International Research on Web Accessibility for Persons with Disabilities

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ABSTRACT

The current research establishes a global benchmark for web accessibility by evaluating 8557 higher education home pages and 6872 national government web pages for 181 United Nations member states. Results show that overall, web pages around the globe have room for improvement on all rated dimensions of accessibility. Fewer than half of the items assessed on any criterion received a "pass" rating. There is very little difference overall between education and government pages on accessibility. However, there are significance differences by country. Cluster analyses revealed a group of 39 countries whose web pages are significantly more accessible than others, and a subgroup of ten countries whose pages are especially more accessible. The correlation between web accessibility and demographic variables provides insights into the characteristics of the more accessible countries.

Keywords: Internet, International, Web, accessibility, accessible design

INTERNATIONAL RESEARCH ON WEB ACCESSIBILITY FOR PERSONS WITH DISABILITIES

Researchers undertaking disability-related studies across nations and cultures face fundamental challenges. First, there is no universal concept of disability. Although physical, sensory, cognitive, and psychological impairments occur universally, there are differences in how nations and cultures explain these impairments and respond to them (Ingstad & Whyte, 1995; Retish & Reiter, 1999; Iwakuma & Nussbaum, 2000). Some languages include labels for individual disabilities, but have no single term that encompasses all disabling conditions (Ingstad & Whyte, 1995). World Health Organization (WHO) has created a common cross-cultural classification system that attempts to address this problem by expressing disability in terms of body/impairment-related functions and the effect of social and environmental factors (WHO, 2001). WHO estimates that 10% of the world's population (approximately 600 million people) meets this definition (WHO, n.d. 1).

For cultures that have embraced or are beginning to embrace technologies such as the Internet, the ability of persons with disabilities to participate is significantly impacted by the accessibility of these technologies. Technology is made accessible in part by people with disabilities using assistive technologies—specialized tools that allow people with disabilities to perform functions that they otherwise would be unable to perform at all or without extreme difficulty. Assistive technologies related to computer access include screen-reader software for people who are blind or dyslexic and speech input systems for people who are unable to operate a mouse or keyboard. There are tens of thousands of assistive technologies available (ABLEDATA, n.d.), and those that process language (either as input or output) are available in dozens of languages and dialects. However, there are still significant gaps in availability of assistive technology for poorer nations and in smaller language markets. WHO estimates that only 5-15% of people who require assistive devices and technologies in low- and middle-income countries have access to them (WHO, n.d. 2).

A second requirement for technology accessibility concerns the actual design of the technology device or system. On the Web, visual images are inaccessible to blind users unless the images are encoded with alternate text, which is read by screen readers and Braille output devices; multimedia content is inaccessible to users with hearing impairments unless captioned; and features that require a mouse are inaccessible to users who are unable to use a mouse.

The problem of web accessibility becomes larger as the web itself becomes larger and plays a growing critical role in commerce, education, and the dissemination of information and services worldwide. The Computer Industry Almanac (2006) estimates that over one billion people worldwide use the Internet, expected to top two billion by 2011. At the start of the new century, approximately 50 percent of economic production in Organization for Economic Co-operation and Development (OECD) countries was generated by knowledge-based industries (United National Development Programme, 2001). The Internet also plays a key role in the inter-country transfer of beliefs, knowledge and experiences, including those related to disability (Mitchell, 1999).

The Internet has potential to provide enormous benefits to individuals with disabilities worldwide, allowing them to communicate, learn, work, and participate in society in ways that might otherwise be unavailable. However, it can also become a significant barrier. To address the problem, the World Wide Web Consortium (W3C), an international organization that develops interoperable specifications, guidelines, software, and tools for the web, has developed the Web Content Accessibility Guidelines (WCAG). Version 1.0 of the WCAG (W3C, 1999) provides definitive guidance on how to develop accessible websites, and is comprised of 14 guidelines, each of which is further explained using specific checkpoints. There are a total of 65 checkpoints, with each assigned a priority level of 1, 2, or 3, where Priority 1 checkpoints are the most critical for accessibility. The WCAG provides the basis for many policies, guidelines, and laws related to web accessibility worldwide. The W3C maintains a growing archive of national laws and policies, which as of January, 2007, includes 19 countries/regions (W3C, 2006).

The United Nations has worked for decades to promote accessibility, and has recently extended these efforts to include technology accessibility. On December 13, 2006, the United Nations General Assembly adopted a Convention on the Rights Of Persons With Disabilities (United Nations, 2006), which prohibits discrimination against persons with disabilities in all areas of life. Article 9 of the Convention specifically calls for State Parties to ensure that persons with disabilities have access to information and communications technologies and systems.

Despite the leadership of the United Nations, the availability of international web accessibility standards, and national laws and policies related to web accessibility, published studies have reported widespread inaccessibility of websites across a variety of societal sectors, including postsecondary education institutions in the United States (e.g., Jackson-Sanborn, Odess-Harnish, & Warren, 2002; Odess-Harnish, 2001; Opitz, Savenye, & Rowland, 2003; Walden, Rowland, & Bohman, 2000; Zaphiris & Ellis, 2001; Schmetzke, 2001, 2002a, 2002b, 2002c, 2004; Thompson, Burgstahler & Comden, 2003; Williamson, 2003; Hacket, Parmato, & Zeng, 2003), Australia (Alexander, 2004), the United Kingdom (Kelly, 2002; Witt & McDermott, 2004), and Ireland (McMullin, 2002); as well as government websites in Taiwan (Chen, Chen, & Shao, 2006) and the United States (Hacket, Parmato, & Zeng, 2004); and websites across all sectors in Cyprus (Zaphiris & Zaphiris, 2001).

The United Nations commissioned the first global report on web accessibility (Nomensa, 2006). The survey was "not intended to be exhaustive", and sought to obtain a "snapshot" of global web accessibility from a sample of 100 home pages across 20 countries. Only three of the pages in the sample met all Priority 1 WCAG 1.0 checkpoints, and 93% did not provide adequate text descriptions for graphical content, thereby creating barriers for people using screen reader software. The present study seeks to extend this effort with a more extensive global assessment of web accessibility, focusing specifically on higher education and national/federal government web pages worldwide and identify demographic predictors of web accessibility.

The following specific research questions are addressed in the present study:

1. Are there significant differences in the accessibility of web pages across countries?
2. Are there significant differences between higher education web pages and national/federal government web pages on accessibility?
3. Are there demographic predictors of web accessibility that might help us to understand why some nations are more inclined to address web accessibility than others?

METHOD

Selection of Countries and Web Sites

Countries included in this research represent the 192 member states of the United Nations (United Nations, 2006b). Home page Uniform Resource Locators (URLs) from 8557 universities within 162 of these countries were collected from the website Universities Worldwide (Förster, 2006). Additionally, 6872 national/federal government websites from 181 of these countries were collected from the website Worldwide Governments on the WWW (Anzinger, 2002). Of the 15,429 URLs collected, researchers were able to connect to 12,520 pages—7239 higher education pages (57.8%) and 5281 government pages (42.2%).

Selection of a Method for Evaluating Website Accessibility

Most web accessibility studies have used an automated web accessibility evaluation software tool. A few others (e.g., Thompson, Burgstahler, & Comden, 2003) have used a manual evaluation method for greater detail and accuracy. A manual method was not practical given the sample size in the present study, so researchers used the Functional Accessibility Evaluator (FAE), a tool developed by the University of Illinois at Urbana-Champaign (UIUC, n.d. 1). FAE evaluates web resources for markup that is consistent with Web Accessibility Best Practices identified by UIUC researchers (UIUC, n.d. 2). FAE focuses on functional requirements that improve access to all users, including people with disabilities, rather than limiting its scope to a set of technical accessibility standards. This approach helps to address issues of usability as well as accessibility.

Selection of Demographic Variables

The World Bank (2006) annually publishes 900 World Development Indicators (WDI). For the present research, a subset of 355 indicators was selected that included measures related to economics, health, education, and technology.

Hofstede (2001) has developed five independent dimensions of culture, and has scored 40 countries on each of these dimensions. The dimensions include a Power Distance Index (the degree to which less powerful members of society expect there to be differences in levels of power), Individualism vs. Collectivism, Masculinity vs. Femininity, Uncertainty Avoidance (the extent to which a society attempts to cope with anxiety by minimizing uncertainty), and Long vs. Short Term Orientation.

Procedures

Using FAE, each web page was automatically evaluated on 31 rules across the following five categories:

Navigation and Orientation: Inclusion of structural markup that facilitates navigation and contextual orientation, e.g., including an HTML title element, HTML headers, and appropriate accessible markup on forms and data tables

Text equivalents: Proper use of images for interoperability across web-enabled browsers, platforms, and devices; inclusion of text descriptions of non-text content for accessibility to non-visual users

Scripting: Avoidance of scripting techniques that compromise accessibility and interoperability

Styling: Use of cascading style sheets (CSS) to separate content and structural information from styling and presentation.

HTML standards: Conformance to the W3C HTML specification, to improve interoperability.

For each category, each web page received scores reflecting the percent of rules passed and percent of rules failed. FAE also outputs a third score, reflecting the percent of rules for which accessibility can not be programmatically determined, and therefore requires manual inspection. Since manual inspection was not practical for the present study, these values were not used in analysis.

RESULTS

Overall, web pages worldwide have room for improvement on all rated dimensions of accessibility (see Figure 1). Conformance to HTML Standards is the criterion that received the highest rating overall, but the average proportion of "pass" ratings on this criterion is slightly less than half of items evaluated. The criteria on which web pages rate most poorly are Navigation and Orientation (only about one-quarter of the items assessed on this criterion received a "pass" rating) and Scripting (nearly all of these items failed on accessibility).

A cluster analysis was conducted to explore which countries are more similar in their web accessibility ratings. The analysis produced two clusters, one with 39 members and another with 119 members. Figure 2 shows the average "pass"

Figure 1. Overall level of accessibility

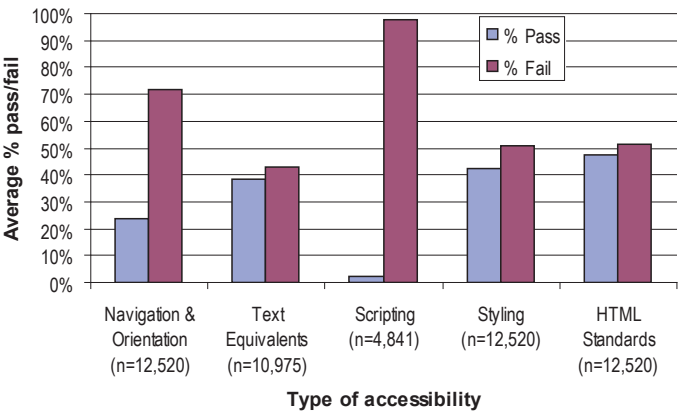

Figure 2. Average "pass" rate on each criterion by cluster group

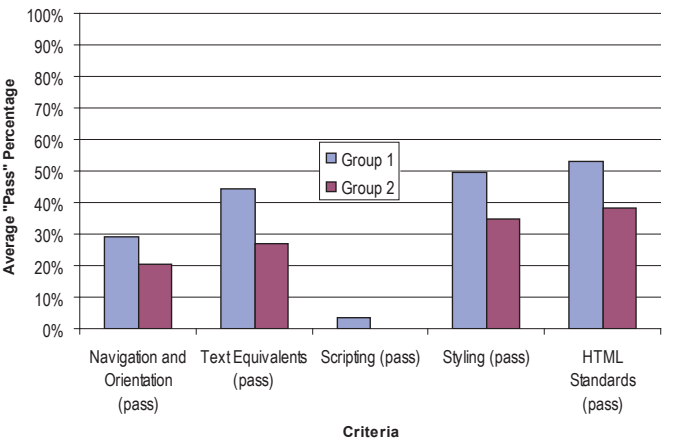

Table 1. Accessibility data for the "Top Ten" group of countries

					% Pass rating				
	# EDU pages	# GOV pages	Total pages	# with Scripting	Nav & Orientation	Text Equivalent	Scripting	Styling	HTML Standards
Australia	50	113	163	53	39%	64%	2%	59%	63%
Czech Republic	24	40	64	13	37%	60%	0%	61%	61%
Congo, Dem.Rep.	3	0	3	2	46%	67%	0%	55%	44%
Ireland	21	78	99	27	31%	51%	22%	48%	60%
Marshall Islands	0	1	1	1	75%	50%	0%	40%	66%
New Zealand	8	84	92	33	46%	62%	0%	53%	64%
Spain	74	70	144	33	34%	52%	8%	64%	59%
Sweden	32	122	154	36	41%	40%	3%	54%	68%
Switzerland	35	65	100	28	41%	44%	5%	54%	65%
United Kingdom	156	290	446	99	43%	64%	11%	57%	71%

rate of the countries in cluster groups 1 and 2 on the criteria used to classify the groups. The group of countries in the first cluster has a higher percentage of "pass" ratings on each of the accessibility measures. Detailed assessment results for each country, including cluster group membership, is available at http://staff.washington.edu/tft/research/international.html.

Additional analysis with country demographic information creates a profile of the countries that have greater accessibility. Group 1 countries, those with more accessible web pages, are countries with more money and with more investment in information and communication technology both publicly and in individual spending. More of the people in Group 1 countries have personal computers and more use the Internet. According to Hofstede's cultural ratings, Group 1 countries have Power Distance Index (PDI) ratings 29% lower than in Group 2, and ratings on Individualism vs. Collectivism (ICI) twice that of those in Group 2. A low PDI rating indicates a strong belief in equal rights held by all members of the society (Group 1 countries also have a higher percentage of women holding a seat in a national parliament). Group 1 countries also have a larger urban population (and a much smaller percentage of the labor force works in agriculture). These countries spend more money on health care and education, and their population lives longer and are more likely to complete school.

A second cluster analysis was performed on Group 1 countries, which further broke this group into two clusters based on web accessibility, revealing a "Top Ten" group of countries which received a higher percentage of "pass" ratings on all accessibility criteria except for scripting. Two of the countries in this group had very low numbers of web pages in the sample. However, the remaining eight countries are the accessibility leaders as measured by this study. Table 1 provides detail on the top ten countries' web accessibility ratings.

Analysis of the demographic factors used above to describe differences between Groups 1 and 2 did not reveal statistically significant differences between the Top Ten and other Group 1 countries in these characteristics. This could reflect the small number of countries included in the analysis, or it could mean that the factors that account for these differences are not embodied in or related to the items included in the analysis. Some factors that could be important but not represented here might include web accessibility initiatives promoted by the national government, or an active organization working to heighten awareness of the needs of people with disabilities, or school curricula that teaches students to consider varying perspectives and varying needs.

Comparison of Higher Education and Government Web Pages

Higher education and government web pages are similar in their accessibility. Government pages performed slightly better in Navigation and Orientation and education pages performed slightly better in HTML Standards. There is little difference in accessibility of Scripting. However, 43% of higher education web pages use scripting, as opposed to only 33% of government pages. This may imply that educational institutions are showing leadership in the adoption of scripting technologies, but without corresponding leadership in accessibility.

Correlations Between Accessibility and Country Demographics

Correlation analysis yields similar results to those attained in the above profile of the Group 1 cluster of countries. A higher "pass" rate across all web accessibility criteria (except in a few cases Scripting, which is suspect because of its poor distribution) is strongly and positively correlated with GDP per capita sales; number of bank branches per 1000 people; value of commercial service imports and exports; both expenditures and receipts on international tourism; per capita expenditure on information and communication technology; per capita health expenditure; female life expectancy; percent of population 65 and above; percent of urban population; use of electricity per capita; number of personal computers, secure Internet servers, and telephone mainlines per 1000 people; number of Internet users; number of mobile phone subscribers; price basket for residential fixed line; and Hofstede's Individual vs. Collective Index (high individualism is associated with greater accessibility). Correlation statistics on these variables range from $r=.29$ to $r=.69$ at $p<.001$. Hofstede's Power Distance Index was strongly negatively associated with web accessibility, which means that more hierarchical countries (less equality) tend to perform more poorly on accessibility (statistics range from $r=-.24$ to $r=-.59$).

Strong and positive correlations were found between secondary and tertiary school enrollment and accessibility. However, surprisingly, few other education demographics correlated significantly with web page accessibility.

DISCUSSION

The correlation findings in the present study suggest that two types of conditions may promote attention to accessibility. One is the level of media use, influenced by the type of commerce important to the country, such as those requiring international communication (tourism, commercial service imports and exports) or by the sheer prevalence of electronic devices among the people. These factors may be related to other correlates of web page accessibility, such as the country's wealth and investment in information and communication technology. The other type of condition these data suggest may promote attention to accessibility is a culture's and government's values regarding individual rights, and the social contract stipulating the relationship between the government and the people. These can be seen in the relationship between Hofstede's PDI and ICI indices and accessibility, as well as the relationship between public health care expenditures and accessibility.

The present study also identifies countries that may employ promising practices. Given the performance of the "Top Ten" countries relative to other countries, a deeper exploration of each of these countries is a logical next step, although even these countries' results show considerable room for improvement.

At least six of these countries (Australia, Ireland, New Zealand, Spain, Switzerland, and the United Kingdom) have laws and/or policies protecting the rights of individuals with disabilities and/or requiring accessibility of electronic communications (W3C, 2006). However, other countries have similar laws, yet did

not perform as well in the current assessment. Further research is required to gain a deeper understanding of the legal, political, social and cultural factors that contribute toward a nation's embracing web accessibility.

This study provides a starting point for understanding the global state of web accessibility. Hopefully a deeper understanding will stimulate dialog and international collaboration, as all nations work toward creating a World Wide Web that is accessible to everyone, including the estimated 600 million people who have disabilities.

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REFERENCES

ABLEDATA (n.d.). *What is ABLEDATA?* Retrieved January 7, 2007 from http://www.abledata.com/abledata.cfm?pageid=19332&ksectionid=19329

Alexander, D. (2004). How accessible are Australian university web sites? *Ariadne, 38*. Retrieved August 22, 2006, from http://www.ariadne.ac.uk/issue38/alexander/intro.html

Anzinger, G. (2002). *Worldwide Governments on the WWW*. Retrieved December 6, 2006 from http://www.gksoft.com/govt/en/world.html.

Chen, Y., Chen, Y, & Shao, M. (2006). 2005 accessibility diagnosis on the government web sites in Taiwan, R.O.C. *ACM International Conference Proceeding Series; 134*, 132-142. Retrieved October 3, 2006 from http://portal.acm.org/citation.cfm?id=1133219.1133243

Computer Industry Almanac (2006). *Worldwide Internet users top 1 billion in 2005*. Retrieved January 7, 2007 from http://www.c-i-a.com/pr0106.htm

Förster, K. (2006). *Universities worldwide*. Retrieved December 6, 2006 from http://univ.cc/

Hackett, S., & Parmato, B. (2005). A longitudinal evaluation of accessibility: Higher education web sites. *Internet Research, Volume 15*(3), 281-294. Retrieved October 2006 from http://www.emeraldinsight.com/Insight/ViewContentServlet?Filename=Published/EmeraldFullTextArticle/Articles/1720150303.html

Hackett, S., Parmato, B., & Zeng, X. (2004). Accessibility of Internet websites through time. *Proceedings of the 6th international ACM SIGACCESS conference on computers and accessibility,* Atlanta GA, No. 18-20, 32 - 39. Retrieved October 2006 from http://portal.acm.org/citation.cfm?id=1028630.1028638

Hofstede, G. (2001). *Culture's consequences, 2nd ed.* Newbury Park, CA: Sage.

Ingstad, B. & Whyte, S. (Eds.). (1995). *Disability and culture.* Berkeley: University of California Press.

Iwakuma, M., & Nussbaum, J. (2000). Intercultural views of people with disabilities in Asia and Africa., in *Handbook of Communication and People with Disabilities*. D. Braithwaite & T. Thompson (Eds.), pp 239 - 255. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Nomensa (2006). *United Nations global audit of web accessibility*. Retrieved January 5, 2007 from http://www.nomensa.com/resources/research/united-nations-global-audit-of-accessibility.html

Jackson-Sanborn, E., Odess-Harnish, K., & Warren, N. (2002). Web site accessibility: A study of six genres. *Library Hi Tech*, *20*(3), 308-317.

Kelly, B. (2002). *An accessibility analysis of UK university entry points*. *Ariadne, 33*. Retrieved February 26, 2003, from http://www.ariadne.ac.uk/issue33/web-watch/

McMullin, B. (2002). *WARP: Web Accessibility Reporting Project Ireland 2002 Baseline Study*. Retrieved February 26, 2003, from http://eaccess.rince.ie/white-papers/2002/warp-2002-00/warp-2002-00.html

Mitchell, D. (1999). Transfer of beliefs, knowledge, and experiences between countries. In Retish, P. & Reiter, S. (Eds), *Adults with Disabilities: International Perspectives in the Community*. Mahwah, NJ: Lawrence Erlbaum Associates.

Opitz, C., Savenye, W., & Rowland, C. (2003). Accessibility of State Department of Education home pages and special education pages. *Journal of Special Education Technology, 18*(1), 17-27.

Reiter, S. (1999). Conclusion: Cross-Cultural Perspectives - Diversity and Universalism. In Retish, P. & Reiter, S. (eds), *Adults with Disabilities: International Perspectives in the Community*. Mahwah, NJ: Lawrence Erlbaum Associates.

Retish, P. & Reiter, S. (Eds). (1999). *Adults with disabilities: International perspectives in the community*. Mahwah, NJ: Lawrence Erlbaum Associates.

Schmetzke, A. (2001). *Accessibility of the homepages of the nation's community colleges*. Retrieved September 19, 2002 from http://library.uwsp.edu/aschmetz/Accessible/nationwide/CC_Survey2001/summary_CCC.htm

Schmetzke, A. (2002a). *Web accessibility survey home page*. Retrieved September 19, 2002, from http://library.uwsp.edu/aschmetz/Accessible/websurveys.htm

Schmetzke, A. (2002b). *Web page accessibility on University of Wisconsin campuses: 2002 survey data*. Retrieved September 19, 2002, from http://library.uwsp.edu/aschmetz/Accessible/UW Campuses/Survey2002/contents2002.htm

Schmetzke, A. (2002c). *Web site accessibility at 56 North American universities: 2002 survey data on libraries and library schools*. Retrieved September 19, 2002, from http://library.uwsp.edu/aschmetz/Accessible/nationwide/Survey2002/contents2002.htm

Schmetzke, A. (2004). *Web page accessibility on University of Wisconsin campuses: 2004 survey and six-year trend data*. Madison, WI: University of Wisconsin. Retrieved January 1, 2006, at http://library.uwsp.edu/aschmetz/Accessible/UW-Campuses/Sursvey2004/contents2004.htm

Thompson, T., Burgstahler, S., & Comden, D. (2003). Research on web accessibility in higher education. *Journal of Information Technology and Disabilities*, 9(2). Retrieved December 5, 2005 from http://www.rit.edu/%7Eeasi/itd/itdv09n2/thompson.htm

United Nations (2006). *Convention on the rights of persons with disabilities*. United Nations General Assembly. Sixty-first session, Item 67(b). Retrieved January 7, 2007 from http://www.un.org/esa/socdev/enable/rights/convtexte.htm

United Nations (2006b). *List of member states*. Retrieved December 6, 2006 from http://www.un.org/Overview/unmember.html

United National Development Programme (2001). *Human development report*. New York: Oxford University Press.

University of Illinois at Urbana-Champaign (UIUC). (n.d. 1). *Functional Accessibility Evaluator*. Retrieved January 7, 2007 from http://fae.cita.uiuc.edu

UIUC (n.d. 2). *Web accessibility best practices*. Retrieved January 7, 2007 from http://www.cita.uiuc.edu/html-best-practices/

Williamson, D. (2003). Web accessibility - Where do we currently stand? In P. Kommers & G. Richards (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2003* (pp. 3291-3295).

Witt, N. & McDermott, A. (2004). Web site accessibility: What logo will we use today? *British Journal of Educational Technology*. 35(1), 45-56.

World Bank (2006). *Development data & statistics: World development indicators*. Retrieved January 7, 2007 from http://www.worldbank.org/data

World Health Organization (WHO). (n.d. 1), *Concept paper: World report on disability and rehabilitation*. Retrieved January 7, 2007 from http://www.who.int/disabilities/publications/dar_world_report_concept_note.pdf.

WHO (n.d. 2). *Assistive devices/technologies*, Retrieved January 7, 2007 from http://www.who.int/disabilities/technology/en/index.html)

WHO (2001). *ICF: Introduction*. Retrieved January 7, 2007 from http://www3.who.int/icf/intros/ICF-Eng-Intro.pdf

World Wide Web Consortium (W3C). (1999). *Web content accessibility guidelines 1.0*. Retrieved May 16, 2003 from http://www.w3.org/TR/WCAG

W3C (2006). *Policies relating to web accessibility*. Retrieved January 7, 2007 from http://www.w3.org/WAI/Policy/

Zaphiris, P. & Ellis, R.D. (2001). Website usability and content accessibility of the top USA universities. *Proceedings of WebNet 2001*, Orlando, FL, USA.

Zaphiris, P. & Zacharia, G. (2001). Website content accessibility of 30,000 Cypriot web sites" In *Proceedings of the 8th Panhellenic Conference on Informatics*, November 8-10. Nicosia, Cyprus. Retrieved October 3, 2006 from http://scholar.google.com/url?sa=U&q=http://agrino.org/pzaphiri/Papers/accessibility-panhellenic_final.pdf