Using accessible digital resources for teaching database design: Towards an inclusive distance learning proposal

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ABSTRACT

This paper introduces a pilot experience in teaching database using accessible digital resources in 3er course of Computer Science degree at Universidad Carlos III de Madrid. A platform containing learning material in different formats (video, audio, slides presentation) has been designed allowing students accessing resources as well as to be evaluated by means of tests. Preliminary results show that 46.81% of the students have already interacted with the system and 97.12% of the students passed the tests.

Categories and Subject Descriptors

H.5.1 Multimedia Information Systems, K.3.1 Computer Uses in Education.

General Terms

Human Factors, Design, Experimentation.

Keywords

Accessibility, web system, digital content, resource, multimedia, learning, education

1. INTRODUCTION

The use of digital learning content in the education and distance education courses as e-learning platforms is rapidly increasing. The electronic books, educational software, multimedia content, web pages, are now used as help tools, complementary resources, and sometimes even as the only resource available to provide certain contents within the educational system. Digital learning contents should be easy to access and use in order to ensure quality and should be available to any student, with or without disabilities, as students who use assistive technology to see, hear, move or interact with the information.

The aim should be to design digital learning contents that are more usable and beneficial for all students, including students with disabilities.

Inclusive methodologies [1] aimed at the user need to be followed as to reach these aims. These methodologies need to be carried out following accessibility standards, Universal Design Principles [2] to obtain accessible products such as multimedia resources and web sites that include in accessible way elements such as: images, multimedia, interactive elements, audio, video, data tables, graphs, scientific expressions and mathematics, etc. as those introduced in this work.

2. RELATED WORK

Several contributions in accessibility in digital educational resources and learning environments as e-learning platforms are found in literature. In the field of accessible digital contents for education, some of these studies follow Universal Design criteria therefore contributing a compatible access for all students [3], including those users with disabilities who have access with the help of assistive technology; in other cases giving a direct access and oriented only to a defined group of users and functionality (resource adaption to deaf o blind students, etc.).

To elaborate and edit accessible digital resources some normative must be followed, as the National Instructional Materials (NIMAS) standard [4] among others. The study in the educational area of Accessible Digital Media [5], which offers a complete and valuable guide of recommendations, tools and development techniques to create all types of accessible multimedia resources, including texts, tactile graphics for the images, guidelines to create accessible electronic books which can be used by blind disabled students with screen readers or audio-description, etc.

To provide access to these resources in accessible applications and web sites there are three standards: the guidelines for developing accessible learning applications (IMS) [6], the World Wide Web Consortium (WC3) [7] and the Web Accessibility Initiative WAI [8] which play a leading role in promoting the importance of accessibility and developing guidelines which can help when developing accessible Web resources.

In the context of multimedia content interaction on the web, there is also a diversity of user agents to be regarded such as different web browsers and media players, as well as the technical assistance or technology by means of people with special needs have access to the Web. Due to the fact that these possibilities are not always compatible among them, there are exceptions to achieve accessible multimedia content on the Web [9].

The W3C researches offers standards which contribute to the Web being an authentic area for information regardless of the hardware, software, net infrastructure, language, culture, and geographic localization of the users. In this way, different applicable standards can be highlighted in the online educational area, specifications in multimedia accessibility such as SMIL, SVG to describe vectors graphics and MathML to express mathematical notations and generate necessary equations in notes and multi modal interaction (audio, visual, tactile and gestures) such as Voice XML, SSML, SRGS, InkML.

The WAI uses the accessibility guidelines for different components: Author Tools ATAG, User Agents UAAG and for the Web Contents WCAG. Several works can be found based on how to apply accessibility guides in educational platforms [10].

The Web Content Accessibility Guidelines 1.0 (WCAG 1.0) [11] is widely considered as a standard by the legislation and normative of many countries. There are also accessibility requirements specified by national governments, such as the American Section 508 of the Rehabilitation Act, the English SENDA or the German BITV.

To provide support to online learning and offer characteristics such accessibility, the e-learning platforms are based on the use of metadata such as Dublin Core Adaptability Statement and IMS Global Learning Consortium to consider accessibility understood as adaptability. The most important initiatives are ISO JTC1 SC36 WG7, AccessForAll [12] and IMS Access for All Metadata Specification (AccMD) [13], educational standards. It is an attempt to repair the imbalance between system resources and the needs of the users, ensuring a definitive access for all the users. Some works with case studies are related to this standard together with others of IMS [14]. In this way, a personalized training is offered which benefits to all students.

Learning Management Systems (LMS) manage and deliver of on-line content to learners. There are LMS which include accessibility criteria such as DotLRN [15], Moodle although they have some problem of accessibility (they use JavaScript) and alternative implementations should be investigated [16].

Finally, there are projects related such as European Unified Approach for Accessible Lifelong Learning (EU4ALL) [15] with the aim to improve the efficiency and efficacy of the Life Long Learning paradigm removing the access barriers that people with functional diversity usually face.

3. ACCESS TO E-RESOUCES

To provide Universal Access to a Web site implies make accessible every Web content in the Web site to everybody. This assumption implies that it is necessary to avoid the physical barriers that unfortunately nowadays we can find in most of the Web sites in Internet and that make impossible or difficult to access to the Web content.

Difficulties accessing the Web content can affect not only to people with disabilities, but also to people without disabilities. It is indispensable to take into account the accessibility needs of the different user profiles using the Web site. Moreover, it is essential to take into account accessibility issues from the very beginning in the design and development process in an accessible Web site.

There is a great variety of way of access to electronic resources in Internet, depending on the personal characteristics access of the Web user and depending on the user context too. Some people have difficulties to process information (totally or partially) because of blind, deaf, physical, cognitive, neurological, etc. problems. But not only people with disabilities have physical barriers to access to the Web content.

The accessibility issue includes different disabilities problems and situations. An accessible system must be designed and developed once the accessibility problems for the different user profiles have been detected and solved previously.

4. SYSTEM REQUIREMENTS

This project arose in response to include didactical and accessible improvements teaching a subject at the University. Specifically, the subject is "Database Design" in the 3rd course of Computer Science studies of the University Carlos III of Madrid (Spain) with a duration of four months. In order to test if this platform[1] benefits to the students (whether they are disable people or not), a first approximation to the platform only offers digital resources related to the two first topics in the subject (covering near one month of classes).

The platform has two different kinds of use: first, it can be used as a complementary resource for students assisting to the traditional classes at the University –the students reinforce the knowledge learned in class with digital archives found in the Web site-; second, the students that cannot assist to the classes can learn the knowledge directly from the platform.

The scope of the project does not try to be an e-learning adaptive platform, where learning environments and adaptability is provided to the students. The objective is to achieve a platform with compatible access to different digital contents, providing several file formats to the students with the purpose to offer several and easy ways to access to the resources. Moreover, this platform lets to evaluate the students' knowledge via tests and it also gathers information about the students' interaction with the system and the students' feedback about the platform.

The methodology for designing and developing the platform must be a user centered design methodology with inclusion [1] to the user in every stage. Besides, usability techniques [17] must be used and a permanent evaluation with users must be done.

4.1 Technical aspects

To achieve the former goal eXtensible Hypertext Markup Language (XHTML) and Cascading Style Sheets (CSS) standards have been chosen to separate presentation, content and structure. The server-side programming language has been PHP. Moreover, The WCAG 1.0 accessibility guidelines have been applied.

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[1]   Platform   is   available   at http://pid_basesdatos.uc3m.es/dadbd08/login.php

4.2 User profiles

This project has been designed for every student enrolled considering that some of them could present disabilities and/or context of use where the accessibility to the digital resources in the platform could result very difficult or even impossible. For this reason the platform provides the same resource in several digital formats via Web, so students can choose the best file format according to their current situation. For instance, a student with temporary or permanent deaf problems can download the resources with captioning; meanwhile a student with temporary or permanent visual problems can download a text resource (for example, a transcription of a video resource).

4.3 Digital resources

Digital content is offered as text, image, audio or video paying attention to the preferences or needs of every student, so the platform can provide accessible content to the resources. Moreover, it is necessary to study the multimedia players, because sometimes the accessibility problem in Web is not only to provide accessible contents, but also to provide accessible use of the multimedia resources [9]. That is why this platform provides several digital formats for each resource and category.

For instance, some documents must be edited, transcribing graphics, figures or other visual contents to offer this resource to people with visual disabilities or context use (temporary or permanent). This work is especially complex in "Database Design" topic, because of the great amount of conceptual or logic figures that need transcription and/or audio-descriptions (see next section). Moreover, some video documents must be edited in order to include captioning to offer this resource to people with deaf disabilities or context use. These captions are provided in SMIL accessible format as shown in Figure 1.
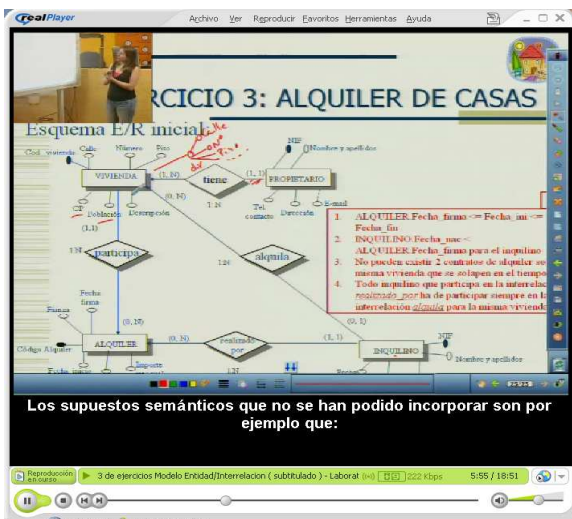

Figure 1. Video with caption implemented with SMIL

5. PLATFORM DESCRIPTION

The "Database Design" subject deals with three main topics: "Conceptual Design", "Logical Design" and "Physical Design". The platform described in this contribution fixes its objectives into the "Conceptual Design" topic, providing different digital resources and evaluation tests so the students can learn the subject content or reinforce this knowledge using these resources.

These content materials comprise two didactic units, a theoretical one (Entity Relationship Model) and a practical one (Entity Relationship Model Exercises). For pedagogical reasons, each unit is divided in three different videos in a sequential order with an approximated duration of 30 minutes offered in several formats. In addition, support information is enclosed to each unit in different formats (video, .pdf and .txt) as shown in Figure 2.

Figure 2. Alternative resource formats in didactic unit

These videos include recorded classes where the database design teacher explains the theoretical and practical knowledge using a blackboard. Students are able to use these content resources anytime during the course.

Moreover, taking into account accessibility issues for contents and multimedia access, the platform allows to download or streaming the video resources in several formats (see Figure 3): .wmv, .rm, .mov, .mp3, .txt, etc. For instance, students with deaf problems can use .smil resources where captions are included; students with visual problems can read the Web information using screen readers and can access to the resource contents using the video transcriptions provided in .txt format.

On the other hand, the system evaluates the usability and accessibility of the platform in order to obtain a feedback from the students and improve this platform. Every student using this platform is asked to fill in usability and satisfaction questionnaires. Furthermore, they are required to include information in these questionnaires about accessibility problems that they could have interacting with the system so this area could be improved too
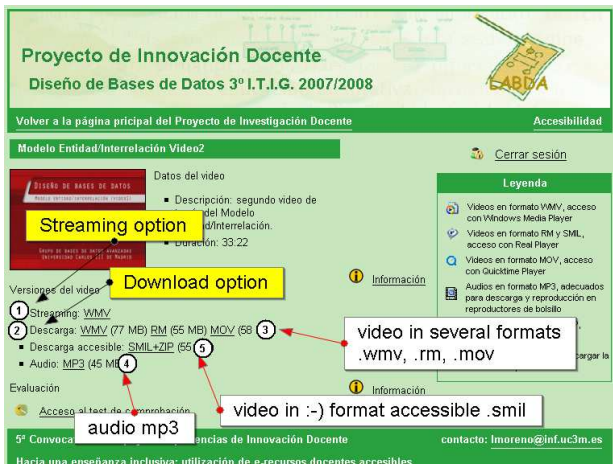
Figure 3. Options to diffuse the video and video formats

5.1 System users

Any student of "Database Design" course can participate in the project. Accessible issues have been taken into account so everybody is able to interact with the accessible Web platform implemented. Moreover, every student is able to access to the digital resources in the platform.

The platform count with an authentication security level that allows us to analyze the interaction results and study the benefits of this platform for the students. In order to obtain a user and password to access the platform, the students are asked to fill in a questionnaire with their name, affiliation and some data about background database design knowledge. This information is used to evaluate the project, but it is not used to adapt the system content to the student, because this platform is not an adaptive platform, as we introduce in section 3. Once the students have their student account in the platform, they can access as many times as needed during four months being not necessary to attend to the classroom traditional classes.

When the student interacts with the platform, s/he can use any resource in any order (although it is advised to follow one) and in any format. After that, s/he is evaluated with one test in order to check if the resource information was useful and clear to the student. Once the test is finish, the student can see which questions has failed and which the correct answer is, so s/he reinforces his knowledge.

6. RESULTS AND SOME CONCLUSIONS

The platform developed is been evaluated in order to improve it including new features or modifying it. This evaluation includes information gathered during four months meanwhile the students have been interacting with the platform.

On the one hand, we can evaluate in a subjective way the platform considering the usability and accessibility questionnaires filled in by the students. Improvements related to usability and accessibility to the e-resources can be defined based in this information. Moreover, a quality group formed by ten students using this platform gives us a valuable feedback about their satisfaction with the system and the benefits provided by the platform.

We can observe that the platform has a good acceptance among the students, because 46.81% of the students have already interacted with the system. This percentage can be considered as a good result taking into account that most of the students have not started yet to study for the exam. According to our quality group predictions and the teachers' previous experience, most of the students usually study one or two weeks before the exam, so it is suppose they are going to use de platform massively during that days.

Each student has logged in the system an average of 4.12 times. This data proves that usually one student does not complete the interaction with the platform in only one access. In the best, to watch a video takes approximately 30 minutes. Adding twenty minutes per questionnaire, approx., we obtain 50 minutes per video. If we multiply this number per 6 videos that are included in the platform, the complete interaction would take approx. 5 hours (too much time to be concentrate studying this topic and ensure good results in the evaluation tests). Most of the students connect to the system more than once, so they can ensure good marks in their evaluation tests.

On the other hand, according to the resource formats preferred by the students (see Figure 4), most of the file downloads or file streaming were in .wmv format (51.83%), and others students preferred to download in .rm format (3.66%) and in .mov format (3.37%) to store it in their computers and watched it whenever they could avoiding in this case the possible Internet problems that could pass. It was curious that, even knowing that there is not disable people in this subject this year, 5.27% of the accesses to the resources were in .smil accessible format.. That means that 36 students download the videos with captioning. Moreover, 29.28% of the students download resources in .txt or .pdf format. Finally, 6.59% of resources accesses were in .mp3 format. That means that some students preferred to download only the audio of the video, maybe (according our quality group prediction), because some students came to the University listening the audio resource in their audio-recorders when they were at the public or private transport or even by walking.
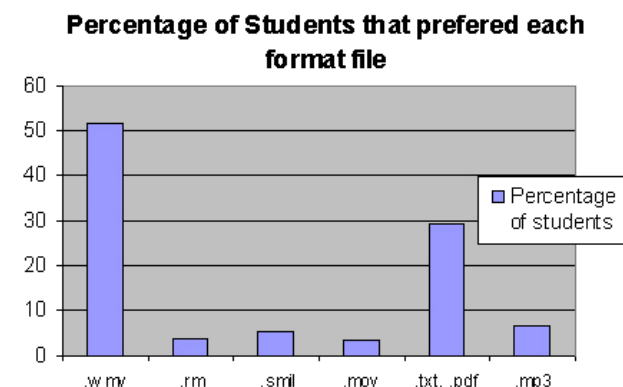

Figure 4. Percentage of students for each format file

The results obtained in the evaluation tests that the students were asked to complete after using the digital resources (watching the videos, reading the translations of the videos, listening the audio of the videos, etc.) were really satisfactory: 97.12% of the students passed the tests. Comparing these results with the student knowledge evaluation the lasts 3 years (where an average of

40.85% of the people failed) we can conclude that this new learning tool provides to the students benefits in their learning.

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