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The Production of Educational Resources and Teaching Aids for an Affordable and Accessible Virtual Education

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ABSTRACT In this paper, we conducted a revision on the Web Content Accessibility Guidelines (WCAG) of the World Wide Web Consortium (W3C), with the purpose of identifying production techniques for low cost (affordable) accessible educational content, to serve as a guideline for production teams of educational resources and teaching aids at education institutions in Colombia which offer distance learning and virtual programs.

The analysis demanded a bibliographical review on the concepts of disability, accessibility and usability in electronic environments, as well as the identification and description of national and international standards on coverage and educational relevance. The research problem is based on the absence of an explicit national policy on the design and supply of accessible vocational training programs – especially in distance learning (traditional and virtual) modalities.

As a result of the research, we designed an instrument to assess accessibility in production of digital educational resources, thereby describing three levels of compliance and providing guidelines for content creators and producers in regards to understanding the standards defined by the W3C.

KEYWORDS accessibility, inclusive education, evaluation of educational resources, e-learning.

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La producción de recursos educativos y medios didácticos para una educación virtual asequible y accesible

RESUMEN Este artículo realiza una revisión a la Guía de Contenidos Web Accesibles de la World Wide Web Consortium (W3C), con el propósito de identificar técnicas de producción de contenidos educativos accesibles de bajo coste (asequibles), que sirvan como guía de trabajo para los equipos de producción de recursos educativos y medios didácticos de instituciones de educación en Colombia, que ofertan programas a distancia y virtual.

El análisis exigió una revisión bibliográfica sobre los conceptos de discapacidad, accesibilidad y usabilidad en entornos electrónicos, así como la identificación y descripción de normas nacionales e internacionales sobre cobertura y pertinencia educativa. El problema de investigación parte de la ausencia de una política nacional explícita sobre el diseño y la oferta de programas de formación profesional accesible, especialmente en modalidad a distancia (tradicional y virtual).

Como resultado de la investigación se diseñó un instrumento para valorar la accesibilidad en la producción de recursos educativos digitales, que describe tres niveles de cumplimiento y orienta a creadores y productores de contenido en la comprensión de los estándares definidos por la W3C.

PALABRAS CLAVE accesibilidad, educación incluyente, evaluación de recursos educativos, e-learning.

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Produção de recursos educativos e material didático para educação virtual disponível e acessível

RESUMO Este artigo faz uma revisão do guia de conteúdo da Web acessível na World Wide Web Consortium (W3C), com a finalidade de identificar as técnicas de produção de conteúdos educativos acessíveis de baixo custo (acessível), que servem como orientação para as equipes de produção de recursos educativos e instituições de ensino na Colômbia, que oferecem programas de ensino à distância e virtual.

A análise exigiu uma revisão da literatura sobre os conceitos de deficiência, acessibilidade e usabilidade em ambientes eletrônicos, bem como a identificação e descrição das normas nacionais e internacionais sobre a cobertura e relevância educacional. O problema da pesquisa advém da ausência de uma política nacional explícita sobre o projeto e fornecimento de programas de formação profissional acessíveis, especialmente no ensino à distância (tradicional e virtual).

Como resultado da pesquisa foi concebido um instrumento para avaliar a acessibilidade na produção de recursos educativos digitais, descrevendo três níveis de conformidade e orientando criadores e produtores de conteúdo a compreender os padrões definidos pela W3C.

PALAVRAS CHAVE acessibilidade, educação inclusiva, avaliação de recursos educacionais, e-learning.

Introduction

According to the National Ministry of Education of the Republic of Colombia, NME (2009), virtual education (also known as online education) refers to the teaching-learning processes that are carried out in online scenarios and do not require "the body, time and space to converge" in one same environment to develop a pedagogical-didactic action. The possibility of teaching and learning extends to interaction and interactivity relationships that are developed in synchronous or asynchronous spaces without physical demand among the actors in the process.

Virtual education *(or e-Learning)* is a training methodology that is derived from distance learning. According to the NME (2009), the latter was born in a social context that required expanding coverage and improving quality, allowing more Colombians (especially those with difficult access due to geographic or economic conditions) to be part of the educational system. As per the above, the national government's intention is to expand the range of possibilities of access to education, understanding it as an exercise of democratization of education.

The concept is in line with Article 67 of the Colombian Constitution (Colombian Congress, 1991), which defines education as "a right of the individual and a public service that has a social function." This indicates that every Colombian, regardless of their cultural, social, political, economic, geographic conditions and -in the framework of this article- of their intellectual, mental and physical conditions, can access and remain in the country's public education system and, where possible, in the private one, at all levels of training.

In this democratization exercise, virtual education offers opportunities and guarantees to expand coverage *(the physical boundaries of the classroom* disappear), educational relevance *(the training programs are offered where* needed), opportunity *(interaction and interactivity among the actors -student, teacher and content- is synchronous and asynchronous, allowing the knowledge to be available when* needed) and quality improvement (the *contents point to different learning styles, and social, constructivist and global learning models are* established), among others.

The challenge is to implement electronic scenarios that enable people with disabilities to achieve the same skills as other citizens. In order to do this, the virtual learning environments, AVA (due to its acronym in Spanish), must be configured with accessible design and production standards. This includes, as stated by the *e-Learning* Association 2.0 Colombia (2007) when presenting the AVA concept, the agents, content, activities, resources, media and communication services.

This article proposes an assessment tool of the production of educational resources and teaching aids for accessible virtual education, taking the recommendations and guidelines presented by the *e-Learning* Association 2.0 Colombia, in their document *Methodology Proposal for Transforming Face-To-Face Programs into Virtual or* e-Learning *Programs* (2007) as the purpose of the study.

The concept of disability

According to the International Classification of Functioning, Disability and Health, ICF (World Health Organization, 2011), disability is "a term that encompasses impairments, activity limitations and participation restrictions". The report states that the concept represents the negative aspects of the interaction between people with health difficulties and personal and environmental factors.

The World Health Organization, WHO (2011) estimates that over one billion people have some type of disability, i.e., about 15% of the world population manifests this condition. Another fact of the WHO says that the numbers are increasing: in a previous survey conducted in 1970, the world population with disabilities amounted to about 10%. This rising behavior has several origins. The main one is the aging of people and the increase of chronic health problems such as diabetes, cardiovascular diseases and mental disorders. Other aspects, which vary according to each country's conditions, are associated to social, cultural, economic and political issues, such as traffic accidents, natural disasters, military and civil conflicts, eating habits and substance abuse issues, among others.

In the case of Colombia, according to statistics from the National Administrative Department of Statistics, DANE (2010), in 2010, about 1.8% of Colombians said to have permanent physical difficulty walking, hearing, speaking and communicating, perceiving light, among others. However, it must be kept in mind that the data from DANE does not include technological and environmental conditions that may hinder the access and use of

electronic learning scenarios. We must consider that the inability to use technology correctly and comfortably also classifies as a disability, perhaps temporary.

Finally, as expressed by the director general of the WHO, Dr. Margaret Chan (World Health Organization, 2011), "disability is part of the human condition [...] almost all of us have some sort of disability, temporary or permanent, at any moment in life."

Other disabilities associated with e-Learning

As mentioned, disability of a person immersed in an electronic environment *(user)* can be temporary or permanent, and framed in the physical, intellectual, mental, environmental or technological aspects. In this regard, Hilera & Hoya (2010), professor at the Universidad de Alcalá, identifies groups of users who may have disabilities in electronic environments:

- People affected by circumstances arising from the environment (low lighting, noisy environments, confined spaces, etc.).
- Users with limited computers and Internet access connections.
- Users who do not speak the language or have a low level of literacy, and
- Users who are inexperienced or unsure of use of electronic devices.

In the case of virtual education, these conditions can be reflected in students and teachers' experience when interacting with the AVA, especially in synchronous and asynchronous communication services and educational resources, as they represent the *core* of the teaching - learning strategies.

Colombian legislation in terms of web accessibility

Although the Colombian legislation recognizes education as a right for every citizen, the NME does not have an explicit policy to guide, monitor, regulate and ensure the quality in the design, production and offer of accessible virtual training programs.

In an article published on the Ministry's website, the need to design quality inclusive educational strategies in the levels of face-to-face preschool, elementary and high school is recognized. According to the NME, "inclusion means tending to the students' common and specific needs with quality and equity, and to do so it is necessary to develop organizational strategies that provide effective responses to address diversity" (2008). This indicates that although the NME's agenda considers inclusion – as an element of accessibility – as a strategic issue, there is still no regulatory support for these levels.

Along the the lines of higher education, the Ministry, through Decree 1295 of 2010 (NME, 2010), states that vocational programs (in any modality) must meet with 15 minimum quality conditions. Non-compliance with the satisfaction of said conditions, prevents the educational institution from obtaining the qualified registration, which is a necessary requirement to begin offering and operating the program in the territory. The quality conditions mentioned by the decree are divided into two groups: nine conditions on the program and six institutional conditions. Unfortunately, none of these establish guidelines on accessible virtual education.

However, the government's outlook improves in other scenarios. The Ministry of ICTs has made efforts in guiding and regulating the spaces of public communication, demanding, among others, the application of accessible production techniques. Proof of this is the *Online Government Manual* (2012) document, which demands that the local authorities comply with Colombian Technical Standard 5854: *Access to web pages* (Icontec, 2011), and the recommendations presented by the World Wide Web Consortium, W3C in its *Web Accessibility* Initiative document.

Finally, Article 24 of the Convention on the Rights of Persons with Disabilities and Optional Protocol to the United Nations, UN *(of which Colombia is a member),* which recognizes the right to education (at all *levels, as well as learning throughout* life) of people with disabilities is highlighted, and specifies that it should be developed in discrimination-free environments.

Thus, in this regulatory scenario, virtual education finds a solid platform to present for training proposals at all levels of education, especially higher education. It is up to the NME to work on the design of policies that guide, monitor and regulate the democratic exercise.

Accessible Web Production Standards

Although there are different standards for the production of accessible educational resources and teaching aids, this article is developed in the framework of the *Web Accessibility Initiative, WAI,* a collection of documents presented by the W3C, which seeks to provide a common standard for web accessibility of individual, organizational and government order worldwide. The selection of this standard is based on the global recognition of the author organization, the production process of the standard *(it is a collective construction between different actors of the* web) and the free license that covers the documentation, allowing any person, institution or government to make use of it at no cost.

The WAI is divided into four macro documents or guidelines: a) accessibility to web content; b) accessibility for user agents; c) accessibility for author tools, and d) accessible enriched Internet applications. Each guideline is split into principles, then into recommendations and, finally, into requirements. Each requirement describes an element of the standard and is classified -according to its complexity- in A *(lowest),* AA *(medium)* and AAA (high). It should be clarified that the guidelines are not the only documents that are part of the standard. There are also accessibility evaluation tools, technical glossaries, *blogs,* papers, and other resources.

For the case of accessibility in educational resources and teaching aids, the guidelines for Web content accessibility version 2.0 (WCAG 2.0) are analyzed and applied. These are divided into four principles: visibility, operability, understanding and robustness.

The purpose of this article, as a first approach of a broader research project, seeks to analyze the implications on production times involved in compliance level A of the WCAG 2.0. For this, an accessibility assessment tool was designed for educational resources, which identifies and describes 23 production requirements.

Creation Process of Accessible Educational Resources and Teaching Aids

Although there is no single model for the creation of digital educational content because they are built and consolidated as of policies and practices of each institution, common elements can be identified among them. For example, for the *e-Learning* Association 2.0 Colombia (2007), the process consists of four stages: selection, planning, design and production. The instructional design model ADDIE proposes five phases: analysis, design, development, implementation and evaluation. Common elements are found when comparing both models: *selection* corresponds to analysis; planning, to *design,* and *design* to development. The implementation and evaluation of ADDIE are not explicitly identified in the first model, but correspond to processing procedures of the production stage.

With regard to the accessible creation of educational resources, following the ADDIE model (Williams, Schrum, Sangrà, & Guàrdia, 2004), the following working points are identified:

Analysis

This phase seeks to identify the training problem and identify its potential solutions, from the perspective of the student's profile, expectations and learning styles.

Thus the accessibility element requires the content designer to know in detail the group of potential users of the program and to adapt the curriculum to allow for inclusion. The designer can rely on population studies that have already been carried out *(the marketing study gives demographic characteristics of the* population), trends of previous cohorts, expectations and goals of inclusion and social outreach, among other instruments.

Design

The teaching strategies for the development of education are defined here, i.e., the course objectives or skills are established, as well as the evaluation methodology, the selection of educational resources and teaching aids, the structure and suggestion of hypertextual reading of the program and its content, the selection of training and strengthening activities, among others.

The accessibility element requires the content designer to define a selection and production model for educational resources that is consistent with the pedagogical model, and that guarantees the user's experience and the development of stated skills. To do this, the designer can use an array

of digital educational resources that describe each of the accessible mediations available for the program development.

Development

It is perhaps the most extensive and expensive phase of the process, because it involves the exercise of virtualization and adaptation of the material to conditions of accessibility (educational resources and teaching aids) required by the program. Among the pedagogical-communicative activities of this phase, the following are identified: development of scripts and storyboards, recording of audiovisual material, creation of hypertext, content production in author tools, selection and capture of photographs, production of sound collections (podcasts), among others.

The accessibility element demands from the content designer the application of the WCAG 2.0 standard. To verify compliance, the designer can use online services that check the structure of the educational resource *(in the case of a web* page) and submit a report of production errors and warnings. Some of these services are: achecker.ca, evaluera.co.uk, accesslint.com, examinator.com, dasilva.org.br, among others. Another option is to use the assessment tool for accessibility of educational resources that is an annex to this article (see next section).

Implementation

In terms of production, at this stage the teaching material is published; the communication, evaluation and support services are set up; adjustments are made to the user interface, and other elements that make up the AVA and that are a part of the teaching - learning experience.

For accessibility, the content designer can use the same tools and services mentioned in the development phase.

Evaluation

Finally, and in accessible production terms, this phase allows the content designer to assess user experience, taking the definitions of the phases of analysis and design as a reference. The findings will serve as a source for analysis and subsequent decision-making on the production process. It should be noted that the standard is not limited or framed to author tools, web browsers, operating systems or specific applications, therefore that the content designer must evaluate the experience in as many conditions and environments that the user can use.

Assessment Tool for Accessible Digital Educational Resources

As a first result shown by the research to which this article refers, the design of a tool for assessing the accessibility of educational resources in level A was achieved. This document identifies the four principles of accessibility for contents, according to the WCAG 2.0 standard. It also describes each guideline and requirement derived from them.

Another element that this tool delivers is the classification of compliance to the satisfaction of the requirement, i.e., each accessibility criterion is described and evaluated in four scenarios: Level 0 indicates that the requirement is essential in the educational resource, but has not been implemented; Level 1, has minimal evidence or development that adds accessibility elements; for Level 2, the resource adds new elements and assumes that Level 1 is satisfactorily complied with; and finally, Level 3 shows a more complex development, giving full satisfaction to the requirement, and assuming that Levels 1 and 2 are met.

In detail, the instrument also serves as a production guide for content designers, because it describes recommendations *(on semantic markup, CSS styles, alternative content, support services,* etc.) to be followed to fulfill the accessibility requirement. This allows the production process to be documented, aligned with the free standards of accessible production, and to consolidate a first element of a knowledge management culture. All this positively affects project planning, and -by default- the budget.

A possible case of semantic and accessible optimization of a code fragment is presented below, following the instructions in each level presented in Table 1.

TABLE 1. Fragment of the accessibility assessment tool for educational resources. Level A

PRINCIPLE	ORIENT.	REQ.	DESCRIPTION	LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3
Perceptibility	Adaptable	Information and relationships	The educational resource can be presented in different ways, without affecting its structure, information and meaning.	Does not comply.	The educational resource provides text content with appropriate semantic markup. Applies to: H1 - H6, P, UL, OL, DL, A, CODE, among others.	The educational resource provides a correct semantic markup for tables (TH, TR, TD), image titles (FIGCAPTION).	The educational resource provides a correct semantic markup for forms (FORM and other tags) and specifies which fields are mandatory.

Source: prepared by the author

FIGURE 1. Original code without semantic and accessible optimization. Level 0

```
1  <p><strong>Título del contenido</strong></p>
2  <p>Párrafo de contenido.</p>
3  <table>
4      <tr>
5          <td>Columna 1</td>
6          <td>Columna 2</td>
7      </tr>
8      <tr>
9          <td>Dato 1</td>
10         <td>Dato 2</td>
11     </tr>
12 </table>
13 <form action="mail.php" method="post">
14     <input type="text">Nombre
15 </form>
```

Source: prepared by the author

FIGURE 2. Optimization on line 1: the title is tagged ‹H1›. Level 1

```
1  <h1>Título del contenido</h1>
2  <p>Párrafo de contenido.</p>
3  <table>
4      <tr>
5          <td>Columna 1</td>
6          <td>Columna 2</td>
7      </tr>
8      <tr>
9          <td>Dato 1</td>
10         <td>Dato 2</td>
11     </tr>
12 </table>
13 <form action="mail.php" method="post">
14     <input type="text">Nombre
15 </form>
```

Source: prepared by the author

FIGURE 3. Part of the table is added, in lines 4, 9, 10 and 15. Level 2

```
1  <h1>Título del contenido</h1>
2  <p>Párrafo de contenido.</p>
3  <table>
4      <thead>
5          <tr>
6              <th>Columna 1</th>
7              <th>Columna 2</th>
8          </tr>
9      </thead>
10     <tbody>
11         <tr>
12             <td>Dato 1</td>
13             <td>Dato 2</td>
14         </tr>
15     </tbody>
16 </table>
17 <form action="mail.php" method="post">
18     <input type="text">Nombre
19 </form>
```

Source: prepared by the author

FIGURE 4. Improves the form's marking and instructions of use. Level 3

```
1  <h1>Título del contenido</h1>
2  <p>Párrafo de contenido.</p>
3  <table>
4      <thead>
5          <tr>
6              <th>Columna 1</th>
7              <th>Columna 2</th>
8          </tr>
9      </thead>
10     <tbody>
11         <tr>
12             <td>Dato 1</td>
13             <td>Dato 2</td>
14         </tr>
15     </tbody>
16 </table>
17 <form action="mail.php" method="post">
18     <label>Nombre:</label>
19     <input type="text" name="fname" placeholder="
       Escriba sus nombres y apellidos completos">
20 </form>
```

Source: prepared by the author

Conclusions

The virtual education methodology is a relevant strategy for the increase in the coverage and quality of the academic offer in a territory, especially for people with disabilities. The facilities offered by ICTs allow them to interact with other people or information systems, with the same advantages and benefits offered by a traditional AVA.

ICTs allow (re)creating accessible, inclusive, democratic scenarios. Despite some weaknesses, Colombia has the legal and technological scenario to create policies that guide, regulate and monitor the academic offer of affordable virtual programs. Efforts such those undertaken by the Ministry of ICTs, the NTC 5854 and the implementation of international standards are the basis for initiating discussions on the subject.

However, the absence of a decree or similar regulation by the NME does not exempt educational institutions from creating accessible programs. There are government commitments that explicitly guarantee education at all levels for people with disabilities.

As suggested by this article (first result of a research on the subject), the productive and financial efforts do not involve large costs for the institution. Research, innovation and knowledge management are tools that contribute to the optimization of the production process of accessible educational resources and digital teaching aids.

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