USABILITY AND ACCESSIBILITY COMPARISON OF GOVERNMENTAL, ORGANIZATIONAL, EDUCATIONAL AND COMMERCIAL AGING/HEALTH-RELATED WEB SITES

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This study is aimed at answering whether aging/health-related web sites of different domain extensions (i.e. .com, .edu, .gov and .org) differ in their accessibility and usability, and whether these two measures are correlated. The usability and accessibility of governmental, organizational, educational and commercial aging/health-related web sites were compared using two automatic evaluation tools: Bobby and LIFT. The governmental web site group has the highest compliance with Web site Content Accessibility Guide although only 52% got an approved status. The accessibility approval was found to correlate significantly with overall usability ratings for all groups, except the commercial web site group.

INTRODUCTION

Health Information on the Internet

The growth of the Internet has brought about a substantial increase in the amount of information readily available to the public. One of the most largely accessed areas on the Internet is the health and medical area, which was accessed by approximately 54 percent of Internet users according to a January 1999 poll (Weber, 1999) across the adults life span. In 1998, 22 millions individuals reported surfing the Web for medical information, with the number estimated to have reached 30 million by 2000 (Elliott & Elliott, 2000).

The medical community is slowly, but cautiously, accepting the Internet as a factor in patient care and doctor-patient relationships, although critics reported that the use of Internet by hospital systems and physicians groups today is still limited to posting billboards (Cochrane, 1999) or as a marketing tool (Weber, 1999). Extensive literature starts to develop on the phenomenon of web-based health Information Retrieval. However, the medical community is generally more concerned with information quality and clinical outcomes arising from usage, rather than focusing on issues of design for accessibility, usability and accommodation (Chi-Lum, 1999, Dakins, 1999).

The philosophy of putting emphasis on the accuracy of the information is understandable given the consequences of inaccurate, incomplete or misused health-related information (Ling, 1999). However, without a focused effort on improving accessibility and usability, high quality information will not necessarily be accessible and clinical outcomes may not be achievable. The accessibility problem of health information on the Internet is so severe that in a survey to the Northeast chapter of the American Medical Association, only 14% of the physicians said that they would recommend the Internet as a medical information resource for patients (Eder & Darter, 1998).

Research reviewing medical and health related web sites has found various accessibility and usability problems. Some examples are the following: while those sites are attractive, they only function as yellow pages (Cochrane, 1999); it is difficult to find specific information and it contains content of varying quality (Hersh, 1999); there is a potential for serious abuse and conflict of interest because of the profit acquired from selling an advertiser's products (Bloom & Iannacone, 1999). The danger of these facts is that while for most topics of searched information, failing to find the proper information on the Internet in a timely manner might not bring severe consequences, in the health and medical areas, there might be serious consequences involved. Therefore, it is crucial to make certain that health and medical information are structured in a way that enables even novice users and users with special needs (such as older users or users with disability) to find the information easily and in a timely manner.

Web Health Information's Uses by the Elderly

A significant increase of older population has led to various studies investigating the age effect in utilizing the Web as information resources. Forecasts projected that by the year 2030 people aged 65+ will represent 22% of the people living in the US (U.S. Census Bureau, 1999). Although an age bias against older adults using computer technology still exists, more older adults are beginning to incorporate the Web as part of their life, currently representing 13% of the online users (Cury, 1999). In a study asking older users of the main use of the Web, one of the top three answers is to get information about health and medical conditions (White, et al, 1999; Cochrane, 1999).

Older adults have some disadvantages in fully utilizing the Internet as their information resources. That is, older people had more trouble finding information in a Web site than younger people (Mead, et al, 1997). Very little research, however, focused on ensuring the accessibility and usability of Web health information for the elderly. Therefore, this study aims to evaluate the usability and accessibility aspects of the web sites that might be of interest to older computer users.

Usability and Accessibility Mandates, Guidelines and Tools

There are some encouraging signs that the accessibility of the Internet is taken into account by mainstream society (Newell & Gregor, 1997). Accessibility for information on the Web has been well regulated in the U.S. Some legal mandates regarding accessibility are Section 255 of the

Telecommunications Act 1996 (http://www.fcc.gov/cib/dro/section255.html), which regulates the accessibility of Internet Telephony, and Section 508 of the Rehabilitation Act Amendments of 1998 (http://www.ed.gov/offices/OSERS/RSA/RehabAct.html), which requires that when Federal departments or agencies develop, procure, maintain, or use electronic and information technology, they shall ensure that the technology is accessible to people with disabilities, unless an undue burden would be imposed on the department or agency.

Various institutions also compiled accessibility guidelines for information on the Web. Those resources are well documented and available for public viewing on the Internet. Some examples of those guidelines are:

- W3C Web Content Accessibility Guidelines (WCAG) (http://www.w3.org/TR/WAI-WEBCONTENT)
- WAI Quick Tips Reference Card (http://www.w3.org/WAI/References/QuickTips)
- Penn State University's Center for Academic Computing Web Accessibility Check-List (http://www.psu.edu/dept/cac/training/outlines/accessibility/check.html)
- Public Service Commission of Canada: Designing Universal Web Pages (http://www.psc-cfp.gc.ca/eepmp-pmpee/access/welcome1.htm)
- Captioning and Audio Description on the Web - The National Center for Accessible Media (http://www.wgbh.org/pages/ncam).

In addition to guidelines, various businesses and organizations have provided (commercial) validation and transformation tools to aid web site's accessibility. Most of them have (limited) free services for public uses. Some of those tools are:

- Bill Loughbourgh's WAI Checkpoint Checker (http://rdf.pair.com/checker.htm)
- VisCheck's Online Color-blindness simulator (http://www.vischeck.com/index.shtml)
- NCAM's Media Access Generator (http://www.wgbh.org/wgbh/pages/ncam/webaccess/ magindex.html)
- UsableNet.Com's LIFT™ Validation Service (http://www.usablenet.com/index.htm)
- The WAI's HTML Table Linearizer (http://www.w3.org/WAI/Resources/Tablin)
- WAVE - PIATs web page accessibility evaluation assistant (http://www.temple.edu/inst_disabilities/piat/wave)
- FITAI Web page Accessibility Verification Tool (http://www.section508.gov/aboutfitai.html)
- Bobby (http://www.cast.org/bobby)
- W3C WAI Content Accessibility Checking Service (http://www.w3.org/2000/07/eval43)
- TIDY (http://www.w3.org/People/Raggett/tidy)

Sullivan and Matson (2000) compared 50 most popular web sites in terms of their usability and content accessibility and found a marginal correlation (ρ=0.23) between manually analyzed content accessibility in conformance to the Priority 1 of the WCAG and overall automated usability testing result provided by LIFT (http://www.usablenet.com/index.htm). The present study extends Sullivan and Mason's study in two ways. First, by automating the content accessibility testing using Bobby (http://www.cast.org/bobby), which performs the test based on all Priorities. Second, by performing group comparisons of commercial, educational, governmental and organizational web site groups (which are the largest groups of web sites) in terms of their usability and content accessibility. This study aims to answer two research questions:

1. Do aging/health-related web sites of different natures (i.e. commercial, educational, governmental and organizational) differ in their accessibility and usability?
2. Is the result of accessibility evaluation of a particular group of web sites related to the result of its usability evaluation?

The two automatic evaluation tools used in this study are LIFT and Bobby. LIFT was chosen because LIFT is the only automatic tool that performs usability evaluation. Bobby is one of the most widely used automatic accessibility evaluation tools.

LIFT provides a report of the number of catastrophic errors (errors that disable users to complete tasks), major errors (errors that cause users to face major impediments), minor errors (errors that are really a nuisance for users) and cosmetic errors (low priority materials). In addition, as a general rating, LIFT assigns a rating of excellent, good, fair or poor.

Bobby recommends effective Web page authoring for special Web browsers (e.g. the one which reads text out loud using a speech synthesizer for blind users). Bobby divides the accessibility errors into 4 sections to be tested:

1. *Priority 1 Errors* are problems that seriously affect the page's usability by people with disabilities, in accordance with Priority 1 of WCAG. A Bobby Approved rating can only be granted to a site with no Priority 1 errors. Bobby Approved status is equivalent to Conformance Level A for the WCAG.
2. *Priority 2 Errors* are secondary access problems. If all items in this section including relevant User Checks passed the test, it meets Conformance Level AA for the WCAG.
3. *Priority 3 Errors* are third-tier access problems. If all items in this section including relevant User Checks passed the test, it meets Conformance Level AAA for the WCAG.
4. *The Browser Compatibility Errors* are HTML elements and element attributes that are used on the page which are not valid for particular browsers. These elements do not necessarily cause accessibility problems, but users should be aware that the page may not be rendered as expected which may impact usability and accessibility.

As a general rating, Bobby gives the rating with the picture of "Bobby-hats". Hats with wheelchairs indicate Priority 1 accessibility errors that are automatically detectable. A question mark identifies a possible Priority 1 error that cannot be fully automatically checked, indicating that the user will need to address that question manually.

METHODOLOGY

Data Collection Method

Because of the importance of facilitating usability and content accessibility of web sites for older computer users, the web sites were collected using keyword search of "aging" from http://www.google.com search engine (all of them contain information about health). The web site's domain name extension (.com, .edu, .gov and .org) was used as a filter.

The analyzed web sites for each extension were limited to the sites listed in the first three pages (30 sites) of the google's search result because the majority of web users are not expected to go beyond 3 pages when looking for information (Zaphiris, 2000). After removing subsections of the same web sites and dead links, the numbers of analyzed sites for each extension ranged from 20-25.

Analysis

To answer the aforementioned two research questions, several statistical analysis techniques are employed. For the first research question, the means and standard deviations of the four domain name extension groups were compared for significant differences using Analysis of Variance (ANOVA). For the second question, two analyses were performed. First, to investigate whether, in general, the accessibility and usability are related, bivariate correlation for all analyzed web sites was calculated. Second, to investigate whether in a particular group of domain names (i.e. .com, .edu, .gov and .org), the accessibility and usability are related, the bivariate correlation of web sites within a group was observed.

RESULTS AND DISCUSSIONS

Table 1 lists the mean and standard deviation of the usability and accessibility ratings for each group of web sites. Bobby's approval rating is converted into a binary variable with '0' representing 'Not Approved' and '1' representing 'Approved' status. The Usability rating is also converted into an ordinal scale with '1' representing 'Fair', '2' 'Good', and '3' 'Excellent'.

Table 1: Mean Usability and Accessibility results (standard deviations in parenthesis)

		.com N=23	.edu N=20	.gov N=21	.org N=25	Total N=89
Accessibility (Bobby)	Approval	0.13 (0.34)	0.25 (0.44)	0.52 (0.51)	0.24 (0.44)	0.28 (0.45)
	Priority 1	1.3 (0.93)	0.95 (0.69)	0.57 (0.75)	0.92 (0.64)	0.94 (0.79)
	Priority 2	3.39 (1.23)	2.2 (1.24)	2.67 (0.66)	2.8 (1.22)	2.79 (1.18)
	Priority 3	1.96 (0.21)	1.6 (0.68)	1.71 (0.56)	1.92 (0.4)	1.81 (0.5)
	Browser Error	13.13 (9.48)	7.75 (7.66)	6.81 (4.32)	9.16 (4.79)	9.31 (7.18)
Usability (LIFT)	Usability Rating	1.7 (0.63)	1.8 (0.7)	2 (0.63)	1.68 (0.56)	1.79 (0.63)
	Catastrophic	0.09 (0.29)	0 (0)	0 (0)	0.04 (0.2)	0.03 (0.18)
	Major	2.43 (1.5)	1.95 (1.23)	1.43 (1.12)	2.04 (1.4)	1.98 (1.36)
	Minor	2.91 (1.88)	3.25 (2.75)	3.33 (1.49)	3.64 (2.63)	3.29 (2.23)

From Table 1 it is apparent that governmental sites are in general the best in terms of accessibility and usability ratings compared to web sites of different extensions. The reason might be related to more strict enforcement by governmental agencies of the Section 255 of the Telecommunications Act to ensure that web sites maintained by the Federal governments are accessible and usable by most people (see Section 1.3 above). However, although the governmental sites are superior to other domain types, only half of the tested web sites (52%) was approved by Bobby.

Table 1 also shows high browser compatibility errors in all groups. One possible reason is that web site designers tend to rely on web design tools that are compatible with only one particular type of browser.

Figures 1 and 2 depicts the means of each web site groups in terms of overall accessibility (Bobby's approval) and overall usability rating.

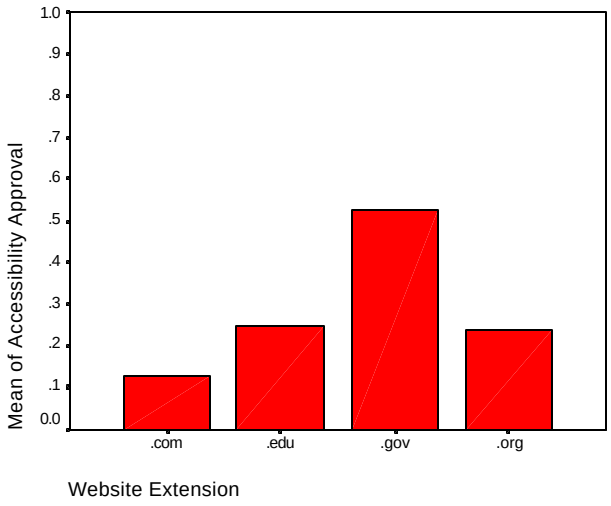

Figure 1: The means of Bobby's Accessibility Approval by web site extension types

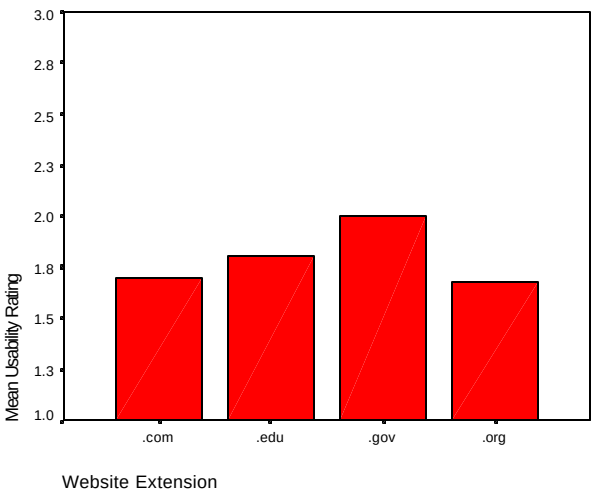

Figure 2: The means of LIFT's Usability Rating by web site extension types

The ANOVA follow-up analysis shows that the mean's differences between those groups of web sites are significant at $p<0.05$ for Bobby's approval ($F_{(3,85)}= 3.193$, $p=0.028$), Priority 1 errors ($F_{(3,85)}= 3.435$, $p=0.021$), Priority 2 errors ($F_{(3,85)}= 4.117$, $p=0.009$) and Browser compatibility errors ($F_{(3,85)}= 3.643$, $p=0.016$). On the other hand, all of the usability measures' group differences (LIFT) are not significant at $p<0.05$. Therefore, as measured by the automated evaluation tools used in the present study, the answer of the first research question is that web sites of different extensions differ significantly in their accessibility but not in their usability.

To answer the second research question, bivariate correlation of different usability and accessibility measures were observed. Observing all web sites (with all extensions), the accessibility approval correlates significantly with the overall usability rating ($\rho=0.531$, $p<0.01$). However, observing bivariate correlation of those measures within the same group, while the educational, governmental and organizational sites' usability and accessibility measures still correlate significantly, in the commercial group, that is not the case. LIFT's evaluation consists of two parts: accessibility issues and usability issues unrelated to accessibility. Since the commercial web site group is relatively high in usability rating yet low in accessibility approval, one can conclude that commercial sites perform high in usability issues unrelated to accessibility. In other words, commercial sites are user-friendly for people with no disability.

CONCLUSIONS

This study aimed to answer two research questions:

1. Do aging/health-related web sites of different natures (i.e. commercial, educational, governmental and organizational) differ in their accessibility and usability?
2. Is the result of accessibility evaluation of a particular group of web sites related to the result of its usability evaluation?

The analysis revealed that the governmental web site group has the highest compliance with Web site Content Accessibility Guide (WCAG) although only 52% got an approved status. The accessibility approval was found to correlate significantly with overall usability ratings for all groups, except the commercial web site group.

The present study brings about several implications for the practitioners. First, because some web sites' accessibility and usability measures are not predictive of each other, it opens a door into exploring the possibility of developing an integrated automated accessibility and usability evaluation tool. Second, the finding that most web sites did not receive the approved status from Bobby could be used to motivate web site designers to improve the accessibility and usability of web sites.

Further research could be conducted in several areas. First, in this study, only simple correlation and ANOVA were employed. Advanced statistical analysis such as structural equation modeling would be fruitful to explore the underlying relationship between different measures of usability and accessibility evaluation. Second, in the present study, the topic of interest is aging/health-related web sites. However, the methodology used in this paper could be applied in any area of interest (e.g. entertainment, e-commerce or, services).

Some limitations of using automatic evaluation tools need to be recognized:

1. There are important elements (such as the web navigation structure, the information's layout, the value of information, or various aesthetic aspects) which are not evaluated by the automatic tools.
2. The meaning/significance/appearance of graphics is not evaluated, only the inclusion of ALT tags are taken into consideration by Bobby and LIFT and only the number (higher number of graphics correlates to lower rating) of graphics is considered in LIFT.
3. Text-only web sites will get high ranking with both tools regardless of the quality of information or the readability of the fonts.

These limitations might imply that, although automatic evaluation tools provide a quick reference of the web site's accessibility and usability, formal usability evaluation involving user testing combined with a series of other non-empirical methods (such as cognitive walkthroughs or GOMS) still hold a major importance in the thoroughness of web site evaluation. Further studies validating the results of Bobby and LIFT with user studies will bring fruitful contribution to the area of Web usability.

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