

Multiple Cultures, Multiple Intelligences: Applying Cognitive Theory to Usability of Digital Libraries

CAROL SMITH

James C. Kirkpatrick Library, University of Central Missouri, Warrensburg, MO, USA

Digital libraries are increasingly serving a worldwide audience. Persons of different cultural backgrounds can hold diverse perceptions of what constitutes an effective, efficient and satisfying information-seeking experience, and digital library design therefore grows more complex when its user population traverses cultural boundaries. This paper reviews the state of research on cross-cultural digital library usability and identifies reasons for lack of progress in the field. An improved framework is proposed to support the discussion and evaluation of subjective cultural factors in a deeper, more systematic fashion. The cognitive theory of Howard Gardner, multiple intelligences theory, is explored as one potential

framework for exploring cross-cultural digital library usability. Each component of Gardner's theory is introduced, placed in a cultural context, and then briefly reviewed in terms of its potential application to digital libraries. Alternative frameworks, particularly the cultural dimensions theory of Geert Hofstede, are also introduced. Multiple intelligences theory is found to be helpful for understanding the nature of cultural variables, but not readily translatable into operational design principles for digital libraries. Combining multiple intelligences cognitive theory with cultural theory and global HCI design principles may prove a useful direction for future research.

Introduction

Problem domain

In an increasingly wired world, digital libraries are increasingly serving a worldwide audience. Even if initially designed for a local user population, a digital library can easily find itself not only serving its own community and culture, but also representing that society to a larger, international audience. As "cultural ambassadors" to the world (Komlodi, Caidi & Wheeler 2004, 585), then, the core mission of digital libraries has been heightened. So, too, are the factors and challenges associated with carrying out that mission.

The International Organization for Standardization (ISO)'s 9241-11 (1998) *Guidance on Usability* defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction

in a specified context of use." (Wikipedia 2005) Successful digital libraries are therefore designed with a clear purpose and serve their intended audience effectively and efficiently in an environment that is both satisfying and easy to explore. User-centered design grows more complex as the user population traverses cultural boundaries, though, because of different cultures holding varying perceptions of what constitutes an effective, efficient and satisfying information-seeking experience.

Related studies

Research into cross-cultural usability of digital libraries can be divided along two dimensions: the study of objective, technical factors, and the study of subjective, user-based factors.

Early studies on global digital library usability focus on objective, technical issues such as multilingual support, international character recogni-

tion and interoperability (Borgman 1997; Oard *et al.* 1999), or distributed digital library architectures (Lagoze, Fielding & Payette 1998; Takahashi *et al.* 1998). Written in the early years of digital library development, the majority of these studies do not address the subjective cultural dimensions of user-centered design. In part, this can be attributed to the natural progression of technological development, from technology-centered to human-centered design over time. Oard *et al.* (1999) acknowledge this technology life cycle, citing "cultural and social aspects" as the highest of five layers of technology, and stating the need for a "greater focus on users."

When attention turned to subjective cultural factors impacting digital library usability, emphasis was initially placed on global interface design principles, and insights gained from the human-computer interaction (HCI) field. Research has shown, for example, that interface design elements appropriate for one culture, such as color, icons and text orientation, may not be appreciated by users from other cultures (Barber & Badre 1998). It is not clear, however, whether interface design guidelines developed for software can be applied without modification to the digital library model. Software can be 'localized'; that is, versions can be tailored for distribution within a particular culture or user group. Digital library designers can strive for maximum interface flexibility, but must still consider the inevitable tradeoffs that exist between designing digital libraries for localization vs. globalization. A localized system may serve a targeted user group well, while a system designed for global use runs the risk of serving no one well.

Interface design, while important and fundamental to global usability, is clearly just one area impacting the effective design of cross-cultural digital libraries. Increasingly, research is focusing on deeper dimensions of the relationship between digital library usability and cultural background, including content presentation, organization, and information access points.

Researchers have long recognized the growing importance of understanding cross-cultural usability in digital library design. Despite this oft-cited need for more research, there is still a noticeable lack of focused studies in the field. Komlodi, Caidi & Wheeler (2004, 592) found that "Current DL UIs [user interfaces] and content do not serve

international users very well...more research is needed on the behavior of culturally diverse user groups of information resources." Caidi & Komlodi (2003, 62) note "little research is available on the influence of culture as it pertains to the design and use of digital libraries," while Duncker, Theng & Mohd-Nasir (2000) lament that "usability has seemed a relatively minor concern." Similar observations have been made by Oard *et al.* (1999) and others.

The reasons for lack of progress in the research of cross-cultural digital library use are manifold:

- Defining even the basic operating concepts of 'culture', 'usability' and even 'digital library' can be problematic. Dozens of sometimes contradicting definitions exist for these terms, with no particular one garnering universal acceptance by the academic community. Without the clarity and consensus provided by core terminology, scholarly discussion and progress is impeded.
- Even though theories of cultural orientation are well established, researchers can still find themselves caught in a delicate balancing act when discussing cultural tendencies. Studies that tiptoe around cultural factors fail to generate focused, practical solutions, while those that over-discriminate can cross over into stereotyping territory. The majority of recent studies seem to fall into the former category, opting for 'safety', and calling for detailed studies by others. .
- Finally, it should be noted that whether and the extent to which culture is truly a factor in digital library usability is characterized as an open question by some (Caidi & Komlodi 2003), an inescapable fact by others (Barber & Badre 1998), and an underlying assumption by others. (Vöhringer-Kuhnt 2001)

Another issue, one that is specifically explored herein, is the difficulty of mapping identified cultural preferences to functional usability. [1] Even if one accepts the premise of a clear link between a user's culture and her perceived usability of technology, it is not necessarily a straightforward matter to translate subjective cultural observations into executable design principles that promote usability.

Some researchers discount the need for translation altogether. Barber & Badre (1998), for example, argue that the concepts of culture and usability are merged together into a unified concept termed 'culturability', and can be readily operationalized by identifying 'cultural markers' in interface design. Such approaches, however, fail to recognize the full depth and complexity of culture. As expressed by Duncker, Theng and Mohd-Nasir

(2000), "Culture is not a monolithic block. It differentiates into subcultures. Cultures can also overlap." The same authors seem to fail to recognize this later in their own paper, though, by expressing the likelihood of a direct connection between colors worn by study participants of a particular culture, and their color preferences for Web interfaces. Such unsubstantiated correlations promote oversimplification of the issues at best, and can lead to incorrect conclusions at worst.

Recognizing the need for a model that explains and predicts the relationship between culture and usability, Vöhringer-Kuhnt (2001) proposed the use of established cultural variables as predictors of a user's attitudes towards usability. Utilizing the five dimensions of culture identified by noted Dutch anthropologist Geert Hofstede (power distance; collectivism; gender roles; uncertainty avoidance; time orientation), he tested their value as an operational framework for global HCI design. This master's thesis paper is refreshing for its vigorously empirical approach, and for its candor about failing to find strong correlation between Hofstede's cultural factors and perceived usability.

Premise and proposal

This paper accepts the premise of a relationship between culture and usability, but holds that the connection between the two is a complex, often indirect one. As identified by Vöhringer-Kuhnt (2001), a means for 'operationalizing' the link between culture and usability is needed. In order for cross-cultural digital library research to progress beyond the study of objective, technology-layer issues, a framework is needed for discussing and evaluating subjective cultural factors in a deeper, more systemic way. Cognitive/educational theory is proposed and explored herein as a possible means for achieving this functionality.

While an extensive review of the literature reveals this proposition to be unique, the idea finds its roots by uniting the observations of several other researchers:

Useful connections exist between the fields of multicultural education and digital library design.

Fox *et al.* (2002) discuss the connection between education and global digital libraries in depth, citing both the need to transform educational prac-

tice to meet an international audience, and the role digital libraries can play in that educational transformation. Adams, Blandford & Lunt (2005, 176) also identify this link between culture, learning and digital library design, noting that knowledge acquisition has "a social element which is often ignored." Although the authors were exploring the relationship between digital libraries and organizational 'communities of practice', their observations apply equally to international communities; culture is not defined by national boundaries, and cross-cultural issues can arise within nations, between organizations, or even between academic fields.

Premise: Effective cross-cultural digital library design provides alternative modes of access. Multiple modes of access are essential for serving individual preferences, as well as cultural preferences.

Komlodi, Caidi and Wheeler (2004) delineate four criteria for evaluating the cross-cultural usability of digital libraries. Of these, two are objective factors that have been explored extensively (supporting multilingual access; promoting universal interface design) and the third one is self-evident, if difficult to achieve (avoiding subjective bias in content selection and representation). The fourth criterion, that of providing alternative content organization and access schemes, appears to have been less frequently explored by researchers. This last usability criterion is emphasized by Hodge (2000), who points out that knowledge organization systems are reflective of their culture, and impose a "particular view of the world on a collection and the items in it." Importantly, she also cites this as a reflection of individual tendency, that "people perceive the world through many modes", and that "some people comprehend information more easily in one mode than another."

The subjective dimensions of cross-cultural usability, then, can be treated from the perspectives of educational theory and individual learning preferences. This approach holds particular appeal in that it recognizes that "access to a digital library should result in the presentation of a context that meets not only cultural expectations, but also personal preference expectations." (Fox *et al.* 2002) All three elements – cultural influence, individual knowledge acquisition and multiple information 'access points' – are brought together in a widely

recognized cognitive theory known as Multiple Intelligences. This paper explores the possible application of multiple intelligence theory as a framework for exploring the cross-cultural usability of digital libraries.

Multiple intelligences theory

A brief introduction

Howard Gardner is a cognitive psychologist and professor of cognition and education at the Harvard Graduate School of Education. In 1983, he published *Frames of Mind: The Theory of Multiple Intelligences*, a book that transformed the fields of cognitive psychology and educational practice by challenging prevailing, widely accepted views on cognition and learning. Rather than considering intelligence as a monolithic entity, Gardner posits that people perceive the world through multiple modes of interpretation and inquiry.

Each identified 'intelligence' is distinguished from the others based on neurological, biological and cross-cultural evidence (Gardner 2004, xxvii), yet the entire theory is presented solely as a descriptive scientific construct. As Gardner puts it, "these intelligences are fictions – at most, useful fictions – for discussing processes and abilities that (like all of life) are continuous with one another" (2004, 70). The intelligences don't exist as independent, isolated entities – they interrelate with each other, and ultimately don't exist at all. They do, however, provide an important vehicle for describing and understanding individual and cultural differences in our approach to the world.

Gardner's theory included seven discrete intelligences when first published in 1983: biological, logical-mathematical; linguistic-verbal; musical; spatial; bodily-kinesthetic; interpersonal and intrapersonal. He later added environmental/naturalist intelligence as an eighth cognitive mode, and has considered the possibility of additional intelligences, including existential and emotional intelligences (Gardner 1999, 47–66). As an initial framework proposal only, however, these additions are not included within the scope of discussion.

A key tenet of multiple intelligence theory (hereafter, 'MI theory') is that while all human beings possess, employ and can appreciate each of these

discrete intellectual modes, each individual is also a unique amalgam of intelligences, a distinctive construct of relative intellectual strengths and weaknesses. Further, while stressing that a person's 'MI profile' is not unalterable, cognitive research has shown that personal constructs are both well-developed and deeply entrenched by the end of early childhood (2004, xxxii).

Two important educational inferences are derived from this fuller view of human cognition. First, Gardner discounts the value of standardized intelligence tests, which emphasize only linguistic and logical-mathematical modes of inquiry, and typically display cultural bias. Second, different instructional approaches are better suited for different modes of intelligence.

In many ways, Gardner's theory closely resembles the multiple modes of perception and access to knowledge organization systems referred to by Gail Hodge (2000), and Gardner acknowledges a close relationship between his theory and discussions of learning styles. He states, "Without question, there will be overlap between these lists, and I may well be trying to get at some of the same dimensions as those in the 'styles' world", but defends his theory as unique in that cognition is described as a complex blend of various capacities, and as inseparable from the experiential/cultural content that surrounds a particular individual (2004, xxxv).

The cultural connection

This emphasis on a person's environs is central to MI theory. Gardner defines intelligence not in terms of raw capacity or mastery, but as "the ability to solve problems, or to create products, that are valued within one or more cultural settings" (2004, xxiv). An individual's spheres of knowledge are not developed within an internal cognitive vacuum, untouched by the objects, persons and events in one's environment. The different domains and disciplines valued by different cultures exert a tremendous influence over how one's intelligences develop, and to what extent they are mobilized. In the twenty-odd years since Gardner first published *Frames of Mind*, he has placed increasing emphasis on the role of culture, and he now cites adherence to the psychological theories of contextualization and distribution, both of which stress the inseparability of intellect from

one's cultural setting (2004, xxvii). Culture and intellect are individual constructs, yet each shapes and constrains the other. Gardner states that a major purpose of his work is to "inspire educationally oriented anthropologists to develop a model of how intellectual competences may be fostered in various cultural settings" (2004, 10), and cites his own desire to conduct future research into the "diverse contexts in which intelligences develop and of the ways in which they develop in those contexts." (2004, xxxvii)

Supporters and detractors

MI theory is not without detractors. In addition to equating his work with learning styles, critics also point to a lack of empirical validation, and question its real-world utility. Gardner addressed these and other criticisms in a 1995 defense of his theory, entitled "Reflections on Multiple Intelligences Myths and Messages".

Forging a connection between culture and intelligence also creates obvious opportunities for willful or unintentional misapplication of MI theory. Gardner expresses great consternation at the work of researchers who reference his theory in defense of racial or ethnic characterizations, and strongly condemns such work. Gardner's critics, however, argue that his work could not help but open the door to abuse of this sort.

MI theory has also won wide acceptance, particularly among educators, as a way to adapt teaching strategies to individual strengths. Emphasis is placed on provided multiple 'access points' to a subject – narration, pictorial, discussion, hands-on, etc. (Gardner 1999, 169–172). It has been widely applied in the design of school curriculums, museum design, software development and corporate training programs.

MI theory and digital library usability

To date, however, MI theory has not been comprehensively applied to digital library design issues. Can Gardner's theory provide a useful framework for understanding cross-cultural variables, and how they impact digital library usability? Caidi and Komlodi (2003) characterize culture as "a complex and shifty notion that is very hard to operationalize in practice." Can MI theory be 'operationalized' into working principles for digital

library design? If not, is it a useful model for understanding observations made in cross-cultural user studies?

This then, is the paper's central point of inquiry: To explore whether a) Gardner's theory of Multiple Intelligences can provide a useful framework in the study of cross-cultural usability of digital libraries, and b) whether it can also provide the field with a much-needed mechanism for implementing findings.

An ideal framework will:

- Move beyond the surface facets of cross-cultural digital library design, such as cultural color preferences and other interface design elements, to a deeper, fuller appreciation of the complex relationship between user and digital library.
- Consider differences in individual and cultural behavior in the same light, differentiating without discriminating. It will facilitate practical digital library design solutions that recognize the complexity of human beings, and the complexity of their relationship with their surroundings. It will afford consideration of both individuals and cultures as fluid, ever-evolving entities.
- Achieve a balance between localization and globalization of design, facilitating usability across cultures, and allowing digital libraries to fulfill their primary mission as vehicles for learning.

In the sections that follow, each of the cognitive intelligences identified by Gardner are introduced briefly, placed in a cultural context, and then discussed in terms of possible application to global digital library research and design. Not all of the identified intelligences are equally suited for application in a digital environment; for this reason, some will be treated in greater detail than others. Still, far from being a barrier to effective learning, digital library technology affords new and innovative ways to support multiple modes of learning. Multiple intelligence theory has long been applied in physical classroom environments; now, digital libraries present a unique opportunity to support knowledge acquisition modes on an international scale. As Gardner points out, future developments in computer technology may well be developed that will eventually facilitate all modes of intelligence, supporting "learning and mastery in the full gamut of intellectual domains (2004, 391). This is the promise of future digital libraries, if cross-cultural usability issues can be successfully addressed.

MI theory and digital library usability

Linguistic intelligence

Linguistic intelligence is characterized by the use and comprehension of language, in both its written and oral forms. As human beings, we are able to perceive subtle shades of meaning in a writer's choice of individual words. As words are combined, we are also able to assess the interrelation of words; we can recognize the phonology of sounds, and examine both the semantic intentions and syntactic constructions underlying linguistic communications. Ultimately, language is a tool that transcends lexical particularities. Long after the words are forgotten, the ideas and emotions communicated remain with us. Linguistic intelligence provides us with the capacity to inform, to remember, to explain, to convince, and to even reflect on language itself. It is perhaps the most closely studied of all intelligences, and is closely intertwined with all other identified intelligences.

Linguistic intelligence, while universal, manifests itself differently across cultures, particularly in a culture's emphasis on oral versus written expression of language. Traditional cultures may place greater emphasis on verbal communication – on oral traditions and rhetorical skills, while other cultures place greater relative value on the written word. As Gardner notes, while "oral and written forms of language doubtless draw on some of the same capacities, specific additional skills are needed to express oneself appropriately in writing (2004, 95). Contextual features of oral conversation, including gestures and vocal inflection, are lacking in written communication, and therefore must be supplanted in other ways. Further, the cognitive faculties drawn upon for written communication can differ across cultures. Ideographic writing systems have been demonstrated to utilize different areas of the brain than phonologically based writing systems. All of these factors hold implications for digital libraries and the presentation of information to a global audience.

Digital libraries can better serve a global audience by supporting a wider range of linguistic communication modes and providing a wider variety of content access mechanisms. The importance of this is underscored by Duncker's 2002 case study of Maori culture, and the challenges they face when interacting with digital libraries.

As she observes (2002, 224), "cultures that traditionally transfer knowledge in an oral fashion often embed their knowledge in stories, songs, artifacts and rituals." Knowledge was historically transferred orally, and still reflects itself today in a Maori preference for face-to-face communication and a discomfort with the formal classification systems of digital libraries. Where appropriate and possible, a greater use of visual and audio communication tools may better support cultures that emphasize the spoken word. While textual communication will always play a central role in digital library design, an enhanced use of multimedia may raise satisfaction levels and perceived usability of cross-cultural users. Because knowledge organization systems reflect a primarily Western understanding of subject classification and publication formats, Duncker (2002, 229) also recommends search mechanisms that use natural language, and local phrases whenever possible.

Multilingual challenges of digital libraries are most often considered in a technical light, but extend well beyond the issues of translation and international character recognition. Ideas can never be fully separated from the language in which they are first communicated, and can never be perfectly expressed in another language. Any translation inevitably results in subtle shifts in meaning. Vladimir Nabokov, the preeminent 20th century author, wrote in three different languages (French, English and Russian), and often commented on the expressive differences between them. As much as he treasured the English language, he (1955, 335) sometimes expressed regret about the expressive limitations it posed, seeing his native language as his "untrammelled, rich, and infinitely docile Russian tongue." While digital libraries will never resolve the inherent imperfections of multilingual translation, supplying users with content in a wider range of media formats may better convey an author's original intent.

Musical intelligence

Musical intelligence is our human capacity to perform, compose and appreciate the tones, rhythms and melodies of organized sound. Cognitive studies have established it as a neurologically distinct mechanism from that of linguistic communication; indeed, musicians alternately describe (Gardner 2004, 101–102) their capacities as a form of "mu-

sical logical thinking", the "musical mind" or the "aural imagination." Often referred to as a language, music provides human beings with a profound form of personal expression, one that communicates the innermost essence of our experiences and emotions, yet defies direct translation or interpretation in a linguistic sense. Like linguistic competence, musical intelligence is notable for not being dependent upon external objects – one's musical capabilities can be explored solely through an individual's oral and aural senses.

Musical intelligence is innate in all of us, yet evidence suggests it relies heavily on early cultivation and immersion during childhood years. Musical intelligence may not be dependent upon one's cultural environment for its existence, but is heavily shaped and influenced by it. Musical talent is emphasized to varying degrees in different cultures. In certain societies it is a highly valued, essential social skill, while in Western culture, Gardner (2004, 109) notes that music "occupies a relatively low niche...and so musical illiteracy is acceptable." Qualitative aspects of music are emphasized to varying degrees in different cultures, a fact that is borne out in the resulting sound. The music of certain cultures places emphasis on pitch variation, while others emphasize rhythmic development. The acquisition of musical competence is approached differently in different cultures as well – some support intuitive, immersive musical development, while others stress formal training. Different cultures can also hold dramatically different understandings and attitudes towards how music 'fits' with society and relates towards one's world. Individual performance, for example, is more heavily emphasized in certain societies, and conceptualizations about an individual's role in the creation and ownership of music can also differ widely.

This multicultural perspective of musical intelligence is particularly relevant to the design of digital audio collections and services. Even domestic ethnographic studies of music information-seeking behavior suggest that musical genres are difficult for users to identify (Cunningham, Reeves and Britland 2003, 14–15). Digital library designers should consider how culture plays a role in user identification of musical genres, and which music attributes best support searching and browsing activities across cultures. Developing digital library technologies that support queries

on rhythm and pitch may better serve a global audience.

Users from different cultures may also have different ways of listening to and interpreting music. Understanding these differences in music comprehension has educational implications for digital libraries, pointing to how they can more effectively relate cultural heritage information: what music tells us about an originating culture, how a culture influences musical history and developments, and how musical cultures influence and interact with each other.

Logical-mathematical intelligence

Logical-mathematical intelligence derives from our interactions with the objects that surround us. It reflects our ability to observe behaviors and actions in our environment, and then employ logical reasoning to make deductions and predictions about those behaviors. From earliest childhood, we learn that certain simple rules of logic apply to the world. As we grow, our abilities to reason grow both more complex and more abstract. In the sciences, which seek to explain natural phenomena, these chains of reasoning always remain grounded in our physical surroundings. In the higher branches of mathematics, however, reasoning can grow increasingly remote from the immediate physical world.

All societies universally possess and utilize logical-mathematical intelligence; indeed, it has been referred to as "the glue that holds together all cognition" (Gardner 2004, 134). All cultures have also developed logical-mathematical capabilities that move beyond simple observations of the physical world to the realm of abstraction. In traditional societies, numerical abilities and logical thinking are highly developed, often in extraordinary ways, but still remain grounded in functions of day-to-day importance within the culture. Western society, however, has been peculiar in its relentless development of a formalized, higher realm of operational thought, creating a field of study that has grown increasingly abstract and arcane, requiring a steady accumulation of knowledge from generation to generation. This knowledge, though one of Western society's highest accomplishments, is not necessarily directly relevant to its cultural milieu, or to the primary functions of everyday life.

Gardner notes that “logical-mathematical intelligence has been of singular importance in the history of the West”, yet also observes that this high valuation on the advancement of a single capacity may possibly come at the expense of others (2004, 167, 164). While all cultures embrace a uniquely human ability to believe in a non-rational, as well as a rational world, the West’s rigorous emphasis on the principles of logic and demonstration has created a culture that differs markedly from others in its willingness to continually challenge itself and its view of the world. These differences are reflected “in the ways in which individuals think about themselves and in how they communicate with other people” (2004, 164).

Digital library technology is grounded in a computational tradition that reflects specific logical techniques and assumptions. Users of a digital library, though, may share very different visions about information, the way it is logically presented, and how to interact with it. For example, Marcus and Gould (2000) observe different cultural preferences in the structure of information organization. Some cultural groups express a preference for highly structured information and ‘tall’ information access hierarchies, while others prefer more shallow structures and interfaces. These preferences can sometimes express themselves paradoxically. Duncker, Theng and Mohd-Nasir (2000), encountered cultural user groups that resisted any tailoring of digital library design to their needs, seeing the challenges they encountered with existing (Western) systems as a kind of technical ‘badge of honor’. Vöhringer-Kuhnt (2001) found similarly varying cultural attitudes towards the relative value of a system’s ease of use.

Spatial intelligence

Like logical-mathematical intelligence, spatial intelligence is centrally associated with interpretation and understanding of the objects in one’s environment. It is the capacity to correctly perceive aspects of the physical world, and the ability to perform accurate mental transformations upon that perception, even when the physical object is no longer available for reference. Although heavily reliant on visual stimuli, spatial intelligence also involves a separate sensory element; lack of vision does not preclude an individual from pos-

sessing and exploiting spatial intelligence. Spatial intelligence is a central aspect of problem solving – individuals often formulate mental solutions before affecting the solution in the real world.

Spatial intelligence manifests itself in many ways, ranging from the ability to navigate one’s environment, to interpret two-dimensional representations, to appreciate and/or create art, and to play spatially oriented games. Spatial abilities are greatly valued greatly in all cultures, although the specific manner in which it is developed and applied will vary according to the activities deemed essential in that society. Gardner describes a wealth of extraordinary examples, from the ability of Eskimos to navigate seemingly featureless terrain, of African tribes to derive to the ability of mariners to navigate by the alignment of stars. Spatial thinking also plays an important role in many branches of science. Despite this wide range of applications, Gardner sees spatial processing as “operating in essentially similar form across diverse cultures, and as relatively resistant to cultural molding”, when compared to the other identified intelligences (2004, 274).

This view is not universally shared. Cognitive research into spatial usability has gained significant by designers of digital libraries, particularly libraries that specialize in geographic information. Montello *et al.* (1998) pose a number of questions relevant to the cross-cultural usability of geographic information systems, including:

How do humans learn geographic information, and how does this learning vary as a function of the medium through which it occurs (direct experience, maps, descriptions, virtual systems, etc.)? What are the most natural and effective ways of designing interfaces for geographic information systems? How do people develop concepts and reason about geographical space, and how does this vary as a function of training and experience? Given the ways people understand geographic concepts, do some models for representing information in digital form support or hinder the effective use of that information? How do people use and understand language about space, and about objects and events in space? How can complex geographical information be depicted to promote comprehension and effective decision-making, whether through maps, models, graphs, or animations? How and why do individuals differ in their cognition of geographic information, perhaps because of their age, culture, sex, or specific backgrounds? Can geographic information technologies aid in the study of human cognition? How does exposure to new geographic information technologies alter human ways of perceiving and thinking about the world?

The authors' underlying belief that differences (including cross-cultural differences) in spatial cognition impact the usability of geographic technology stands in interesting contrast to Gardner's views, and this may reflect an area of academic conflict. It is a topic deserving of further exploration, because of the resulting implications for digital library design. If, as Gardner posits, spatial intelligence is deployed similarly across all cultures, then spatial technologies (maps, virtual systems, models, graphs, navigation systems etc.) might be important tools for promoting universally accessible digital library design. If, on the other hand, spatial cognition differs across societies, culturally specific factors must be identified and addressed to ensure global usability. Marcus and Gould (2000)'s study, for example, suggests differing cultural attitudes towards interface asymmetry, density of content and number of choices. If digital library users perceive and move through virtual space in different ways, providing a variety of navigation modes may enhance cross-cultural usability.

Bodily-kinesthetic intelligence

Bodily-kinesthetic intelligence, like logical-mathematical and spatial intelligence, involves our relationship with physical objects and our physical environment. Gardner identifies two discrete capacities associated with bodily-kinesthetic intelligence – our ability to control our body's actions for personal expression or functional purpose, and our ability to manipulate objects in our environment in a skilled fashion. Many human pursuits, including athletics, dance and acting, require precise physical coordination and execution of movements. Other professions also require highly developed bodily-kinesthetic development, but in less obvious ways. Technicians, for example, may need to manipulate and rearrange materials with great dexterity and finesse.

Gardner acknowledges that some may initially reject the concept of a bodily intelligence, and attributes this as a reflection of current Western culture. In recent decades, Western society has increasingly compartmentalized the concepts of physical vs. intellectual pursuits, and has placed different cultural valuations on them. Although athleticism and other forms of physical prowess

are highly valued in our culture, they are also seen as separate and "somehow less privileged, less special" than academic pursuits (2004, 208). Some physical activities, such as dance, have reached the level of 'taboo' in Western society, particularly for young males, despite being an ancient, universal form of expression present in all cultures. These prevailing attitudes may even be subtly reflected in the way cognitive psychologists discuss motor control as involving "lower" functions of the brain cortex than "higher" thought processes (Gardner 2004, 210).

This disconnected view of the physical and mental realms is not shared across all cultures, however, and Gardner invites us to question the distinction as a "universal imperative" (2004, 208). Indeed, few if any activities in any culture are completely reliant on just a single intelligence, and many incorporate bodily-kinesthetic intelligence along with the use of other cognitive facilities, such as spatial, or logical-mathematical intelligence.

It is not immediately clear how an understanding of differing cultural conceptions of bodily intelligence might translate into enhanced usability principles for digital library design. As virtual environments, digital libraries are already several steps removed from the physical realm. Recognition that physical skills are emphasized in a greater degree in some societies may perhaps suggest the use of greater manipulation activities in digital libraries – the ability to virtually move objects, and recombine them in ways that supports usability, learning and the communication of ideas.

Ultimately, cultural bias in bodily-kinesthetic intelligence is inescapable in digital library design, because of assumptions – largely Western – inherent in the underlying technology. Digital libraries are accessed via personal computers, which require highly specialized kinesthetic skills (i.e., mouse manipulation, keyboarding skills and use of other input/output devices). Even proficient computer users can gain new appreciation for these assumptions by attempting to use an unfamiliar, international keyboard layout. Efficiency, effectiveness and satisfaction with a digital library experience are all negatively impacted by the frustrations of using unfamiliar technology. Digital library designers therefore need to consider how to better support users with varying computing proficiencies.

Interpersonal / intrapersonal intelligence

Gardner identifies two discrete capacities related to personal intelligence, an intrapersonal intelligence that looks inward to a person's internal feelings, and an interpersonal intelligence that reflects outwardly upon the feelings and personalities of other individuals. While identifying them as separate cognitive activities, he acknowledges the relationship between the two is so connected as to be inseparable. One's self-knowledge is dependent upon one's interactions with others, and a person's relationships with other individuals are drawn from one's internal existence. Gardner therefore treats both intelligences jointly, and the same is done herein.

In addition to wielding great influence on each other, the two personal intelligences are in turn immensely impacted by the culture in which an individual is raised and resides. One's culture provides the interpretive systems and nurturing that shape how individuals view their inner self, their role in the community, and the balance between the two. Gardner notes that of all the identified intelligences, the personal intelligences display the greatest variety of forms, and are most impacted by one's social environment: "While the forms of spatial or bodily-kinesthetic intelligence are readily identified and compared across diverse cultures, the varieties of personal intelligence prove much more distinctive, less comparable, perhaps even unknowable to someone from an alien society." (2004, 240)

In particular, cultures differ in their relative emphases on personal self vs. social self. Western society is known for being a highly individualistic culture; in contrast, Hindu culture eschews the assertion of personal self over one's outward role in the community. In between these two extremes, some cultures emphasize balance between the two personal intelligences, while others develop segregated, compartmentalized roles for the two selves. Furthermore, different cultures place different emphases on the extent to which one personal intelligence can assert itself over the other; some societies see intrapersonal self as being under the power and control of greater society, while others (including Western culture) believe personal self has the free will to influence and even change the world.

The personal intelligences are perhaps the most significant in terms of potential impact on the cross-

cultural usage of digital libraries. Indeed, without understanding the personal intelligences, it is "difficult to understand the goals of many cultures, and the ways in which these goals are achieved" (Gardner 2004, 241). Despite this importance, they've attracted scant attention from cognitive researchers (Gardner 2004, 241). They do, however, figure centrally among cultural theorists. According to noted Dutch anthropologist Hofstede, for example, cultures vary along five primary dimensions:

- Power distance (authority structures and hierarchies)
- Collectivism vs. individualism
- Gender roles
- Uncertainty avoidance
- Long-term vs. short term orientation

Hofstede's theory has gained wide acceptance among anthropologists, and has been proposed as a framework for cross-cultural HCI design (Vöhringer-Kuhnt 2001; Marcus and Gould 2000). For this reason, it must be considered as a possible alternative to MI theory, for approaching cross-cultural digital library usability. Hofstede's dimensions, though, can all be seen as falling within the scope of Gardner's personal intelligences, suggesting that MI theory is the larger framework, and one that incorporates Hofstede's cultural variables.

As such, Hofstede offers a useful framework for specifically considering the personal intelligences and digital libraries. For example, a culture's authority structure (power distance), gender distinctions and emphasis on collectivism may all impact a user's comfort level with self-expression when using the collaborative, community-building tools of digital libraries. Uncertainty avoidance may impact a user's willingness to challenge presented viewpoints, or experiment with open-ended digital library activities. Time orientation may affect a user's patience in achieving goals and completing tasks, or influence the perceived credibility of digital library materials. A heightened sensitivity towards these interpersonal / intrapersonal factors can lead to the design of more welcoming digital libraries, libraries that invite broad, distributed participation across cultural groups.

Conclusion

So – does Gardner's cognitive theory provide a useful framework for understanding cross-cultural variations, and how they impact digital library usage? Can MI theory be 'operationalized' into working principles for global digital library design?

The answers appear to be 'yes', and 'no', respectively.

MI theory does not map readily to digital library design principles, and not all of Gardner's identified intelligences have obvious implications for cross-cultural digital library usability. Relating MI theory to specific digital library design guidelines proved difficult at best, and yielded less than satisfying results. While rich in explanations of cultural diversity, MI theory doesn't easily translate into practical usability recommendations. The premise itself may be faulty, or may be missing some essential element not yet identified. Additional grounding in global HCI design and ethnographic research may be needed.

Gardner himself views multiple intelligence theory as a solely descriptive construct, not a prescriptive methodology, and has expressed surprise at the number of educational programs claiming to implement MI theory (although he also endorses many of them). Taking a closer look at these programs, they all clearly share an emphasis on multiple modes of knowledge acquisition. Gardner may justifiably distinguish his cognitive theory from the 'learning styles' field, but it is less clear whether educational programs based on his theory can claim the same.

MI theory's appropriate role may therefore be as a descriptive model for interpreting the underlying cultural and cognitive factors of cross-cultural usability. While not the solution-oriented route originally mapped out for the project, this is a far more satisfying and useful conclusion for the field, and one that the author believes merits further research. Cultural differences are difficult to discuss accurately and without bias; MI theory provides a useful scientific construct for identifying and evaluating qualitative cultural observations within an objective framework. When carrying out future cross-cultural user studies, digital library researchers may therefore wish to consider the incorporation of MI theory.

A practical framework is still needed to guide global digital library design, however. The ideal

framework will ideally incorporate findings from the fields of anthropology, cognitive psychology, education, user interface design and digital library development, and will map subjective dimensions of cross-cultural usability into operational design principles. Although this inquiry was ultimately not successful in identifying such a framework, it achieved success in recognizing the need for one and in clarifying the global usability challenges facing digital library design.

Exploration of these issues has also led to a deeper appreciation of the problem's complexity, and the need for additional research. The integration of cultural theory into human-computer interaction studies is still a relatively new area of study. As cultural factors are better understood in relation to interactive technologies, global usability of digital libraries will no doubt improve.

Notes

1. Several researchers use the term 'operationalize' to refer to this mapping process; although not strictly a word in the English language, the term is adopted for use within this paper.

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Editorial history:
paper received 14 April 2006;
accepted 12 September 2006.