used to visually support the vocabulary, the vocabulary was always inserted as text so that users cannot learn the vocabulary solely on the basis of the graphics on display. When implementing graphics, the ALT and title attributes were used, which can be read aloud by screen readers and can help people with visual impairments (Fig. 5).

4.5 Legibility

To make the texts easier to read and the information more accessible, simple and straightforward language was used, and technical jargon

was avoided. To this end, short main sentences and simple, familiar words were used. In addition, care was taken to use sufficient line spacing, a good font size, and sufficient contrast so that the texts are recognizable. Plain language is not only helpful for people with cognitive impairments but also for people with learning disabilities, deaf people, illiterate people, and people with little knowledge of German [10].

5 BITV Tests

The Barrier-free Information Technology Ordinance (BITV) is a German ordinance designed to ensure that federal public bodies use barrier-free information technology. The BITV tests are a vital component in checking compliance with this regulation. There are other standardized tests, such as Selenium [12]. However, the automation of accessibility tests is not always advantageous, as many accessibility requirements must be tested with screen readers and assistive technologies [5]. For this reason, the working group has opted for manual testing based on the BITV. BITV tests ensure digital offerings, such as websites or applications, are accessible to people with different impairments. This includes, for example, people with visual, hearing, motor, or cognitive impairments. The aim is to create an inclusive digital environment that enables all users to participate equally in digital life [11].

The tests often include a comprehensive review of the website or application structure and the implemented functions. This includes using alternative text for images, implementing subtitles for videos, ensuring easy navigation for screen readers, adaptability to different screen sizes and resolutions, and avoiding barriers for people with motor impairments. Various tools and guidelines are used in BITV tests to assess accessibility. These include, for example, the WCAG (Web Content Accessibility Guidelines) standard and various test tools that check specific aspects of accessibility.

The results of BITV tests are crucial to ensure that digital offerings meet accessibility requirements. Therefore, Companies and public bodies must carry out regular BITV tests to ensure that their digital products and services are accessible to all users. This contributes to social inclusion and opens up more excellent potential users for digital offerings.

In the following, the results of the BITV test are divided into several chapters, presented and tested in tabular form using the BITV features.

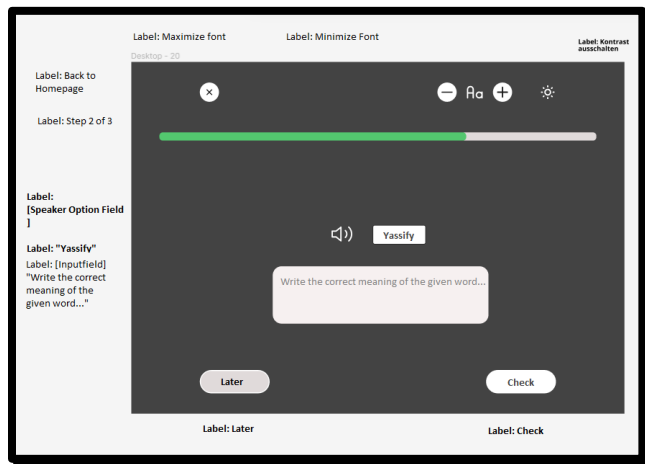


Figure 5 Labels for people with visual impairments

5.1 General requirements

According to the results of the BITV test's general part, the website fulfills the activation of accessibility functions in test step 5.2. It offers functions such as the read-aloud function, different color schemes, and font size adjustment and prevents automatic playback of animations, videos, and audio. However, biometrics still need to be fulfilled in test step 5.3, which is irrelevant to the prototype. Similarly, in test step 5.4, the preservation of accessibility information during conversion is not fulfilled, but this is also irrelevant for the prototype, as no document conversion takes place.

Test step	Evaluation	Justification/suggestion for improvement	Notes
5.2 Activation of barrier freedom functions	Absolutely fulfilled	The website offers barrier-free functions to meet the special needs of users, and the activation of these functions is also possible for all user groups.	Read-aloud function, Different color schemes, Adjustment of the font size, Animations, videos and audio are not played automatically.
5.3 Biometrics	Not fulfilled	This test step is not relevant for the prototype.	
5.4 Preservation of barrier-free information during conversion	Not fulfilled	This test step is not relevant for our prototype.	No document Conversion.

Table 1 Test chapter - General requirements

5.2 Two-way voice communication

According to the current planning status of the Swag Trainer, two-way voice communication is not planned. However, the function would be an addition to an application of this type and could be part of a later version. In this case, the test steps would be queried.

5.3 Video capability

The BITV test for video capability shows predominantly positive results. The website meets the requirements regarding the playback of subtitles and audio description. Overall, the platform has good accessibility for users with different video-related needs.

Test step	Rating	Justification / suggestion for improvement	Notes
7.1.1 Playback of subtitles	Absolutely fulfilled	The video is subtitled. The subtitles can be switched on or off depending on the user's input.	
7.1.2 Synchronous subtitles	Rather fulfilled	The video and subtitles are synchronized and there is no delay.	Play the video in the player embedded on the website and the time stamps are correct.
7.1.3 Preservation of subtitles	Partially fulfilled	The font size of the video caption can be adjusted. The font size of the web page can be changed at the top of the header.	The font size can be changed, but not the font.
7.1.4 Subtitle adjustments	Partially fulfilled	The font size of the video caption can be adjusted.	
7.1.5 Spoken subtitles	Fulfilled	The video and sound are played with the original sound and translation.	
7.2.1 Playback of audio description	Absolutely fulfilled	The audio description can be switched on and off.	
7.2.2 Synchronous audio description	Rather fulfilled	There is a mechanism for selecting and playing the available audio description.	
7.2.3 Preservation of audio description	Rather fulfilled	Audio description can still be switched on and is displayed synchronously with the picture and sound.	
7.3 Controls for subtitles	Absolutely fulfilled	The controls for activating subtitles and audio	

and audio description		description are located on the same interaction level as the controls for playback control.	
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Table 2 Test chapter - Video capability

5.4 Text alternatives

The BITV tests in area 5.4 focus on ensuring text alternatives for elements on websites or digital applications. Text alternatives are crucial for making information accessible to people with visual impairments or other limitations. The test checks whether all non-textual content, such as images, graphics, or multimedia elements, are provided with concise and meaningful text alternatives. These text alternatives should convey the content and purpose of the element to ensure comprehensive accessibility. Successful implementation of this requirement helps ensure that digital offerings function according to accessibility standards and can be used by a broader user base.

Test step	Rating	Justification/suggestion for improvement	Notes
9.1.1.1a Alternative texts for operating elements	Rather fulfilled	Alt texts are included in the prototype. This includes buttons, graphics, logo and video.	
9.1.1.1b Alternative texts for graphics and objects	Rather fulfilled	Alt texts are included in the prototype.	
9.1.1.1c Empty alt attributes for layout graphics	Partially fulfilled	Layout graphics have ALT attributes.	
9.1.1.1d Alternatives for CAPTCHAs	Not fulfilled	This test step is not relevant for our prototype.	No captchas

Table 3 Test chapter - Text alternatives

5.5 Time-based media

The results of the BITV test for time-based media show that the platform needs to consider alternatives for audio files and silent videos, which are irrelevant to the prototype. Recorded videos offer full subtitles and an available audio description. The test step is not relevant for live videos and their subtitles. Audio description for videos, on the other hand, is completely fulfilled. There is room for

improvement in the more precise description of visual information in the audio description and the testing of alternatives for audio files.

Test step	Rating	Justification / suggestion for improvement	Notes
9.1.2.1 Alternatives for audio files and silent videos	Not fulfilled	This test step is not relevant for our prototype.	No audio file
9.1.2.2 Recorded videos with subtitles	Absolutely fulfilled	Subtitles are automatically displayed alongside the video and/or can be switched on.	
9.1.2.3 Audio description or full text alternative for videos	Partially fulfilled	The audio description is already included in the normal audio track. All visual information, including descriptions of the visual context, actions and facial expressions of the actors are not described.	
9.1.2.4 Videos (live) with subtitles	Not fulfilled	This test step is not relevant for our prototype.	No live videos
9.1.2.5 Audio description for videos	Absolutely fulfilled	The audio description is available for the video.	

Table 4 Test chapter - Time-based media

5.6 Customizability

The "Adaptability" chapter in the BITV test is crucial for accessibility, as it ensures that digital content can be flexibly adapted to the needs of different users. The evaluations show that some HTML structural elements, such as headings and lists, are not marked up accordingly in the prototype, but this can be considered in later programming. The sensible sequence and usability without reference to sensory features are fulfilled in the prototype. The test step "No restriction on screen orientation" is partially fulfilled, as the display in Figma is unrestricted, but the final programming still needs to be checked. The prototype cannot check the display of input fields for user data transfer and other aspects, such as customizable text spacing and operable displayed content. In the "Distinguishable" section, the prototype meets criteria such as "Can be used without colors" and "Sound can be switched off," while others such as "Content breaks" and "Text spacing can be adjusted"

cannot be checked. Despite some shortcomings, the prototype offers essential customizability that can be optimized in the final implementation.

Test step	Rating	Justification/suggestion for improvement	Notes
9.1.3.1a HTML structural elements for headings	Not fulfilled	The prototype was already geared towards the use of structural elements such as the headings h1-h6 during development.	Due to the presentation of the prototype in the Figma tool, the headings are not yet provided with the html structural elements.
9.1.3.1b HTML structural elements for lists	Not fulfilled	Lists can also be quickly implemented as html structural elements.	
9.1.3.1c HTML structural elements for quotations	Not fulfilled	Quotations can also be quickly marked as such during programming.	
9.1.3.1d Content structured	Not fulfilled	The bookmarklet required for this test cannot be used on a Figma prototype.	
9.1.3.1e Correct structure of data tables	Not fulfilled	The bookmarklet required for this test cannot be used on a Figma prototype.	
9.1.3.1f Assignment of table cells	Not fulfilled	The bookmarklet required for this test cannot be used on a Figma prototype.	
9.1.3.1g No structure markup for layout tables	Not fulfilled	The bookmarklet required for this test cannot be used on a Figma prototype.	
9.1.3.1h Labeling of form elements can be determined	Not fulfilled	The verification of programmatic elements cannot be carried out on a Figma prototype.	

programmatically			
9.1.3.2 Sensible sequence	Not fulfilled	This step cannot be verified using the prototype.	
9.1.3.3 Usable without reference to sensory characteristics	Absolutely fulfilled	All elements can be operated without having to rely on sensory features.	
9.1.3.4 No restriction on screen orientation	Partially fulfilled	The Figma software, with which the prototype was created, enables a display without screen orientation restrictions.	
9.1.3.5 Input fields for user data convey the purpose	Not fulfilled	This step cannot be verified using the prototype.	

Table 5 Test chapter - Adaptability

5.7 Distinctiveness

The "Distinguishability" section of the BITV test shows that the prototype is successful in several criteria. All parts of the prototype are understandable and usable without colors. The function of switching the sound on or off is fulfilled, although the final programming is still pending. Contrasts of texts and graphic control elements are sufficient and meet the requirements. However, some aspects, such as the adaptability of text spacing and the usability of displayed content, cannot be verified in the prototype and require evaluation in the final implementation.

Test step	Evaluation	Justification/suggestion for improvement	Notes
9.1.4.1 Usable without colors	Absolutely fulfilled	All parts of the prototype are understandable and usable without colors.	
9.1.4.2 Sound can be switched off	Basically fulfilled	The prototype does not contain a programmed function that switches the sound on or off, but does	The function was considered and designed for programming

		contain buttons that offer this function.	g in the prototype.
9.1.4.3 Contrasts of texts sufficient	Absolutely fulfilled	All contrasts have been checked and are sufficient.	
9.1.4.4 Text can be enlarged to 200	Partially fulfilled.	The prototype can only be completely enlarged or reduced in size.	The function was considered and designed for programming in the prototype.
9.1.4.5 No font graphics	Fulfilled	The check cannot be carried out completely with the developer tools, but no font graphics are used.	
9.1.4.10 Break content	Not fulfilled	This step cannot be verified using the prototype.	
9.1.4.11 Contrasts of graphics and graphic control elements sufficient	Fulfilled	The application largely dispenses with graphical controls. However, all contrasts have been checked and are sufficient.	
9.1.4.12 Customizable text spacing	Not fulfilled	This step cannot be verified using the prototype.	
9.1.4.13 Displayed content operable	Not fulfilled	This step cannot be verified using the prototype.	

Table 6 Test chapter - Distinctness

5.8 Access via keyboard

In the "Access via keyboard" section of the BITV test, several evaluation criteria cannot be checked in the prototype. Accessibility without a mouse, the absence of keyboard traps, and the customizability or disabling of keyboard shortcuts cannot be assessed based on the prototype presentation and require evaluation in the final implementation.

5.9 Time sufficiency

In the context of "Time sufficiency" of the BITV test, it can be seen that the test step for the adaptability of time limits is not relevant for the prototype, as there are no such limits. The ability to turn off moving content is more likely to be fulfilled in the

prototype, as the pause button is placed in the direct context of the moving content, and the content remains available after pausing, even if this is not displayed correctly due to prototype limitations. Improvements could include a more precise representation of this aspect in the prototype.

Test step	Evaluation	Justification/suggestion for improvement	Notes
9.2.2.1 Customizable time limits	Not fulfilled	This test step is not relevant for our prototype.	No time limit
9.2.2.2 Moving content can be switched off	Rather fulfilled	The button or instruction to stop the movement is clearly located in the direct context of the moving content.	

Table 7 Test chapter – Time sufficiency

5.10 Seizures

This test checks whether there are mechanisms to protect potentially susceptible users from risks such as visual overstimulation or other potential triggers. The focus is to ensure that the design elements are not too flickering, dazzling, or otherwise problematic for people with epileptic seizures or similar sensitivities. Successful testing in this area ensures safe and comfortable use of the digital platform for all users, regardless of potential vulnerabilities. This chapter was not relevant to the prototype.

5.11 Navigation

Navigation in accessible applications is crucial to ensure that users with different abilities and needs can navigate effectively and seamlessly through the user interface. The test step "Areas can be skipped" is partially fulfilled, as clear page structures and demarcated areas are present. However, exact verification still needs to be completed due to missing HTML structural elements in the prototype. A sensible use of document titles, a coherent keyboard operation sequence, meaningful link texts, and alternative access paths cannot be checked in the prototype. However, these elements are crucial for efficient navigation. The partial fulfillment for "Meaningful headings and labels" shows that structured content with clearly visible questions as headings is present. At the same time, the "Current position of focus clearly" is not verifiable. Overall, the evaluation underlines the need to carefully design the navigation structure in the final implementation to ensure barrier-free and practical use.

Test step	Evaluation	Justification/suggestion for improvement	Notes
9.2.4.1 Areas can be skipped	Rather fulfilled	The test step can only be partially tested. The pages are clearly structured and the areas are clearly distinguishable from each other.	
9.2.4.2 Meaningful document titles	Not fulfilled	This step cannot be verified using the prototype.	
9.2.4.3 Conclusive sequence for keyboard operation	Not fulfilled	This step cannot be verified using the prototype.	
9.2.4.4 Meaningful link texts	Partially fulfilled	Some control elements are provided with text indicating the purpose of the link. Other links are designed as icons and contain no text.	
9.2.4.5 Alternative access routes	Not fulfilled	This step cannot be verified using the prototype.	
9.2.4.6 Meaningful headings and labels	Partially fulfilled	The learning path shown in the prototype does not show any direct headings, but the questions of the lesson as "headings". These are clearly visible and structured.	
9.2.4.7 Current position of the focus clearly	Not fulfilled	This step cannot be verified using the prototype.	

Table 8 Test chapter - Navigation

5.12 Input modalities

The BITV test for the prototype reveals several aspects in the context of input modalities. The lack of verifiability of alternatives

for complex pointer gestures and the ability to cancel or revoke pointer gestures indicates that careful implementation of these functions is necessary for the final implementation. The assessment that the visible labeling part of the accessible name is not met emphasizes the importance of screen reader compatibility and recommends conversion to HTML for better accessibility. It is also pointed out that the prototype's alternatives for motion activation need to be verifiable. These results highlight the challenges of designing accessible input modalities and the need to consider these aspects in the development process.

Test step	Evaluation	Justification/suggestion for improvement	Notes
9.2.5.1 Alternatives for complex pointer gestures	Not fulfilled	This step cannot be verified using the prototype.	smartphone call, but the pointing gestures are theoretically supported by the browser.
9.2.5.2 Pointer gesture inputs can be canceled or revoked	Not fulfilled	This step cannot be verified using the prototype.	
9.2.5.3 Visible labeling part of the accessible name	Not fulfilled	Screen readers such as "Pericles" cannot be checked with Firefox or Safari using the prototype. Conversion to HTML.	
9.2.5.4 Alternatives for movement activation	Not fulfilled	This step cannot be verified using the prototype.	

Table 9 Test chapter - Input modalities

5.13 Legibility

BITV tests by Guideline 5.13 focus on the readability of digital content. This involves checking whether the texts on websites or applications are easily understood and structured. The test ensures that the information is accessible to a broad target group, including people with reading or comprehension difficulties.

Test step	Evaluation	Justification/suggestion for improvement	Notes
9.3.1.1 Main language specified	Not fulfilled	This step cannot be verified using the prototype.	
9.3.1.2 Other language words and sections marked	Not fulfilled	This step cannot be checked using the prototype, as the screen reader cannot be activated. Figma-to-HTML plugins will not achieve the desired results.	

Table 10 Test chapter - Readability

5.14 Predictability

The BITV test shows mixed results about predictability in the prototype. The step "No unexpected context change on focus" is not fulfilled, as the tab essential function is missing; therefore, no focus is possible. In contrast, "No unexpected context change on input" is fulfilled, as no unexpected context changes occurred in the tests of flows 1, 2, and 3, and form elements such as checkboxes and radio buttons worked as expected. The "Consistent navigation" is rated as rather fulfilled, as not all functions of the various navigation mechanisms can be called up in the prototype. Nevertheless, navigation mechanisms, menu items, and recurring functions in different website areas are named meaningfully and consistently.

Test step	Evaluation	Justification/suggestion for improvement	Notes
9.3.2.1 No unexpected context change with focus	Not fulfilled	This step cannot be checked using the prototype. Tab button function is not available, therefore no focus possible.	
9.3.2.2 No unexpected context change on input	Fulfilled	There were no unexpected context changes during the tests of Flow 1, 2 and 3. Form elements (checkboxes and radio buttons) as expected.	
9.3.2.3 Consistent navigation	Rather fulfilled	Not all functions of the different navigation mechanisms can be called up.	

9.3.2.4 Consistent designation	Rather fulfilled	All uniformly named.	
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Table 11 Test chapter - Predictability

5.15 Assistance with input

The "error detection" function is not fulfilled and could be particularly useful for entering email addresses, while for other aspects, correct entry is considered part of the game. On the other hand, "labels of form elements are available," which indicates good accessibility and comprehensibility of the input fields. However, the "Help with errors" function is not fulfilled and may need to be generated during conversion for fields such as syntactically incorrect email addresses. The function "Error avoidance is supported" is also not fulfilled, as it is not provided for in the application and has therefore not been tested.

Test step	Evaluation	Justification/suggestion for improvement	Notes
9.3.3.1 Error detection	Not fulfilled	Cannot be stored in the prototype. The function would be useful when entering the e-mail address. Otherwise, it is part of the game to enter the correct spelling.	
9.3.3.2 Labeling of form elements	Fulfilled		
9.3.3.3 Help with errors	Not fulfilled	Not fulfilled by the prototype application.	
9.3.3.4 Error prevention is supported	Not fulfilled	The function is not provided for in the application and does not need to be tested.	

Table 12 Test chapter - Assistance with input

5.16 Compatibility

The "correct syntax" aspect is not fulfilled and cannot be checked in the prototype, as there is no HTML. A possible solution could be to use the "Check serialized DOM of current page" bookmarklet to check the validity of the parsed source code in the W3C validator. The requirement "Name, role, value available" is also not fulfilled and cannot be checked in the prototype due to missing HTML. This requirement refers to the fact that self-

designed components should provide corresponding semantic information. In addition, "Status messages programmatically available" is not fulfilled, as no corresponding status messages were implemented in the prototype.

Test step	Evaluation	Justification/suggestion for improvement	Notes
9.4.1.1 Correct syntax	Not fulfilled	Not verifiable in the prototype. No HTML	
9.4.1.2 Name, role, value available	Not fulfilled	Cannot be checked in the prototype, as no HTML was implemented.	
9.4.1.3 Status messages per g available in the frame	Not fulfilled	A status message has not been implemented.	

Table 13 Test chapter - Compatibility

5.17 User-defined settings

These tests evaluate the support of user-defined settings on digital platforms. They check whether websites or applications allow customization to meet individual needs. This includes, for example, the ability to change font sizes, adjust color contrasts, or set other personal preferences. A successful test in this area ensures flexible adaptability, enabling users to design the digital environment according to their individual needs and thus ensure barrier-free use. This chapter was not relevant to the prototype.

5.18 Authoring tools

The function "Accessible content creation" is not evaluated, as the tested application is not an authoring tool. The same applies to the preservation of accessibility information during transformations, repair assistance, and the use of templates. The web application is not designed as an authoring tool, so these specific functions are irrelevant and, therefore, not tested. However, in an accessible environment, authoring tools are crucial to ensure the content created is accessible from the start and retains its accessibility after various transformations.

Test step	Evaluation	Justification/suggestion for improvement	Notes
11.8.2 Accessible content creation	Not fulfilled	The web application to be tested is not an authoring tool.	

11.8.3 Maintaining accessibility information during transformation	Not fulfilled	The web application to be tested is not an authoring tool.	
11.8.4 Repair assistance	Not fulfilled	The web application to be tested is not an authoring tool.	
11.8.5 Templates	Not fulfilled	The web application to be tested is not an authoring tool.	

Table 14 Test chapter - Authoring tools

5.19 Documentation and support

Regarding documentation and support, the reviewed web application has some things that could be improved. Compatibility and accessibility documentation are unavailable, which can challenge developers and users. It is recommended that comprehensive technical documentation be created that covers both the functions of the service and specific details on accessibility. Furthermore, there is a lack of accessible documentation for the general use of the website. Here, it is advisable to create product documentation that explains the essential functions and points out additional features that can improve accessibility for specific user groups.

The test shows that technical support is not applicable as the application could be more productive. However, it is recommended that adequate technical support be implemented to assist future users in case of problems or questions. Clear and effective communication and documentation the support team provides are also essential to ensure an accessible and user-friendly environment.

Test step	Evaluation	Justification/suggestion for improvement	Notes
12.1.1 Documentation	Not fulfilled	No technical documentation of functions of the offer available.	Create technical documentation for application.
12.1.2 Accessible documentation	Not fulfilled	No product documentation of the web offer to provide assistance for the general use of functions of the offer	Create product documentation.
12.2.2 Technic	Not fulfilled	Not applicable	Implement support.

al support			
12.2.3 Effective communication	Not fulfilled	Not applicable	
12.2.4 Documentation provided by Support	Not fulfilled	Not applicable	

Table 15 Test chapter - Documentation and support

6 Results

The Figma tool was chosen to develop a prototype based on the team's experience. Figma was particularly suitable as a tool for developing a prototype for the working group, as several team members can work on a design simultaneously, and Figma has plugins that make designing more accessible and faster. In addition, created designs can be shared easily within the team so that solutions can be presented easily and feedback can be obtained quickly. Unfortunately, Figma is limited in implementing accessible functions and UX elements, so we could not implement some planned and desired functions and UX elements.

Implementing the individual test steps of the BIK BITV test (web) was easy to work through. An agile way of working was known to all group members and could be implemented excellently. In retrospect, however, it would have been better to involve people from each disability group in the design process. This would have promoted the integration of these people and allowed their points of view to be incorporated directly.

7 Discussion

Unfortunately, some test steps of the BITV test could not be carried out properly, as the prototype development with Figma limits this. When creating the prototype, the focus was on the accessible functions and elements described in chapters 3 and 4. When programming the application, the functions and elements described would be accessible from the outset.

In addition, the application presented in the prototype should be supplemented with further learning modes and difficulty levels to cater to other individual preferences. People with cognitive impairments could also be catered for more effectively by carrying out surveys in advance to ascertain the target group's needs. During the development of the prototype, some ideas also had to be discarded; these could be reintroduced with more time. In summary, however, the prototype provides a reasonable basis for an accessible learning application.

Other methods and international standards were also found in the research, such as components of web accessibility in [14] (Fig. 6).

It was found that a great deal of knowledge and awareness of the topic of accessibility was gained through the development of this project work and the implementation of the test steps, which will be immensely helpful in the future creation of user interfaces.

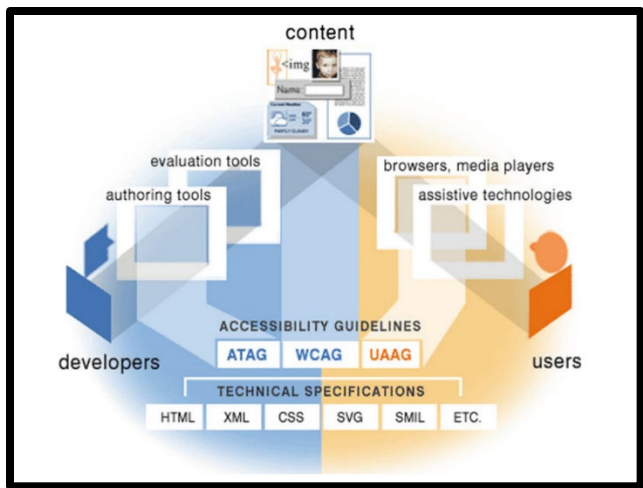


Figure 6 Essential components of web accessibility [14]

8 Conclusion

In summary, it can be said that the development of the Swag Trainer has provided excellent insight into accessible applications. In particular, accessibility became clear when demographic change meant that more and more people were encountering digital barriers. The development of the prototype has strengthened the understanding of this group of people and underpinned the need for language-based learning applications. Only those who speak the target language can communicate and function. An accessible learning application that is playfully structured and divided into different difficulty levels can significantly help one learn a language.

It was also recognized that accessibility must be seen as a strategic goal in every application development and must be continuously promoted by the management. Involving affected people would further strengthen the achievement of this goal.

The findings of this study should be used to make future applications accessible. In this way, they will be made accessible to all people and thus promote inclusive progress in the digital world.

* Acknowledgement

Special thanks go to Alexandra Rott, Inggita Arundina, Josefine Theden-Schow and Reyko Krasemann, with whose help the prototype was created. The joint processing of the tasks within the group represented successful project work that led to a satisfactory result.

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