Informatics and Society: The Challenge of Improving IT Accessibility

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ABSTRACT

Information technology (IT) is an important part of society and has assumed an increasing role in education, medicine, commercial, leisure, and sociopolitical applications. However, while progress in developing IT hardware and software has advanced, our understanding of user needs and how these needs can be translated into more accessible and effective system design lags behind. The challenge that we face is rooted in the fact that many individuals across this planet who are differently-abled due to aging, developmental or neurologic conditions or to individual differences in learning, face obstacles in using and accessing IT. The central thesis of this paper is that the effective delivery of IT to the differently-abled is contingent on deriving enough information about user populations to allow for the development and use of personalized interfaces and customized content. To this end, it is proposed that a combination of adaptive hypermedia and cognitive adaptive strategies integrating metadata architecture for representing the results of cognitive and functional assessments be designed and implemented.

Keywords: Information technology, computer accessibility, differently-abled, adaptive hypermedia, informatics

Information technology (IT) is an integral part of developed and developing societies. In fact, it is woven into the fabric of a diverse spectrum of cross-cultural and interdisciplinary communities (e.g., education, medicine, commerce, leisure, politics and community networking). IT has also been incorporated into a diverse array of applications and devices, such as instructional CD's, digital textbooks, web-based tools, PDA's, electronic devices, smart homes, robots and telemedicine.

While advances in hardware and software design have been rapid, our understanding of user needs and how these needs can be translated into better system design has not advanced as rapidly. That is, adaptive transformations that could help facilitate the full participation of all citizens in IT use (e.g., in e-commerce, leisure, and in the workforce) need to be designed and implemented. Why is this a problem? The crux of the matter is that many individuals across diverse cultures and societies are differently-abled in ways that may impede their access to information technology. For example, individuals may be differently-abled due to the effects of normal aging, developmental or neurologic conditions or to individual differences in their approach to learning [1]. These individuals may not able to use, access or share in the IT revolution equitably. In this paper, we briefly review an important IT application; the impact of accessibility issues and possible solutions.

Clearly, the effectiveness with which issues relating to accessibility and functionality are addressed will critically impact the role that IT will play in our educational, social, political and health care communities. And the extent to which all citizens can share and participate in these communities will impact the very core of our democratic institutions.

So, for example, the use of IT in the area of telemedicine offers promise of achieving the goal of delivering health care services to those who are disenfranchised from traditional health care communities due to geography, economics, medical conditions or availability of local health resources. A growing body of literature supports the usefulness of telemedicine applications in the delivery of psychiatric services [2]; psychotherapy and cognitive assessments to clients in rural areas suffering from brain injury and stroke [3]; delivery of telemedicine services where issues of security are paramount (i.e., prison environments) [4]; delivery of rehabilitation services to home-bound individuals with brain injuries [5] and to patients with arthritis [6].

Virtual reality (VR) represents another manifestation of IT [7]. VR has been used to develop immersive virtual kitchens with individuals with traumatic brain injuries [8] and computer-based virtual systems may offer adjunctive techniques for evaluating driver behavior [9], and for delivering physical therapy (PT) [10]. Some studies have suggested that virtual PT is as effective as conventionally delivered therapy [11] strongly indicating that this technology may offer an effective and viable complementary treatment modality.

If potential user communities of IT-based health care systems cannot derive the medical, educational and health benefits offered by these services because of problems with accessibility, these communities will not have equal access to the health care system. This will further isolate these communities both within and across their borders.

Communities that desperately need better access to health care resources, consultation and supportive services

In order to help improve accessibility, the relationships between neurologic impairments and the ability to use an IT or telemedicine system need to be delineated. Diamond and Shreve et al. [1], demonstrated that there are relationships between the severity and nature of cognitive impairments and the ability to use IT. These authors found that while all participants learned how to use a telerehabilitation system (referred to as the VRC), the rate of learning or the number of "trials to acquisition" varied among participants with traumatic brain injuries. In other words, while severity of cognitive impairment was a predictor of IT utilization performance, the type of cognitive impairment also impacted the rate of IT learning. For example, individuals who needed more trials to acquisition were more impaired in visuo-spatial construction, reasoning-similarities and language repetition. Interestingly, 50 percent of those individuals who required fewer trials to acquisition and 75 percent of those who required more trials to acquisition exhibited impairments in memory. Thus, while memory impairments were pervasive, memory alone did not account for all or even most of the variability in differences in learning and accessibility that were observed.

The relationship between discrete areas of cognitive impairment and performance on the VRC may be due to the information architecture of the VRC and other internet and computer-based systems. In other words, many of these systems require users to process and store visual and auditory information (i.e., streaming video and digital images). The processing of text-based information requires reading and skills that tap working memory and executive-type functions (e.g. reasoning and organization). The rehabilitation modules and menus in the VRC used images and icons that tapped visual-spatial memory and organizational skills as well. Overall, impairments in cognitive domains reflecting visual-spatial integration, memory, language processing and executive-type functions inhibited learning efficiency and VRC accessibility. What did we learn from this work? The work underscored the need to link system design intended for differently-abled populations to individualized, higher-level cognitive, sensory and functional adaptations and compensatory actions.

The central thesis put forth in this paper is that in order to help solve this class of problem, and achieve the goal of effectively delivering IT to the differently-abled via the Internet, personal computers or information appliances, solutions will be contingent on our ability to derive enough information about the user populations. That is, to allow for the development and deployment of personalized interfaces, customized content and adaptive techniques. Current research in adaptive hypermedia systems [12]; user modeling [13]; [14] and web accessibility [15] suggests that to make content more accessible, it is important to couple "user profiles" or models with neurobehaviorally based cognitive and sensory assessments.

For example, visual profiles for low-vision computer users suggest the need to account for visual capabilities like acuity, contrast sensitivity, color perception and field of view when designing human-computer interfaces [16]. Development of adaptive models is especially challenging in our current generation of older people as they are less likely than younger people to have computer experience [17] and the special knowledge and skills required for interacting with current electronic search systems [18]. Memory and reasoning skills may be critical in performing on-line information seeking and the decline of these skills in the elderly and in individuals with neurologic impairments may account for many of the observed disparities in the performance of on-line information-seeking tasks [19], including less efficient search strategies [20], and in searching on-line library databases [21] in these populations..

Czaja et al., [22] reported relationships between search and retrieval performance in older participants and their cognitive abilities (e.g., processing speed, memory and verbal speed). Westerman, Davies, and Glendon et al., [23] in examining age differences in accuracy and latency reported that in older versus younger participants, older participants were slower in retrieving information and those with low spatial ability also took longer at retrieval.

These findings may be attributable to difficulty in recall of prior links and information. In other words, attention and working memory likely mediate some of these findings.Taken together, these reports suggest that digital information architectures, whether they are embedded in instructional CD's, digital textbooks, web-based tools, PDA's or electronic devices would be more accessible and functional to users with diverse needs, if these systems could adapt to individual user needs.

In trying to achieve the long-term objective of creating systems that adapt to individual user needs (i.e., higher-level cognitive and interface or display- related functions), it is proposed that solutions such as adaptive hypermedia or cognitive adaptive strategies alone will not solve the problem. Instead, an integration of these approaches is needed. This integration might consist of a metadata architecture for representing the results of cognitive and functional assessments in a computationally and machine-usable form (such as XML schema).

Adaptive strategies will be more effective if they are informed by multidimensional neurobehavioral and functional assessments. These assessments could be expressed as multi-domain user profiles. As we move closer to achieving this goal, we will move closer to achieving the goal of seeing all individuals exercise their right to share equitably in the information technology age.

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