

Accessible Web-based Educational System

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Abstract: This paper identifies challenges for designing accessible web pages. It proposes to help meeting the need of disable people in a simple and reliable way by enabling access to information technologies. In this paper, the principles of quality of a web site will be developed. Also, we will discuss the accessibility dimensions in web-based education, and identify the main elements to design an accessible web-based application system. The prototype and the case study of the proposed system are presented in this paper.

Key words: E-learning, Web site application, Accessibility, Disability, Learning design, Educational system.

1. Introduction

While the number of users increases, the number of persons with disabilities on the web also increases. Other media crossed step by making the content accessible to people with disabilities. The film on DVD and shows on television, for example, are closed captions. The books are printed in several copies, electronic and audio formats Braille editions also. The content of web sites must also be accessible. People with disability should be able to understand, navigate, and interact with a web site. Many sites are designed without taking into consideration the problem of accessibility. One of the reasons is that creating an accessible site is considered as a complex task, and is perceived as expensive. Another reason is that most of the owners of sites ignore and underestimate the number of visitors who have a disability. In addition, many designers are ignorant, when it comes, to create accessible sites and as a result, there is little attention reserved for accessibility of web sites when they are created.

Creating an accessible website is not too complex if the designer follows the established rules, guides, and the best practices when writing HTML code. An accessible site is simply a site that disabled people can easily navigate and access all of its contents. Web accessibility should encompass all kind of disability that affect the access to the web including the physical, visual, auditory, speech, and neurological disabilities i.e., low view people should be able to adjust the size of characters,

according to their needs for reading. Example using Firefox, Mozilla or Netscape, Ctrl and the key "+" enlarge the size and Ctrl and key "-" to decrease, and using Opera, the keys "+" or "-" on the numeric keypad. Also, low view people should have the maximum contrast colors. Blind people who use screen reading should be able to take cognizance quickly and easily of the content when they navigate the site. Those who have problems to use the mouse should be able to use the keyboard in place. The list is not exhaustive, but it gives an idea of the various needs. The W3C (World Wide Web Consortium) define the criteria and publish the recommendation to have an accessible web site, and publish the Web Content Accessibility Guidelines (WCAG 1.0) in 1999. The WCAG consists of 14 principles of accessible design that includes a set of checkpoints that explain how the guideline applies to Web development [1, 2]. Accessibility has been recognized as one of the principle design requirements for web-based content and systems [3, 4]. The paper is organized as follows: in section 2 we discuss the features of a website and the accessibility dimensions in Web-based application. For each accessibility dimension, we analyze the accessibility requirements. Section 3 presents different existing methodology used to build an accessible Website. Sections 4, and 5 present the role of guidelines based on assistive technology and how to create an accessible E-learning web site. Finally, Section 6 presents a

prototype and the case study of the proposed system.

2. Challenges for designing an accessible web site

A good web site must be useful (fulfilling a need) and available for all. When designing a Web site, designers should consider all spectrums of users that may visit this site. Below, are listed and discussed the five most important features of a website.

- 1- **Accessibility:** Use of the Web (the most rapidly adopted technology) is an integral part of our daily life and is spreading rapidly in all areas of society. The web represents the source of many information. Accessibility is the ability of the web site to be accessed by universal people, i.e. any kind of users, including the person with low vision and also by blind people. To create a website which is accessible by large number of person, there are some simple rules that a designer should follow, regardless of their hardware and software configuration or disability.
- 2- **Compatibility:** Nowadays, we are using different browser platforms. Website compatibility consists of making the website compatible with a range of browser platforms. The designer should check the website on different browsers, and operating systems.
- 3- **Navigability and Usability:** The navigability represents the most important aspect that the designer should take care about. People visiting a web site should be able to navigate easily through it. They should also be able to easily and rapidly find the information that they are looking for. A good web site should be conforms to the usability guidelines.
- 4- **Readability:** A good designer should make the web site easy to read. For example, the designer should not use too many font sizes, and should not choose many typefaces. They should choose typefaces which are clear on screen and easy to read.

3. HCI in E-learning domain

In recent years, many research activities have focused on design that aims to produce universally accessible systems, taking into account special needs of various user groups. These special needs are associated with many user factors, such as impairments of speech, hearing or vision, cognitive

limitations, aging, as well as with various environmental factors [9]. Fields that address this problem, such as Usability, Universal Accessibility, Universal Design, or Inclusive Design have been developed as relatively independent domains, but they share many aspects with other human-computer interaction (HCI) disciplines. Applying HCI in E-learning environment is important, it has many features that increase the effectiveness of E-learning system, these features can be summarized as follows:[10]

1. Usability: The usability is the basic parameter for the evaluation for the technologies and systems of E-learning. It considers users and their real needs in the center. Therefore investigation of usability and its integration or contribution to the learning process is worthwhile.

2. Safety: HCI is recognized as a important safety issue. In the industries of entertainment and advertising, interactive and social computing are so central. Top managers highly value HCI practitioners and the specialists of HCI acts as liaisons among graphic designers, business managers, developers and end users.

3. Enable virtual reality: The multi-using of 3D techniques which uses avatars to do social interaction through a virtual reality environment. The use of 3D technology from a user standpoint is going to be acting within virtual worlds like the Metaverse, or in Multi-Player Role-playing Games like Everquest or World of War craft.

4. Disability: Using HCI in education is very important specially for disabled people because HCI give the opportunity for the disabled arise who are suffering from motor disabilities. Such type of people may find it difficult to use standard input devices of a computer such as a mouse or the keyboard. People suffering from hearing disabilities or total deafness cannot find the correct content. Also, illiterate people who do not have any physical disability may suffer considerable barriers in having computer accessibility. HCI is associated with different area and has many features the concentration in the rest of this chapter will be on the usability feature which is a basic HCI parameter that helps us to design a new Model for developing interactive Learning Objects. Martrin J. et al. [8] also identified “8 Golden Rules of Interface Design”, most of which overlap with Nielsen’s usability principles. These 8 rules are presented in table 1.

Rule	Requirements / examples
Strive for consistency	<ul style="list-style-type: none"> • Keep action sequences consistent in similar situations.

	<ul style="list-style-type: none"> • Use identical terminology in prompts, menus, and help screens. • Employ consistent commands throughout.
Enable frequent users to use shortcuts	<ul style="list-style-type: none"> • To increase the pace of interaction use abbreviations, macros, special keys, and hidden commands.
Offer informative feedback	<ul style="list-style-type: none"> • System feedback should be provided for every operator action. • Frequent and minor actions can provide a modest response, while the response should be more substantial for infrequent and major actions.
Design dialog to yield closure	<ul style="list-style-type: none"> • Organized sequences of actions into groups with a beginning, middle, and end. • Informative feedback when a group of actions is completed, gives the operators a sense of accomplishment and an indication that they can proceed to the next group of actions.
Offer simple error handling	<ul style="list-style-type: none"> • The system should be designed so the user cannot make a serious error. • If an error is made, the system should be able to detect the error and offer simple, comprehensible ways to recover from the error.
Permit easy reversal of actions	<ul style="list-style-type: none"> • If the user knows that errors can be undone, they are encouraged to explore unfamiliar options without undue anxiety. • The units of reversibility may be a single action, a data entry, or a complete group of actions.
Support internal locus of control	<ul style="list-style-type: none"> • Experienced operators like to sense that they are in control of the system and that the system responds to their actions. • Design the system to make users the initiators of actions rather than the responders.
Reduce short-term	<ul style="list-style-type: none"> • Displays should be kept simple and sufficient training

memory load	time
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Table 1: the 8 Golden Rules of Interface Design

4. Designing for disabilities and the role of Guidelines Based on assistive technology

Based on assistive technology, there are many ways to improve the accessibility of applications of users with various disabilities. The most obvious way to enhance accessibility is to consider the needs of people with disabilities in all stages of the design process, including requirements gathering, task analyses, usability tests, and design guidelines. Other strategies include evaluating the usability of software in conjunction with popular assistive technologies, and testing under simulated disability conditions (e.g., unplug the mouse, turn off the sound, and use a screen reader with the monitor turned off). Designing software that takes the needs of users with disabilities into account makes software more usable for all users: people with disabilities who use assistive technologies, those who use systems “off the shelf”, as well as users without any significant disabilities. Underlying the whole theme of HCI is the belief that people using a computer system should come first. Their needs, capabilities and preferences for conducting various tasks should direct developers in the way that they design systems. People should not have to change the way that they use a system in order to fit in with it. Instead, the system should be designed to match their requirements.

When a user has a disability, access to learning software may depend entirely on how flexibly that product can deliver its content. Some users may need only to modify the parameters in which media is presented; other users may require entirely different media. Developers who achieve the kind of flexibility that diversity requires will enhance the accessibility of their product. Considerable literature already exists that discusses how people with disabilities can use assistive hardware and software to interact with computers. For this reason, this section discusses some of the needs, capabilities, and assistive technologies used by people with disabilities, and provide guidelines for improving application accessibility.

Perhaps the fastest increasing disability in today's computerized workplace is Repetitive Strain Injury (RSI) which is a cumulative trauma disorder that is caused by frequent and regular intervals of repetitive actions. Common repetitive stress injuries are tendonitis and carpal tunnel syndrome, although other types of injuries also occur.

Symptoms of computer based RSI include headaches, radiating pain, numbness, tingling, and a reduction of hand function. For computer users, mouse movements and typing may be causes or contributors to RSI. Assistive technologies such as alternate pointing devices, predictive dictionaries, and speech recognition can benefit these users by saving them keystrokes, reducing or eliminating use of the mouse, and allowing different methods of interacting with the system. Table 2 shows the assistive technology used to aid people with physical disabilities and RSI.

Assistive Technology	Function Provided
Alternate Pointing Device	Gives users with limited or no arm and hand fine motor control the ability to control mouse movements and functions. Examples include foot operated mice, head-mounted pointing devices and eye-tracking systems.
Screen Keyboard	On-screen keyboard which provides the keys and functions of a physical keyboard. On - screen keyboards are typically used in conjunction with alternate pointing devices.
Predictive Dictionary	Predictive dictionaries speed typing by predicting words as the user types them, and offering those words in a list for the user to choose.
Speech Recognition	Allows the user with limited or no arm and hand fine motor control to input text and/or control the user interface via speech.

Table 2: Assistive Technologies for physical disabilities and RSI

5. Computer Assisted Learning

The computer assisted learning helps a lot in training and education of disabled students. The assistance as a virtual teacher helps the student to interact in different forms and guided with proper examples. Nowadays the “e-learning” become more popular and provides more dynamicity in education and research. In the E-learning sector, many systems trying to address the need of providing access to learning material for disable people exist.

5.1- Create an accessible E-learning web site

More and more universities and schools are developing and using E-learning applications and solutions that allow students to do distance learning. As all the other systems, those applications should be accessible by disable person. During the last years, a number of systems aiming to meet the educational needs of people of special needs have been built and proposed. *Advanced Distributed Learning* (ADL) [4] encompasses a variety of learning applications, including e-learning, Web-based learning. ADL represents an evolution of distance learning that emphasizes collaboration on standards-based versions of reusable objects, networks and learning management systems, includes some legacy methods and media. ADL specify the following list of characteristics that an instructional products should have:

- 1- Accessibility that represent the ability for any person to access the instructional components from one remote location and be able to carry them to other locations.
- 2- Interoperability that consists in the ability to use instructional components developed in one location with one set of tools or platform in another location with a different set of tools or platform (note: there are multiple levels of interoperability).
- 3- Durability, which means that changing the technology, should not require redesigning the instructional components.
- 4- Reusability which means that an instructional component may be incorporated into different applications.
- 5- Adaptability that means that an instruction should be adapted to individual and situational needs.
- 6- Affordability that means that learning can be increased effectively while reducing time and costs.

5.2- Building an accessible Web-based educational system

Most of the special needs institutions in the Middle East depend on manual communication, which is the training method at institutes for the deaf in Bahrain. The majority of the special needs schools for the deaf rely on sign language to teach their students but unfortunately some of deaf or hearing impaired students suffer from autism or they turned into introvert individuals especially in their childhood so they would prefer self- study instead of socializing with others, Online linguistic

education would be the suitable and appropriate solution for those kind of children. Many websites have been browsed. The majority of the websites provides online sign languages and is professionals and attractive such as two ways communications (Automatic Translation of Text to Sign Language) but unluckily it has something missing which is User Friendliness especially for novice children students who just learn how to use the internet or any applications. Young children prefer pictures or images over text because they find text boring so what we have done is integrating both graphics and text in addition to video clips to enhance their skills. Application was created by macromedia director as our main tool to create a useful and accessible application for deaf and dumb children, we tried to make it very simple, static and user friendly so students can interact easily with it ,clear and clickable buttons with no dynamic animations or some vague objects that may student would struggle with them.

Our application was implemented as a compact disk therefore it has been tested and evaluated through many deaf students in addition to their instructors and they have given us their feedback and suggestions and most of the feedback were positives and all their suggestion were taken into consideration. Macromedia Director is one of the leading animation tools for creating multimedia applications for sharing and distribution on CD's and applicable on the Web. Lingo object-oriented programming language is one of the most significant factors and is to incorporate a diversity of multimedia resources, and its integration with Shockwave for distribution on the Web. Our first perception is to find out an easy website address, which easy to remember, memorize and to find especially because our main target audience are children. Application uses a useful tool that allows the user to run any English or any other languages application on any Windows platform. Although it is powerful program but is very easy to use and does not require any lingos or any programming comprehension. This software is specially personalized for Macromedia Director and solves almost all Arabic Language problems in Macromedia Director. Scalability is one of the most significant factors of web-based applications; this system was developed using Macromedia Director by having all the benefits of this type of tool. More over Microsoft Access was selected as well because of the functionality such as portability, easiness both for updating and deploying and applicability for web based applications.

Database would be sharing and holding all signs and gesture along with connected file names used for matching clickable buttons with their representative video clips or pictures. Prototype is considered to be an indispensable phase in any application. The system development life cycle has been choosing as macro-process that shapes the general approach and strategy to follow to carry out the system. Such strategy includes the following steps: System initiation/planning, requirement analysis and specification, prototyping, partition and selection, architectural design, detailed component design specification, component implementation and debugging, software integration and testing, system delivery, installation, training and use, and software maintenance. This system is designed as Web Based Application that includes three tiers layer as shown in Figure 1.

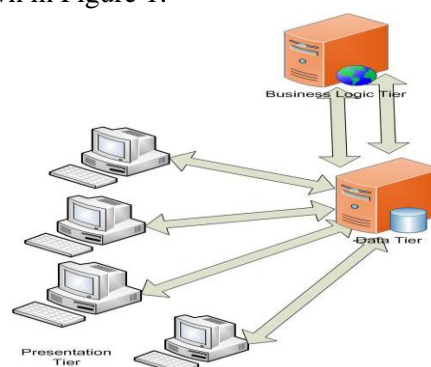


Fig 1: Three tier architecture of the proposed system

The general architecture of the proposed system consists of:

1. First tier is the presentation interface: this layer provides the graphical user interface (GUI) used for E-Learning for special needs, this layer serve to help the users to access the application and manage the data through the web.
2. Second tier is the Business Logic: this layer use SQL server to build the required functions to determine what kind of data is needed and where it is located, this tier contains validation and calculation related to the data.
3. Third tier is the database that will make easy the access to the data. It helps business logic tier to reach the data and perform required modifications, and manipulating (add, remove, delete etc).

6. Establish prototype Objectives

Without the basic objectives it is not possible to define system specifications that are needed to

create the functionalities. This stage will create a plan for building the prototype. The plan should include the basic functions that have to be performed by the prototype, the end user requirements, the definition of the functions, the tools to be used, the time frame for developing the prototype, and the cost implications and resource requirements. Figure 2 presents the process of prototype development.

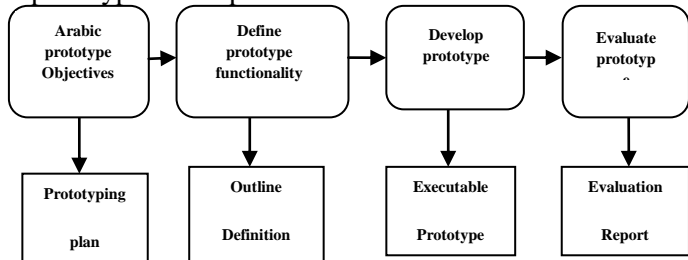


Fig 2: The process of prototype development.

The use case for the proposed system is shown in Figure 3:

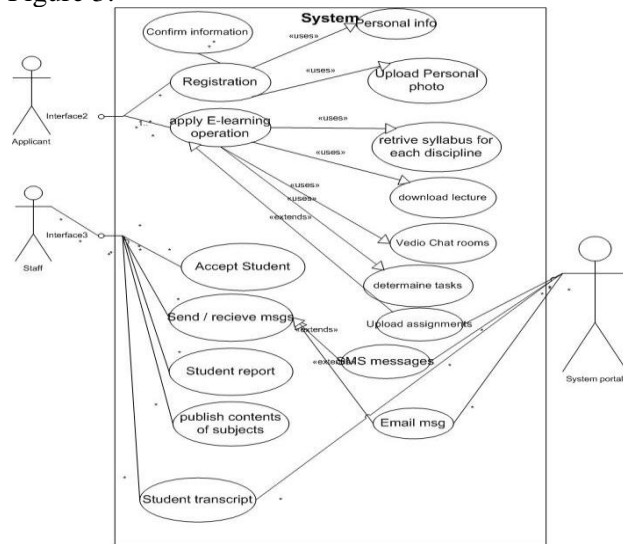


Fig 3: The use case for the proposed system

7. Conclusion

The technology is becoming very important in all fields especially in education. ICT tools facilitate the learning process by giving the students the possibility to explore, analyze, and discover meaningful and real activities, and enhance the interaction between the real and virtual environments. Nowadays, the use of mobile phones, and other wireless devices are becoming indispensable for everyone. Mobiles are more easily accessible by disable because they are light and easy to handle. Person with low vision can use PDAs with text to speech software installed. This paper identifies challenges for designing accessible web pages. An application was implemented as a compact disk and has been tested and evaluated

through many deaf students and their instructors. Most of the feedback was positives and all the suggestion were taken into consideration. This application proposes to help meeting the need of disable people in a simple and reliable way by enabling access to information technologies. In this paper, the principles of quality of a web site have been developed. The educational system presented in this paper, can be applied on mobile application systems. The Application uses a useful tool that allows the user to run any English or any other languages application on any Windows platform. The software used is personalized for Macromedia Director and solves almost all Arabic Language problems in Macromedia Director.

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